
# MANONMANIAM SUNDARANAR UNIVERSITY
# TIRUNELVELI – 12

## MODIFIED AND CORRECTED SYLLABUS
**(RECEIVED FROM CHAIRPERSON ON 16.10.2023.)**

# M.Sc BOTANY

## TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION, CHENNAI – 600 005

## FROM THE ACADEMIC YEAR 2023 – 2024

**Contents**

## 1. Introduction: PO & PSO

**Programme Outcome, Programme Specific Outcome and Course Outcome**

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

| **TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION** | |
|---|---|
| **Programme** | **M.Sc. Botany** |
| **Programme Code** | |
| **Duration** | **PG - 2 years** |
| **Programme Outcomes (Pos)** | **PO1: Problem Solving Skill**<br>Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.<br>**PO2: Decision Making Skill**<br>Foster analytical and critical thinking abilities for data-based decision-making.<br>**PO3: Ethical Value**<br>Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.<br>**PO4: Communication Skill**<br>Ability to develop communication, managerial and interpersonal skills.<br>**PO5: Individual and Team Leadership Skill**<br>Capability to lead themselves and the team to achieve organizational goals.<br>**PO6: Employability Skill**<br>Inculcate contemporary business practices to enhance employability skills in the competitive environment.<br>**PO7: Entrepreneurial Skill**<br>Equip with skills and competencies to become an entrepreneur.<br>**PO8: Contribution to Society**<br>Succeed in career endeavours and contribute significantly to society.<br>**PO 9 Multicultural competence**<br>Possess knowledge of the values and beliefs of multiple cultures and a global perspective.<br>**PO 10: Moral and ethical awareness/reasoning**<br>Ability to embrace moral/ethical values in conducting one's life. |
| **Programme Specific Outcomes (PSOs)** | **PSO1 – Placement**<br>To prepare the students who will demonstrate respectful engagement with others' ideas, behaviours, beliefs and apply diverse frames of reference to |

| | |
|---|---|
| | decisions and actions.<br>**PSO 2 - Entrepreneur**<br>To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate start-ups and high potential organizations.<br>**PSO3 – Research and Development**<br>Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.<br>**PSO4 – Contribution to Business World**<br>To produce employable, ethical and innovative professionals to sustain in the dynamic business world.<br>**PSO 5 – Contribution to the Society**<br>To contribute to the development of the society by collaborating with stakeholders for mutual benefit. |

**Component wise Credit Distribution**

| Credits | Sem I | Sem II | Sem III | Sem IV | Total |
|---|---|---|---|---|---|
| Part A | 14 | 14 | 19 | 17 | **64** |
| Part B Discipline Centric / Generic Skill | 6 | 6 | 3 | 3 | **18** |
| Soft Skill | - | 2 | 2 | 2 | **06** |
| Summer Internship / Industrial training | - | - | 2 | - | **02** |
| Part C | - | - | - | 1 | **01** |
| **Total** | **20** | **22** | **26** | **23** | **91** |

A component and Part B (i) will be taken into account for CGPA calculation for the post graduate programme and the other component Part Band Part C have to be completed during the duration of the programme as per the norms, to be eligible for obtaining PG degree.

**Written Examination: Theory Paper (Bloom's Taxonomy based)**
**Question paper Model**

1. **Testing Pattern (25 +75)**
   Internal - 25 marks
   External - 75 marks

2. **Internal Assessment**
   Internal – 25 marks

**Theory Course:**

For theory courses there shall be three tests conducted by the faculty concerned and the average of the best two can be taken as the Continuous Internal Assessment (CIA) for a maximum of 15 marks. The duration of each test shall be one/one and a half hour.

| | |
|---|---|
| Continuous Internal Assessment | 15 marks |
| Seminar | 5 marks |
| Assignment | 5 marks |

**For theory Papers:**

Part A 15 X 1 = 15 Marks - Answer all questions (No choice)
Part B 5 X 4 = 20 Marks - Choosing either (a) or (b)
Part C 5 X 8 = 40 Marks - Choosing either (a) or (b)
**Total = 75 marks**

**Laboratory Courses:**

Internal - 50 marks
External - 50 marks

For Laboratory Courses, there shall be Continuous Internal Assessment Test and Record. One test in Laboratory part, attendance and class participation.

The CIA for a maximum of 50 marks. The duration of each test shall be 3 hours

| **Methods of Evaluation Practical's (The existing pattern will be followed)** | | |
|---|---|---|
| Internal | Continuous Internal Assessment Test | 50 Marks |
| | Attendance and Class Participation | |
| External | End Semester Examination | 50 Marks |

There is no improvement for CIA of both theory and laboratory, and, also for University End Semester Examination.

***As per the final template received from the TANSCHE for PG Programmes Professional Competency Course is not included for PG first semester – #MSU**

| **Programme: M.Sc. Botany :** | **Duration: 2 years** |
|---|---|
| **Programme outcomes (PO)** | |
| The M.Sc. Botany program is designed to achieve the following objectives | |
| PO 1 | To impart knowledge on the fundamental, advanced and emerging concepts in Botany. |
| PO 2 | To provide up-to-date theoretical knowledge on various forms of plants, their interactions with biotic and abiotic entities in the ecosystem and relevant practical skills. |
| PO 3 | To comprehend and interpret various facets of Botany including the importance and judicious utilization of plant sources. |

| | |
|---|---|
| PO 4 | To address various critical issues in conserving the biodiversity with special reference to economically important plants and the plants listed in RED data. |
| PO 5 | To understand the principles and applications of various traditional and modern techniques used in Botany. |
| PO 6 | To disseminate knowledge on the design and execution of experiments in Botany with emphasis on the operation of relevant sophisticated instruments. |
| PO 7 | To impart knowledge on the economic importance of plant/microbial resources and their products and to promote entrepreneurship skill. |
| **PO 8** | To promote proficiency in designing the research problems, review of literature, laboratory experiments, data analyses and preparation of reports with professional ethics. |
| **PO 9** | To motivate the students to take up innovative and cutting-edge research in frontier areas of Botany and related biology subjects. |
| **PO 10** | To enable the students to take up various qualifying examinations concerning Botany and to face the challenges in career opportunities. |

**Program Specific Outcomes (PSO)**

| On successful completion of the M.Sc. Botany program, the students are expected to | |
|---|---|
| **PSO1** | Familiarize with the fundamental, advanced and emerging concepts in Botany. |
| **PSO2** | Understand the role of plants and their interactions with other organisms in various ecosystems. |
| **PSO3** | Identify the potency of plant resources in contemporary research and visualize future thrust areas in Botany. |
| **PSO4** | Design scientific experiments independently and to generate useful information to address various issues in Botany. |
| **PSO5** | Acquire basic knowledge on principles and applications of laboratory instruments and adequate skills to handle them. |
| **PSO6** | Choose and apply appropriate tools, techniques, resources, etc. To perform various experiments in Botany. |
| **PSO7** | Carryout scientific experiments independently or in collaboration with inter-disciplinary or multidisciplinary approaches. |
| **PSO8** | Disseminate knowledge on conservation of biodiversity and protection of environment. |
| **PSO9** | Awareness on the sustainable utilization of plant/microbial resources following the bioethical norms. |
| **PSO10** | Demonstrate proficiency in communicating with various stakeholders like students, teachers, scientists and society. |

## Template for P.G., Programmes – Botany 2023 – 2024

| Semester–I | Credit | Hours | Semester-II | Credit | Hours | Semester-III | Credit | Hours | Semester–IV | Credit | Hours |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.1 Core-I | 5 | 7 | 2.1. Core - V | 4 | 5 | 3.1. Core-X | 4 | 5 | 4.1 Core-XVI | 5 | 5 |
| 1.2 Core-II | 5 | 7 | 2.2 Core - VI | 4 | 5 | 3.2 Core-XI | 4 | 5 | 4.2 Core-XVII | 5 | 5 |
| 1.3 Core III - Laboratory Course - 1 | 2 | 3 | 2.3 Core – VII | 4 | 5 | 3.3 Core –XII | 4 | 5 | 4.3 Core XVIII– Laboratory course- 7 | 2 | 2 |
| 1.4 Core IV – Laboratory Course - 2 | 2 | 3 | 2.4 Core VIII - Laboratory Course - 3 | 2 | 3 | 3.4 Core XIII Laboratory course- 5 | 2 | 2 | 4.4 Core XIX– Laboratory course- 8 | 2 | 2 |
| 1.5 Discipline Centric Elective - I | 3 | 5 | 2.5 Core IX - Laboratory Course - 4 | 2 | 3 | 3.5 Core XIV Laboratory course- 6 | 2 | 2 | 4.5. Core - XX Project with Viva Voce | 4 | 8 |
| 1.6 Generic Centric Elective - II | 3 | 5 | 2.6 Discipline Centric Elective – III | 2 | 3 | 3.6 Core –XV | 4 | 5 | 4.6 Elective – VI (Industry / Entrepreneurship) 20% Theory 80% Practical | 2 | 4 |
| | | | 2.7 Generic Centric Elective IV | 2 | 3 | 3.7 Discipline Centric Elective – V | 2 | 3 | 4.7 Skill Enhancement course III / Professional Competency Skill | 2 | 4 |
| | | | 2.8 SEC I | 2 | 3 | 3.8 SEC -II | 2 | 3 | 4.8. Extension Activity | 1 | - |
| | | | | | | 3.9 Internship/ Industrial Activity | 2 | - | | | |
| | **20** | **30** | | **22** | **30** | | **26** | **30** | | **23** | **30** |
| | | | | | | | | | **Total Credit Points** | **91** | |

**Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credits and Hours Distribution System for all Post – Graduate Courses including Lab Hours**

**First Year - Semester - I**

| Part | Courses | Credit | No. of Hours |
|---|---|---|---|
| | 1.1 Core-I | 5 | 7 |
| | 1.2 Core-II | 5 | 7 |
| | 1.3 Core III - Laboratory Course - 1 | 2 | 3 |
| | 1.4 Core IV – Laboratory Course - 2 | 2 | 3 |
| | 1.5 Elective - I | 3 | 5 |
| | 1.6 Elective - II | 3 | 5 |
| | | **20** | **30** |
| **Semester - II** | | | |
| Part | **Courses** | **Credit** | **No. of Hours** |
| | 2.1. Core - V | 4 | 5 |
| | 2.2 Core - VI | 4 | 5 |
| | 2.3 Core – VII | 4 | 5 |
| | 2.4 Core VIII - Laboratory Course - 3 | 2 | 3 |
| | 2.5 Core IX - Laboratory Course - 4 | 2 | 3 |
| | 2.6 Elective – III | 2 | 3 |
| | 2.7 Elective IV | 2 | 3 |
| | 2.8 Skill Enhancement course I | 2 | 3 |
| | | **22** | **30** |
| **Second Year – Semester - III** | | | |
| Part | **Courses** | **Credit** | **No. of Hours** |
| | 3.1. Core-X | 4 | 5 |
| | 3.2 Core-XI | 4 | 5 |
| | 3.3 Core –XII | 4 | 5 |
| | 3.4 Core XIII Laboratory course- 5 | 2 | 2 |
| | 3.5 Core XIV Laboratory course- 6 | 2 | 2 |
| | 3.6 Core –XV | 4 | 5 |
| | 3.7 Elective – V | 2 | 3 |
| | 3.8 Skill Enhancement course - II | 2 | 3 |
| | 3.9 Internship/ Industrial Activity | 2 | - |
| | | **26** | **30** |
| | **Semester - IV** | | |
| Part | **Courses** | **Credit** | **No. of Hours** |
| | 4.1 Core-XVI | 5 | 5 |
| | 4.2 Core-XVII | 5 | 5 |
| | 4.3 Core XVIII– Laboratory course - 7 | 2 | 2 |
| | 4.4 Core XIX–Laboratory course - 8 | 2 | 2 |
| | 4.5. Core – XX Project with Viva Voce | 4 | 8 |
| | 4.6 Elective – VI | 2 | 4 |
| | 4.7 Skill Enhancement course III / Professional Competency Skill | 2 | 4 |
| | 4.8. Extension Activity | 1 | - |
| | | **23** | **30** |
| | **Total Credits for PG Courses** | **91** | |

Credit Distribution for PG Programmes - Semester wise papers – Botany - 2023 – 2024

| Course Name | | Lecture & Tutorial Hours Per week<br>1 contact hour = 1 credit | Credits |
|---|---|---|---|
| **SEMESTER 1** | | | |
| **CORE** | Core I Plant Diversity - I: Algae, Fungi, Lichens and Bryophytes | 7 | 5 |
| | Core II Plant Diversity - II: Pteridophytes, Gymnosperms and Paleobotany | 7 | 5 |
| | Core III - Laboratory Course - 1: Covering Core Paper - I | 3 | 2 |
| | Core IV – Laboratory Course – 2 Covering Core Paper - II | 3 | 2 |
| **Elective I** (Generic Discipline-Centric) | EG1: (One from each Group A)<br>1. Microbiology, immunology and plant pathology | 5 | 3 |
| | 2. Conservation of natural resources and policies | | |
| | 3. Mushroom cultivation | | |
| | 4. Phytopharmacognosy | | |
| **Elective II** (Generic Discipline-Centric) | ED1: (One from each Group B)<br>1. Algal Technology | 5 | 3 |
| | 2. Ethnobotany, naturopathy and Traditional Healthcare | | |
| | 3. Horticulture | | |
| | 4. Herbal Technology | | |
| | **Total** | **30** | **20** |
| **SEMESTER 2** | | | |
| **CORE** | Core V Taxonomy of Angiosperms and Economic Botany | 5 | 4 |
| | Core VI Plant Anatomy and Embryology of Angiosperms | 5 | 4 |
| | Core VII Ecology, phytogeography, Conservation Biology and Intellectual property rights | 5 | 4 |
| | Core VIII - Laboratory course - 3 Covering Core Paper V | 3 | 2 |

| | | | |
|---|---|---|---|
| | Core IX - Laboratory course - 4<br>Covering Core Papers VI and VII | 3 | 2 |
| **Elective III** (Generic Discipline-Centric) | EG2: (One from each Group C)<br>1.Medicinal Botany (or) | 3 | 2 |
| | 2.Phytochemistry | | |
| | 3. Research methodology, computer applications & bioinformatics | | |
| | 4. Biopesticide Technology (4) | | |
| **Elective IV** (Generic Discipline-Centric) | ED2: (One from each Group D)<br>1. Applied bioinformatics<br>2. Biostatistics<br>3. Intellectual Property Rights<br>4. Nanobiotechnology (4) | 3 | 2 |
| **Skill Enhancement Course I** | SEC1 Agriculture and Food Microbiology | 3 | 2 |
| | **Total** | **30** | **22** |
| **SEMESTER 3** | | | |
| **CORE** | Core X Cell and Molecular Biology | 5 | 4 |
| | Core XI Genetics, Plant Breeding & Biostatistics | 5 | 4 |
| | Core XII Recombinant DNA technology and industrial applications | 5 | 4 |
| | Core XIII - Laboratory course - 5<br>Covering Core Papers X and XII | 2 | 2 |
| | Core XIV- Laboratory course - 6<br>Covering Core Paper XI | 2 | 2 |
| **Industry Module** | Core –XV Industrial Botany: | 5 | 4 |
| **Elective V** (Generic Discipline-Centric) | EG3: (One from Group E) (4)<br>1. Secondary Plant Products and Fermentation Biotechnology<br>2. Entrepreneurial Opportunities in Botany<br>3. Applied plant cell & tissue culture<br>4. Silviculture and Commercial Landscaping (4) | 3 | 2 |
| **Skill Enhancement** | SEC2 Seminar paper (Open Choice)<br>Professional Communication Skill (2) | 3 | 2 |

| | | | |
|---|---|---|---|
| **Course II** | | | |
| | Internship/Industrial Activity (Carried out in Summer Vacation at the end of I year– 30 hours) | - | 2 |
| | **Total** | **30** | **26** |
| **SEMESTER 4** | | | |
| **CORE** | Core XVI Plant Physiology and Plant metabolism | 5 | 5 |
| | Core XVII Biochemistry & Applied Biotechnology | 5 | 5 |
| | Core XVIII– Laboratory course – 7 Covering Core Paper XVI | 2 | 2 |
| | Core XIX–Laboratory course- 8 Covering Core Paper XVII | 2 | 2 |
| **Project** | Core – XX Project with Viva Voce | 8 | 4 |
| **Elective VI** (Generic or Discipline-Centric) | EG3: (One from Group F) (4)<br>1. Organic farming<br>2. Forestry and Wood Technology<br>3. Gene Cloning and Gene Therapy<br>4. Farm Sciences- Green Wealth | 4 | 2 |
| **Professional Competency / Skill Enhancement Course III** | SEC3<br>1. Training for Competitive Examinations<br>2. Botany for NET/UGC-SIR/SET/TRB competitive examinations (2 hours)<br>3. General Studies for UPSC/TNPSC/other competitive examinations (2 hours) or<br>4. Botany for Advanced Research (4 hours)<br>5. Naan Mudhalvan Scheme | 4 | 2 |
| | Extension activities | . | 1 |
| | **Total** | **30** | **23** |
| | **Total Credits** | | **91** |

**M.Sc. BOTANY CURRICULUM**
**CORE I - PLANT DIVERSITY – I: ALGAE, FUNGI, LICHENS AND BRYOPHYTES**

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

| **UNIT** | **CONTENTS** |
|---|---|
| **I** | **ALGAE:**<br>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). 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. Origin and evolution of sex in algae.<br>Structure, reproduction and life histories of the following genera: *Oscillatoria, Scytonema, Ulva, Codium, Diatoms, Dictyota* and *Gracilaria* |
| **II** | **FUNGI:**<br>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.<br>Heterothallism in fungi, sexuality in fungi, Parasexuality in fungi.<br>Structure, reproduction and life histories of the following genera: *Plasmodiophora, Phytophthora, Rhizopus, Polyporus* and *Colletotrichum.* |
| | **LICHENS:**<br>Introduction and Classification (Hale, 1969). Occurrence and inter-relationship of |

| | |
|---|---|
| **III** | phycobionts and mycobionts, structure and reproduction in Ascolichens, Basiodiolichens and Deuterolichens. |
| **IV** | **BRYOPHYTES:**<br>General characters and Classification of Bryophytes by Watson (1971). Distribution, Structural variations and evolution of gametophytes and sporophytes in Haepaticopsida, Anthoceropsida and Bryopsida, General characters of major groups - Marchantiales, Jungermaniales, Anthocerotales, Sphagnales, Funariales and Polytrichales. Reproduction - Vegetative and sexual, spore germination patterns in bryophytes.<br>Structure, reproduction and life histories of the following genera: *Targionia, Lunularia, Porella* and *Polytrichum.* |
| **V** | **ECONOMIC IMPORTANCE:**<br>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. Lichen –economic importance and as indicator pollution. Bryophytes – Ecological and economic importance – industry, horticulture and medicine. |

**Course Outcomes**

| CO | Course outcomes – on completion of this course, the students will be able to | Programme outcomes |
|---|---|---|
| **CO 1** | Relate to the structural organizations of algae, fungi, lichens and bryophytes | K1 |
| **CO 2** | Demonstrate both the theoretical and practical knowledge in understanding the diversity of basic life forms and their importance | K2 |
| **CO 3** | Explain life cycle patterns in algae, fungi, lichens and Bryophytes | K3 |
| **CO 4** | Compare and contrast the mode of reproduction in diverse groups of basic plant forms. | K4 |
| **CO 5** | Discuss and develop skills for effective conservation and utilization of lower plant forms | K5 & K6 |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved(To be discussed during the Tutorial hour) | |
| Skills acquired from this course | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | |

**Recommended texts**


1. Kumar, H.D.1999. Introductory Phycology. Affiliated East-WestPress,Delhi.
2. Barsanti, L. and Guadtieri, P. 2014. Algae: Anatomy, Biochemistry and Biotechnology, 2nd Edition, CRC Press, ISBN: 1439867321.

3. Sharma, O.P. 2011. Fungi and Allied Microorganisms, Mc Graw Hill, ISBN:9780070700383, 0070700389
4. Kevin K. 2018. Fungi biology and Application, 3rd Edition, Wiley Blackwell.
5. Pandey, P.B. 2014. College Botany-1: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. Chand Publishing, New Delhi.
**6.** Singh, Pandey and Jain. 2020. A text book of Botany, 5th Edition, Rastogi Publication, Meerut.
**7.** Sharma, O.P. 2014. Bryophyta, Mcgraw Hill, ISBN: 9781259062872, 1259062872

**Reference Books**

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

**Web resources**

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

**Mapping with Programme Outcomes:**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | 3 | 2 | 3 | 2 | 1 | 2 | 2 | 2 | 2 |
| **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)**

## CORE II- PLANT DIVERSITY – II : PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">PLANT DIVERSITY – II : PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="4">CORE II</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td>Credits</td><td>5</td><td>Course Code</td><td></td></tr>
<tr><td>Semester</td><td>I</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours Per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>2</td><td colspan="2">--</td><td colspan="2">7</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Students should know about the fundaments of Pteridophytes, Gymnosperms and fossil records</td></tr>
<tr><td colspan="2">Learning Objectives</td><td colspan="6">1. To investigate the classification, distinctive traits, distribution and reproduction and lifehistory of the various classes and major types of Pteridophytes and Gymnosperms.<br>2. To identify and characterize diversity of lower vascular plants in order to comprehend the dynamics of diversity to realize the importance of diversity.<br>3. To research the classification, phylogeny and economic importance of Pteridophytes and Gymnosperms.<br>4. To study and understand the phylogeny and Paleontology of Pteridophytes and Gymnosperms.<br>5. To learn about the concept of fossils and process of fossilization; distinctive characteristics of fossil records of Pteridophytes and Gymnosperms</td></tr>
<tr><td>UNIT</td><td colspan="7">CONTENTS</td></tr>
<tr><td>I</td><td colspan="7">PTERIDOPHYTES:<br>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, Economic importance of Pteridophytes.</td></tr>
<tr><td>II</td><td colspan="7">PTERIDOPHYTES:<br>Structure, anatomy, reproduction and life histories of the following genera: Selaginella, Isoetes, Equisetum Angiopteris, Pteris,Azolla and Marselia.</td></tr>
<tr><td>III</td><td colspan="7">GYMNOSPERMS:<br>General characters - A general account of distribution of Gymnosperms. Morphology, anatomy, reproduction, phylogeny and classification (K.R. Sporne, 1965). Economic importance of Gymnosperms.</td></tr>
<tr><td>IV</td><td colspan="7">GYMNOSPERMS:<br>Structure (Exomorphic and endomorphic), anatomy, reproduction and life histories of the following genera: Thuja, Cupressus, Araucaria, Podocarpus, Gnetum and Ephedra.</td></tr>
<tr><td>V</td><td colspan="7">PALEOBOTANY:<br>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.</td></tr>
</table>

**Course Outcomes**

| CO | Course outcomes – on completion of this course, the students will be able to | Programme outcomes |
|---|---|---|
| **CO 1** | Recall on classification, recent trends in phylogenetic relationship, General characters of Pteridophytes and Gymnosperms. | K1 & K4 |
| **CO 2** | Learn the morphological/anatomical organization, life history of major types of Pteridophytes and Gymnosperms | K2 |
| **CO 3** | Comprehend the economic importance of Pteridophytes, Gymnosperms and fossils. | K3 |
| **CO 4** | Understanding the evolutionary relationship of Pteridophytes and Gymnosperms. | K5 |
| **CO 5** | Awareness on fossil types, fossilization and fossil records of Pteridophytes and Gymnosperms. | K5 & K6 |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour) | |
| Skills acquired from this course | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | |

**Recommended texts**


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


**Reference Books**


1. Parihar, N.S. 2019. An Introduction to Embryophyta Pteridophytes. 5th Edition, Surjeet Publication, Delhi.
2. Pandey, S.N and Trivedi, P.S. 2015. A Text Book of Botany Vol. II- 12 th edition (Paperback), Vikas Publishing.
3. Rashid, A. 2013. An introduction to Pteridophyta – Diversity, Development and differentiation ($2^{nd}$ edition), Vikas Publications.
4. Arnold A.C. 2005. An Introduction to Paleobotany. Agrobios (India).Jodhpur.

5. Sporne, K.R. 2017. The morphology of Pteridophytes (The structure of Ferns and Allied Plants) (Paperback), Andesite Press.
6. Sporne, K.R. 1967. The Morphology of Gymnosperms. Hutchinson & Co., London.
7. Taylor, E, Taylor, T, Krings, M. 2008. Paleobotany: The Biology and Evolution of Fossil Plants, 2nd Edition, Academic Press.

**Web resources**

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

**Mapping with Programme Outcomes:**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 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)**

## CORE III - LABORATORY COURSE – 1

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Title of the Course** | **Laboratory course - 1**<br>**COVERING CORE PAPER I** | | | | | | |
| **Paper Number** | **CORE III** | | | | | | |
| **Category** | **Core** | **Year** | **I** | **Credits** | **2** | **Course Code** | |
| | | **Semester** | **I** | | | | |
| **Instructional Hours Per week** | **Lecture** | **Tutorial** | | | **Lab Practice** | | **Total** |
| | | **--** | | | **3** | | **3** |
| **Pre-requisite** | Students should be familiar with the fundamentals of algae, fungi, lichens, Bryophytes, in addition to essential laboratory techniques. | | | | | | |
| **Learning Objectives** | 1. To learn how to employ the use of instruments, technologies and methodologies related to thallophytes 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, 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**<br>Study of algae in the field and laboratory of the genera included in theory.<br>Algal collection trip and submission of five herbarium sheets.<br>External morphology and internal anatomy of the vegetative and reproductive structures of the following living forms: *Oscillatoria, Scytonema, Ulva, Codium, Diatoms, Dictyota* and *Gracilaria* |
| II | To record the local algal flora – Study of their morphology and structure.<br>Identification of algae to species level (at least One).<br>Identification of micro algae (green / blue green) in the given algal mixtures. |
| III | **FUNGI**<br>Study of morphological and reproductive structures of the following living forms: *Puccinia, Phytophthora, Rhizopus, Taphrina, Polyporus* and *Colletotrichum* (depending on the availability of the specimens) |
| IV | Isolation and identification of fungi from soil.<br>**LICHENS:**<br>Study of morphological and reproductive structures of the genera *Parmelia/ Usnea.* |
| V | **BRYOPHYTES**<br>External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Targionia, Lunularia, Porella* and *Polytrichum* |

| | |
|---|---|
| | (depending on the availability of the specimens). |

**Course Outcomes**

| CO | Course outcomes – on completion of this course, the students will be able to | Programme outcomes |
|---|---|---|
| **CO 1** | Recall and applying the basic keys to distinguish at species level Identification of important algae and fungi through its structural organizations | K1 & K4 |
| **CO 2** | Demonstrate practical skills in thallophytes. | K2 |
| **CO 3** | Describe the structure of algae, fungi, lichens and bryophytes | K3 |
| **CO 4** | Determine the importance of structural diversity in the evolution of plant forms. | K5 |
| **CO 5** | Formulate techniques to isolate and culture of alga and fungi as well as to understand the diversity of plant forms | K5 & K6 |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour) | |
| Skills acquired from this course | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | |

**Recommended texts**

1. Kumar, H.D. 1999. Introductory Phycology. Affiliated East-West Press, Delhi.
2. Das, S and Saha, R. 2020. Microbiology Practical Manual. CBS Publishers and Distributors (P) Ltd., New Delhi, India.

**Reference Books**

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

**Web resources**

1. 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

**Mapping with Programme Outcomes:**

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

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

## CORE IV - LABORATORY COURSE – 2

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Title of the Course** | **Laboratory course - 2**<br>**COVERING CORE PAPER II** | | | | | | |
| **Paper Number** | **Core IV** | | | | | | |
| **Category** | **Core** | **Year** | I | **Credits** | **2** | **Course Code** | |
| | | **Semester** | I | | | | |
| **Instructional Hours Per week** | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** |
| | | | **--** | | **3** | | **3** |
| **Pre-requisite** | Students should be familiar with the fundamentals of Pteridophytes, Gymnospersms, Paleobotany in addition to essential laboratory techniques. | | | | | | |
| **Learning Objectives** | 1. To learn how to employ the use of instruments, technologies and methodologies related 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 Pteridophytes and Gymnosperms through morphological changes and evolution, anatomy and reproduction. | | | | | | |
| | 4. To develop the technical abilities in staining, sectioning, sterilizing, and characterizing varieties of non-flowering plants. | | | | | | |
| | 5. To compare the structural diversity of fossil and extant plant species. | | | | | | |

| UNIT | EXPERIMENTS |
|---|---|
| I | **PTERIDOPHYTES**<br>External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Selaginella*, *Isoetes*, *Equisetum Angiopteris*, *Pteris* and *Marselia / Azolla* (depending on the availability of the specimens). |
| II | **PTERIDOPHYTES**<br>*Fossil slides observation: Rhynia, Lepidocarpon, Calamites.* |
| III | **GYMNOSPERMS**<br>External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Thuja*, *Cupressus*, *Araucaria*, *Podocarpus*, *Gnetum* and *Ephedra* (depending on the availability of the specimens). |
| IV | Fossil slides observation*: Cordaites* and *Lyginopteris.* |

**Course Outcomes**

| CO | Course outcomes – on completion of this course, the students will be able to | Programme outcomes |
|---|---|---|
| **CO 1** | Recall and applying the basic keys to distinguish at species level Identification of important algae and fungi through its structural organizations | K1 & K4 |
| **CO 2** | Demonstrate practical skills in thallophytes. | K2 |
| **CO 3** | Describe the structure of algae, fungi, lichens and bryophytes | K3 |
| **CO 4** | Determine the importance of structural diversity in the evolution of plant forms. | K5 |
| **CO 5** | Formulate techniques to isolate and culture of alga and fungi as well as to understand the diversity of plant forms | K5 & K6 |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour) | |
| Skills acquired from this course | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | |

**Recommended texts**


1. Sharma, O.P. 2012. Pteridophyta, Tata McGraw-Hills Ltd,NewDelhi.
2. Sharma O.P and S, Dixit.2002.Gymnosperms.PragatiPrakashan.
3. Johri, R.M, Lata, S, Tyagi, K. 2005. A text book of Gymnosperms, Dominate pub and Distributer, New Delhi.


**Reference Books**


1. Chmielewski, J.G and Krayesky, D. 2013. General Botany laboratory Manual. Author House, Bloomington, USA.
2. 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.
3. Gangulee, H.C and A.K. Kar. 2013. College Botany. V$^{th}$ Edition. S. Chand


**Web resources**

1. https://www.amazon.in/Practical-Manual-Pteridophyta-Rajan-Sundara/dp/8126106883
2. https://www.google.co.in/books/edition/Gymnosperms/3YrT5E3Erm8C?hl=en&gbpv=1&dq=gymnosperms&printsec=frontcover
3. https://www.amazon.in/Paleobotany-Biology-Evolution-Fossil-Plants/dp/0123739721

**Mapping with Programme Outcomes:**

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

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

## ELECTIVE I
## 1. MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Title of the Course** | **MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY** | | | | | | |
| **Paper Number** | **ELECTIVE I** | | | | | | |
| **Category** | **Elective** | **Year** | **I** | **Credits** | **3** | **Course Code** | |
| | | **Semester** | **I** | | | | |
| **Instructional Hours per week** | | **Lecture** | **Tutorial** | | **Lab Practice** | **Total** | |
| | | **3** | **2** | | **--** | **5** | |
| **Pre-requisite** | 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:**<br>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.<br>Reproduction - Fission and sporulation. Genetic recombination- Transformation, Transduction and Conjugation. Isolation and cultivation of bacteria. Maintenance of bacterial culture. |
| **II** | **VIRUSES:**<br>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. |
| | **FOOD MICROBIOLOGY:**<br>Beneficial role of microbes – yoghurt, Olives, Cheese, Bread, Wine, Tempeh, Miso & Fermented green tea. Spoilage of fruits, vegetables, meats, |

| | |
|---|---|
| **III** | 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:**<br>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:**<br>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.<br>Principles of disease management – Cultural practices, physical, chemical and biological methods, disease controlled by immunization. Biocontrol - merits and demerits;<br>Plant quarantine and legislation. Integrated Pest Management system. Diagnostic technique to detect pest/pathogen infection - Immunofluorescence (IF). |

**Course outcomes:**

| CO | On completion of this course the student will be able to | Programme outcomes |
|---|---|---|
| CO1 | Recognize the general characteristics of microbes, plant defense and immune cells | K1 |

| | | |
|---|---|---|
| CO2 | Explain about the stages in disease development and various defense mechanisms in plants and humans. | K2 |
| CO3 | Elucidate concepts of microbial interactions with plant and humans. | K3 |
| CO4 | Analyze the importance of harmful and beneficial microbes and immune system | K4 |
| CO5 | Determine and interpret the detection of pathogens and appreciate their adaptive strategies. | K5 & K6 |

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

*******

**Recommended Text:**


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


**Reference Books:**


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


**Web resources:**

1. https://www.wileyindia.com/a-textbook-of-plant-pathology.html

2. https://www.britannica.com/science/plant-disease.
3. https://www.planetatural.com/pest-problem-solver/plant-disease/
4. https://www.elsevier.com/books/plant-pathology/agrios/978-0-08-047378-9
5. https://www.elsevier.com/life-sciences/immunology-and-microbiology/books
6. https://www.amazon.in/INTRODUCTION-IMMUNOLOGY-RAFIA-IMRAN-ebook/dp/B09B66SD3J

**Mapping with Programme Outcomes:**

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

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

## ELECTIVE - I: 2. CONSERVATION OF NATURAL RESOURCES AND POLICIES

<table>
<tr><td>Title of the Course</td><td colspan="6">CONSERVATION OF NATURAL RESOURCES AND POLICIES</td></tr>
<tr><td>Paper Number</td><td colspan="6">ELECTIVE I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td>3</td><td colspan="2">2</td><td>--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="5">To create awareness of environmental problems and their consequences.</td></tr>
<tr><td colspan="2" rowspan="5">Learning Objectives</td><td colspan="5">1. Explain the term natural resources.</td></tr>
<tr><td colspan="5">2. Describe the reasons for degradation of natural resources and suggest measures to prevent these.</td></tr>
<tr><td colspan="5">3. List the various endangered species of animals and plants.</td></tr>
<tr><td colspan="5">4. State the various environmental laws passed to conserve the natural resources.</td></tr>
<tr><td colspan="5">5. Explain sustainable development and justify its need; and describe the various conventional as well as non-conventional sources of energy.</td></tr>
<tr><td>UNIT</td><td colspan="6">CONTENTS</td></tr>
<tr><td>I</td><td colspan="6">NATURAL RESOURCES:<br>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.</td></tr>
<tr><td>II</td><td colspan="6">FOREST RESOURCES:<br>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.</td></tr>
<tr><td>III</td><td colspan="6">LAND AND SOIL RESOURCES:<br>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.</td></tr>
</table>

| | | |
|---|---|---|
| **IV** | **MINERAL RESOURCES:**<br>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:**<br>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 student will be able to CO** | **Programme outcomes** |
| **CO1** | Understand the concept of different natural resources and their utilization. | K1 |
| **CO2** | Critically analyze the sustainable utilization land, water, forest and energy resources | K2 & K6 |
| **CO3** | Evaluate the management strategies of different natural resources | K3 |
| **CO4** | Reflect upon the different national and international efforts in resource management and their conservation. | K4 |
| **CO5** | State the various environmental policy passed to conserve the natural resources. | K5 |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour) | |
| Skills acquired from this course | Knowledge, Problem Solving, Analytical ability, Professional<br>Competency, Professional Communication and Transferrable Skill | |

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| **Recommended Text:** |
|---|
| 1. Trivedi R.K.1994. Environment and Natural Resources Conservation.<br>2. Murthy J.V.S.1994. Watershed Management in India.<br>3. Raymond, F Dasmann. 1984. Environmental Conservation, John Wiley.<br>4. Nalini, K.S. 1993. Environmental Resources and Management, Anmol Publishers, New Delhi.<br>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

**Mapping with Programme Outcomes:**

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

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

## ELECTIVE-I: 3. MUSHROOM CULTIVATION

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Title of the Course** | **MUSHROOM CULTIVATION** | | | | | | |
| **Paper Number** | **ELECTIVE I** | | | | | | |
| **Category** | **Elective** | **Year** | **I** | **Credits** | **3** | **Course Code** | |
| | | **Semester** | **I** | | | | |
| **Instructional Hours per week** | | **Lecture** | **Tutorial** | | **Lab Practice** | **Total** | |
| | | **3** | **2** | | **--** | **5** | |

| | |
|---|---|
| **Pre-requisite** | Basic knowledge on structure and function of various groups of mushrooms. |
| **Learning Objectives** | 1. To teach the identification of mushrooms. |
| | 2. To differentiate the edible mushrooms with toxic and hallucinating fungi. |
| | 3. To study the cultivation technique of mushrooms |
| | 4. To learn the economic importance of mushroom in various fields. |
| | 5. To study how to establish mushroom cultivation as business enterprise. |
| | 6. To teach the identification of mushrooms. |

| **UNIT** | **CONTENTS** |
|---|---|
| **I** | **INTRODUCTION:**<br>Mushroom, Edible Mushroom, commercial production, medicinal value of mushrooms, nutraceuticals and dietary supplements |
| **II** | **MORPHOLOGICAL AND MICROSCOPICAL IDENTIFICATION OF EDIBLE AND POISONOUS MUSHROOMS**:<br>Keys for identification of edible mushrooms: *Agaricus bisporus*, *Pleurotus sajorcaju*, *Volvariella volvcea* and *Calocybe indica.* Key for identifying hallucinogenic mushroom (*Psilocybe* sp.) Medicinal Mushroom – *Cordyceps, Ganoderma lucidum* and *Lentinus edodes.* |
| **III** | **CULTIVATION:**<br>Substrate sterilization, bed preparation, cropping room and maintenance,raising of pure culture and spawn preparation, factors effecting button mushroom production (Temp, pH, air and water management, competitor moulds and other disease). |
| **IV** | **POST-HARVEST MANAGEMENT:**<br>Harvest, storage, quality assurance of mushrooms. Pestmanagement. |
| **V** | World production edible mushroom, Legal and regulatory issues of introducing the medicinal mushrooms in different countries. Developing small scale industry and Government schemes. Mushroom Research Centres – International and National levels. |
| **Course Outcomes:** | **On completion of this course the student will be able to** — **Programme outcomes** |

| CO | | |
|---|---|---|
| **CO1** | Knowledge on identification of edible and toxic mushrooms belonging toAscomycota and Basidiomycota. | K1, K3 |
| **CO2** | Outline the nutraceutical properties of edible mushrooms. | K2, K4 |
| **CO3** | Knowledge on cultivation techniques of edible and medicinal mushrooms. | K3, K6 |
| **CO4** | Understand the harvest and post-harvest techniques of mushroom crops. | K4 |
| **CO5** | Knowledge on the production and marketing strategies for mushrooms. | K5 |

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

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**Recommended Text:**


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


**Reference books:**


1. Tiwari., SC., Pandey K. 2018. Mushroom cultivation. Mittal publisher, New Delhi.
2. Philips, G., Miles, Chang, S-T. 2004. Mushrooms: Cultivation, nutritional value, medicinal effect and environmental effect. 2nd ed. CRC Press.
3. Diego, C.Z., Pando-Gimenez, A. 2017. Edible and medicinal mushrooms: Technology and Application. Wiley-Blackwell publishers.
4. Nita Bahl. 2002. Handbook on Mushroom 4th edition Vijayprimlani for oxford & IBH publishing co., Pvt., Ltd., New Delhi. Dr.C. Sebastian Rajesekaran Reader in Botany Bishop Heber College, Trichy – 17.
5. Suman. 2005. Mushroom Cultivation Processing and Uses, M/s. IBD Publishers and Distributors, New Delhi.


**Web resources:**

1. https://www.amazon.in/Mushroom-Cultivation-India-B-C/dp/817035479X
2. http://nrcmushroom.org/book-cultivation-merged.pdf
3. http://agricoop.nic.in/sites/default/files/ICAR_8.pdf
4. http://www.agrimoon.com/mushroom-culture-horticulture-icar-pdf-book/
5. https://books.google.co.in/books/about/Mushroom_Cultivation_in_India.html?id=6AJx99OGTKEC&redir_esc=y

**Mapping with Programme Outcomes:**

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

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

## ELECTIVE I – 4. PHYTOPHARMACOGNOSY

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

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

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

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**Recommended Text:**


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


**Reference books:**


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


**Web resources:**

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

**Mapping with Programme Outcomes:**

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

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

## ELECTIVE II - 1. ALGAL TECHNOLOGY

<table>
<tr><td>Title of the Course</td><td colspan="7">ALGAL TECHNOLOGY</td></tr>
<tr><td>Paper Number</td><td colspan="7">ELECTIVE II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td colspan="2">2</td><td>--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Students should be familiar with the basic and applied knowledge on algal biotechnology.</td></tr>
<tr><td colspan="2">Learning Objectives</td><td colspan="6">1. To provide a basic overview of algae cultivation techniques and resource potentials.</td></tr>
<tr><td colspan="2"></td><td colspan="6">2. To educate people about the widespread commercial uses of algae.</td></tr>
<tr><td colspan="2"></td><td colspan="6">3. To educate people about the therapeutic uses of algae.</td></tr>
<tr><td colspan="2"></td><td colspan="6">4. To enrich the current knowledge of how algae are used in basic research andtechnological applications.</td></tr>
<tr><td colspan="2"></td><td colspan="6">5. To spread awareness of the value of algae biotechnology and its applications in diverse industries.</td></tr>
<tr><td>UNIT</td><td colspan="7">CONTENTS</td></tr>
<tr><td>I</td><td colspan="7">SCOPE OF ALGAL TECHNOLOGY<br>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.</td></tr>
<tr><td>II</td><td colspan="7">ALGAL PRODUCTS<br>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.</td></tr>
<tr><td>III</td><td colspan="7">ALGAL PRODUCTION AND UTILIZATION<br>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.</td></tr>
<tr><td>IV</td><td colspan="7">IMMOBILIZATION AND RDNA TECHNOLOGY IN ALGAE<br>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</td></tr>
</table>

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

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

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**Recommended Text:**


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

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.

**Web resources:**

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

**Mapping with Programme Outcomes:**

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

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

## ELECTIVE – II: 2. ETHNOBOTANY, NATUROPATHY AND TRADITIONAL HEALTHCARE

<table>
<tr><td>Title of the Course</td><td colspan="7">ETHNOBOTANY, NATUROPATHY AND TRADITIONALHEALTHCARE</td></tr>
<tr><td>Paper Number</td><td colspan="7">ELECTIVE II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td colspan="2">2</td><td>--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">The training imparts the knowledge and abilities required to conduct field studies on how humans use plants.</td></tr>
<tr><td colspan="2" rowspan="5">Learning Objectives</td><td colspan="6">1. Understand the concept of ethnobotany and the life style and traditional practices of plants by Indian tribals.</td></tr>
<tr><td colspan="6">2. Emphasize the importance of non-timber forest products for Indian tribal people livelihoods.</td></tr>
<tr><td colspan="6">3. Evaluate the various research techniques to gather tribal knowledge of ethnobotany.</td></tr>
<tr><td colspan="6">4. Use strategies to turn ethno botanical knowledge into goods with value additions.</td></tr>
<tr><td colspan="6">5. To save and document ethno botanicals in order to use plant resources sustainably.</td></tr>
<tr><td>UNIT</td><td colspan="7">CONTENTS</td></tr>
<tr><td>I</td><td colspan="7">ETHNOBOTANY:<br>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.</td></tr>
<tr><td>II</td><td colspan="7">PLANTS USED BY TRIBALS OF INDIA:<br>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.</td></tr>
<tr><td>III</td><td colspan="7">SOURCES OF ETHNOBOTANICAL DATA:<br>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.</td></tr>
</table>

| | |
|---|---|
| **IV** | **NATUROPATHIC MEDICINE:**<br>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,<br>**TRADITIONAL HEALTH CARE:**<br>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:**<br>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** |
|---|---|---|
| **CO1** | Recall or remember concept of ethnobotany. | K1 |
| **CO2** | Understand the life style and traditional practices of plants by Indian tribals. | K2 & K6 |
| **CO3** | Highlight the role of Non-Timber Forest products for livelihood of tribal people of India | K3 |
| **CO4** | Assess the methods to transform ethnobotanical knowledge into value added products. | K4 |
| **CO5** | Build idea to make digitization of ethnobotanical knowledge. | K5 |

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

**

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

**Mapping with Programme Outcomes:**

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

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

## ELECTIVE – II: 3. HORTICULTURE

<table>
<tr><td>Title of the Course</td><td colspan="7">HORTICULTURE</td></tr>
<tr><td>Paper Number</td><td colspan="7">ELECTIVE II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td colspan="2">2</td><td>--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Students should know fundamental knowledge on horticulture applications.</td></tr>
<tr><td colspan="2">Learning Objectives</td><td colspan="6">1. Know about the brief history, divisions, classification and structure of horticultural plants.</td></tr>
<tr><td colspan="2"></td><td colspan="6">2. Acquire knowledge on plant growth processes and stages of plant growth.</td></tr>
<tr><td colspan="2"></td><td colspan="6">3. Understand the plant growth environment in relation to soil, nutrients, fertilizers, and bio inoculants.</td></tr>
<tr><td colspan="2"></td><td colspan="6">4. Study the sexual and vegetative propagation methods including propagation through specialized vegetative structures.</td></tr>
<tr><td colspan="2"></td><td colspan="6">5. Develop practical skills in micro propagation techniques and soil-less production of horticultural crops.</td></tr>
<tr><td>UNIT</td><td colspan="7">CONTENTS</td></tr>
<tr><td>I</td><td colspan="7">INTRODUCTION TO HORTICULTURE<br>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.</td></tr>
<tr><td>II</td><td colspan="7">FACTORS AFFECTING PLANT GROWTH<br>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.</td></tr>
<tr><td>III</td><td colspan="7">PLANT PROPAGATION<br>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.</td></tr>
<tr><td>IV</td><td colspan="7">MICROPROPAGATION TECHNIQUES<br>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</td></tr>
</table>

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

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

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

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**Recommended Text:**


1. Acquaah, G. 2011.Horticulture: Principles and Practices. (4th ed), Pearson Education, London, UK.
2. Janik, J. 1972. Horticultural Science. W.H. Freeman & Company, San Francisco.
3. Kumar, N. 1994. Introduction to Horticulture, Rajalakshmi Publication, India.
4. Manibhushan Rao, K. 2005. Text Book of Horticulture. (2nd ed), Macmillan India Ltd., New Delhi.
5. Schilletter, J. C. and Richey, H. W. 2005. Text Book of general Horticulture. 2nd ed.

Biotech Books, Delhi.
6. Sharma, R.R. 2016. Propagation of horticultural crops. Kalyani Publishers, New Delhi.
7. Subba Rao, N.S. 1997. Biofertilizers in Agriculture and Forestry. India Book House Limited, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.

**Reference Books:**

1. Acquaah, G. 2002. Horticulture Principles and Practices. 2nd ed. Pearson Education (Singapore) Pvt. Ltd.
2. Ashman, M.A. and Puri, G. 2002. Essential soil science-A clear and concise introduction to soil science. Blackwell scientific publishers, London.
3. Denisen, E.L. 1979. Principles of Horticulture. MacMillan Publishing co, Inc. New York.
4. Dirr, M. and Heuser, C.W. 2009. The Reference Manual of Woody Plant Propagation: From Seed to Tissue Culture. Timber Press, Oregon, USA.
5. Thomson, L.M. and Troen, F.R. 1975. Soils and soil fertility Tata, McGraw Hill Publication Co. Ltd. New Delhi.
6. Tolanus, S. 2006. Soil fertility, Fertilizer and Integrated Nutrient management. CBS Publication, Delhi, India.

**Web resources:**

1. https://www.kobo.com/in/en/ebooks/horticulture
2. https://www.gale.com/gardening-and-horticulture
3. https://www.iaritoppers.com/p/horticulture-icar-ecourse-pdf-books.html
4. https://www.amazon.in/Introduction-Horticulture-N-Kumar-ebook/dp/B08M4289M6
5. https://www.researchgate.net/publication/316438576_Polyembryony_in_Horticulture_and_its_significance

**Mapping with Programme Outcomes:**

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

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

## ELECTIVE – II: 4. HERBAL TECHNOLOGY

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Title of the Course** | **HERBAL TECHNOLOGY** | | | | | | |
| **Paper Number** | **ELECTIVE II** | | | | | | |
| **Category** | **Elective** | **Year** | **I** | **Credits** | **3** | **Course Code** | |
| | | **Semester** | **I** | | | | |
| **Instructional Hours per week** | | **Lecture** | **Tutorial** | | **Lab Practice** | **Total** | |
| | | **3** | **2** | | **--** | **5** | |
| **Pre-requisite** | | To understand the importance of herbal technology. | | | | | |
| **Learning Objectives** | | 1. To understand various plants based drugs used in ayurvedha, unani, homeopathy, siddha etc. | | | | | |
| | | 2. To apply the knowledge to cultivate medical plants. | | | | | |
| | | 3. To know the pharmacological importance of medicinal plants. | | | | | |
| | | 4. To enlist phytochemicals and secondary metabolites of market and commercial value. | | | | | |
| | | 5. To design and develop their own business prepositions such as the in the making of herbal insecticides. | | | | | |
| **UNIT** | **CONTENTS** | | | | | | |
| **I** | **PHARMACOGNOSY**<br>Pharmacognosy scope and importance - source - Crude Drugs – Scope and Importance, Classification (Taxonomical, Morphological Chemical, Pharmacological); Cultivation, Collection and processing of crude drugs. Cultivation and utilization of medicinal and aromatic plants in India. | | | | | | |
| **II** | **PLANT TISSUE CULTURE AS SOURCE OF MEDICINES**<br>Plant tissue culture as source of medicines, Role of plant tissue culture in enhancing secondary metabolite production (*Withania somnifera, Rauwolfia serpentina, Catheranthus roseus, Andrographis paniculata* and *Dioscorea sp*) - Elicitation - Biotransformation, Hairy root culture. Factors affecting secondary metabolites production. Biogenesis of phytopharmaceuticals. | | | | | | |
| **III** | **PLANT PROPAGATION**<br>**ANALYSIS OF PHYTOCHEMICALS**<br>Methods of Drug evaluation (Morphological, microscopic, physical and chemical). Phytochemical investigations – standardization and quality control of herbal drugs. Preliminary screening, Assay of Drugs - Biological evaluation/assays, Microbiological methods - Chemical Methods of Analysis, Detection of Adulterants: Chemical estimations, Spectrophotometry and fluorescence analysis. Drug adulteration - Types of adulterants. | | | | | | |
| **IV** | **GENERAL METHODS OF PHYTOCHEMICAL AND BIOLOGICAL SCREENING**<br>Carbohydrates and derived products: Glycosides - extraction methods (*Digitalis, Dioscorea*); Tannins (Hydrolysable and Condensed types); Volatile | | | | | | |

| | | |
|---|---|---|
| | oils - extraction methods (Clove, Mentha). Study of some herbal formulation techniques as drug cosmetics. | |
| **V** | **TYPES OF PHYTOCHEMICALS**<br>Alkaloids - extraction methods (*Taxus, Cinchona*); Flavonoids- extraction methods, Resins- extraction method: Application of phytochemicals in phytopharmacueticals; Biocides, Biofungicides, Biopesticides. Women entrepreneurship development – marketing cultivated medicinal plants – National Medicinal Plants Board of India. | |
| **Course outcomes: to: CO** | **On completion of this course, the students will be able** | **Programme outcomes** |
| **CO1** | Recollect the importance of herbal technology. | K1 |
| **CO2** | Understand the classification of crude drugs from various botanical sources. | K2 |
| **CO3** | Analyze on the application of secondary metabolites in modern medicine. | K3 |
| **CO4** | Create new drug formulations using therapeutically valuable phytochemical compounds for the healthy life of society. | K4 |
| **CO5** | Comprehend the current trade status and role of medicinal plants in socio economic growth. | K5 & K6 |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour) | |
| Skills acquired from this course | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | |

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**Recommended Text:**


1. Kokate, C.K., Purohit, A.P and S.B. Gokhale. 1996. Pharmacognosy. NiraliPrakashan, 4th Ed.
2. Roseline, A. 2011. Pharmacognosy. MJP publishers, Chennai.
3. Tilgner, Sharol Marie. 2018. Herbal ABC's: The Foundation of Herbal Medicine.
4. Natural Products in medicine: A Biosynthetic approach. 1997. Wiley. Hornok, L. (ed.).
5. Chichister, U.K.J. 1999. Cultivation and Processing of Medicinal Plants, Wiley & Sons. Treaseand Evans.

6. Mukherjee, P.K. 2008. Quality control of herbal drugs. 3rd edition. Business Horizons Pharmaceutical Publishers, New Delhi, India.
7. Kirthikar and Basu. 2012. Indian Medicinal Plants. University Bookstore, Delhi. India
8. Biswas, P.K. 2006. Encyclopedia of Medicinal plants (Vol. I-VII). Dominant Publishers, New Delhi.
9. Chaudhuri, A.B. 2007. Endangered Medicinal Plants. Daya Publishing House, New Delhi.
10. Tilgner, Sharol Marie. 2018. Herbal ABC's: The Foundation of Herbal Medicine.

**Reference Books:**

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

**Web resources:**

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

**Mapping with Programme Outcomes:**

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

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

## CORE V - TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Title of the Course** | | **PLANT TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY** | | | | | |
| **Paper Number** | | **CORE V** | | | | | |
| **Category** | **Core** | **Year** | **I** | **Credits** | **4** | **Course Code** | |
| | | **Semester** | **II** | | | | |
| **Instructional Hours Per week** | | **Lecture** | **Tutorial** | | **Lab Practice** | | **Total** |
| | | **3** | **2** | | **-** | | **5** |
| **Pre-requisite** | | 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**<br>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**<br>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**<br>Polypetalae, Nympheaceae, Sterculiaceae, Portulacaceae, Rhamnaceae, Vitaceae, Sapindaceae, Combretaceae and Apiaceae. |
| IV | **SYSTEMATIC ANALYSIS OF PLANTS-II**<br>Gamopetalae, Sapotaceae, Oleaceae, Boraginaceae, Scrophulariaceae, Bignoniaceae, Convolvulaceae, Acanthaceae, Verbenaceae.<br>Monochlamydeae, Nyctaginaceae, Aristolochiaceae, Casuarinaceae.<br>Monocots – Orchidaceae, Amarylidaceae, Lilliaceae, Commelinaceae, Cyperaceae. |
| V | **ECONOMIC BOTANY**<br>General account on utilization of selected crop plants: (i) Cereals (rice and wheat) – (ii) Pulses (red gram and black gram), (iii) Drug yielding plants (***Withania somnifera*** and ***Coleus aromaticus)*** (iv) Oil yielding plants (Groundnut, sunflower). (v) Sugar |

| | |
|---|---|
| | yielding plants (sugarcane and sugar beet), (vi) Spices and condiments (***Cardamom, Cinnamon***). (vii) Commercial crops - fibre (jute), (viii) Timber (Teak and red sanders wood), (ix) Resins and gums (***Asafoetida*** and Gum arabic) – (x) Essential oils (lemon grass and menthol), (xi) Beverages (tea, coffee), (xii) Plants used as avenue trees for shade, pollution control and aesthetics (xiii) Energy plantation - uses of ***Casuarina***. |

**Course Outcomes**

| CO | Course outcomes – on completion of this course, the students will be able to | Programme outcomes |
|---|---|---|
| **CO 1** | Recollect the basic concepts of morphology of leaves, flowers. Identify the types of compound leaves, inflorescence and fruits Describe their characteristic features | K1, K2<br>K3 |
| **CO 2** | Explain the principles of taxonomy. Summarize the taxonomic hierarchy. Define Binomial nomenclature. Group Activity –Construct key preparation | K1, K2<br>K5, K6 |
| **CO 3** | Explain the various types of classification. Distinguish its advantages and disadvantages Construction of floral formula and floral diagram. | K1, K2<br>K3, K4 |
| **CO 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, K2<br>K3, K4 |
| **CO 5** | Illustrate and explain the characteristic features and list out the Economic importance of the families. | K1, K2<br>K3, K5 |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour) | |
| Skills acquired from this course | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | |

**Recommended texts**


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 MedicinalPlants Board, Govt. of India, New Delhi.
4. Vallabh. 2000. Practical Pharmacognosy, Kolkata. New Delhi.
5. Acharya Vipul Rao. 2000. Herbal cure for common diseases. Diamond books, Pvt. Ltd.
6. Dey, A.C. 1998. Indian medicinal plants used in Ayurvedic preparations, Bishen Singh Mahendra Pal Singh.
7. Sathya, S., Jaiganesh, K.P and Sudha, T. 2019. Current Trends in Herbal Drug Technology. Pharmacy Council of India New Delhi.
8. Mohamad Ali. 2009. Pharmacognosy and Phytochemistry. CBS Publications& Distribution, New Delhi, Volume.1.
9. Lewis, W.H and M.P.F. Elwin Lewis. 1976. Medical Botany. Plants affecting Man's Health. A Wiley Inter Science Publication. John Wiley and Sons, New York.


**Web resources**

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

**Mapping with Programme Outcomes:**

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

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

## CORE VI: PLANT ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Title of the Course** | | **PLANT ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS** | | | | | |
| **Paper Number** | | **CORE VI** | | | | | |
| **Category** | **Core** | **Year** | **I** | **Credits** | **4** | **Course Code** | |
| | | **Semester** | **II** | | | | |
| **Instructional Hours Per week** | | **Lecture** | **Tutorial** | | **Lab Practice** | | **Total** |
| | | **3** | **2** | | **--** | | **5** |
| **Pre-requisite** | | 1. To acquire knowledge on the anatomical structure and reproductive phase of angiosperms. | | | | | |
| **Learning Objectives** | | 2. Learn the importance of plant anatomy in plant production systems. | | | | | |
| | | 3. Classify meristems and identify their structures, functions and roles in monocot and dicot plants growth and secondary growth of woody plants. | | | | | |
| | | 4. Understand the mechanism underling the shift from vegetative to reproductive phase. | | | | | |
| | | 5. Trace the development of male and female gametophyte. | | | | | |
| | | 6. 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:**<br>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:**<br>Causes of Polyembryony, classification, induction and practical application. Apomixis and its significance. Seed and Fruit development and role of growth substances. Parthenocarpy and its importance. |

**Course outcomes**

| **CO** | **Course outcomes – on completion of this course, the students will be able to** | **Programme outcomes** |
|---|---|---|
| **CO1** | Learn the structures, functions and roles of apical *vs* lateral meristems in monocot and dicot plant growth. | K1 & K2 |
| **CO2** | Study the function and organization of woody stems derived from secondary growth in dicot and monocot plants. | K1 &K4 |
| **CO3** | Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development. | K2 & K6 |
| **CO4** | Understand the various concepts of plant development and reproduction. | K3 & K6 |
| **CO5** | Profitably manipulate the process of reproduction in plants with a professional and entrepreneurial mindset. | K5 |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour) | |
| Skills acquired from this course | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | |

**Recommended texts**


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 Publishing 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.
5. Crang, R., Lyons-Sobaski, S and Wise, R. 2018. Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants. Springer International Publishing.
6. Cutler, D. F., Botha, T and Stevenson, D.W. 2008. Plant Anatomy: An Applied Approach. Blackwell Publishing, Malden, USA.
7. Eames, A.J and Mac Daniels, L.H. 2013. Introduction to Plant Anatomy, 3rd Edition. McGraw-Hill Inc., US.

**Web resources**

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

**Mapping with Programme Outcomes:**

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

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

## CORE VII - ECOLOGY, PHYTOGEOGRAPHY, CONSERVATION BIOLOGY & INTELLECTUAL PROPERTY RIGHTS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Title of the Course** | | **ECOLOGY, PHYTOGEOGRAPHY, CONSERVATION BIOLOGY & INTELLECTUAL PROPERTY RIGHTS** | | | | | |
| **Paper Number** | | **CORE VII** | | | | | |
| **Category** | **Core** | **Year** | **I** | **Credits** | **4** | **Course Code** | |
| | | **Semester** | **II** | | | | |
| **Instructional Hours Per week** | | **Lecture** | **Tutorial** | | **Lab Practice** | **Total** | |
| | | **3** | **2** | | **-** | **5** | |
| **Pre-requisite** | | Understanding the environmental factors impacting biodiversity is crucial after taking this course and Basic understanding of how laws are structured and interpreted. | | | | | |
| **Learning Objectives** | | 1. To analyze and comprehend the fundamental ideas of plant ecology as a scientific study of environment. | | | | | |
| | | 2. To study the plant communities and plant succession stages. | | | | | |
| | | 3. To be aware of the causes, impacts and control measures of pollution. | | | | | |
| | | 4. To study biodiversity management and conservation. | | | | | |
| | | 5. To enhance the knowledge of the students and equip them in evaluate and protecting invaluable components of nature and interactions with the environment. | | | | | |

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

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

**Course Outcomes**

| CO | Course outcomes – on completion of this course, the students will be able to | Programme outcomes |
|---|---|---|
| **CO 1** | Understand the scope and importance of population ecology, plant communities and ecosystem ecology | K1 & K2 |
| **CO 2** | Understand the applied aspect of environmental botany. | K1 & K4 |
| **CO 3** | Identify different plant communities, categorize plant biomes and identify threatened, endangered plant species and create awareness program in protection of biodiversity. | K2 & K6 |
| **CO 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. | K3 & K6 |
| **CO 5** | Analyze insight into the vegetation types, species interaction and their importance and the factors influencing the environmental conditions. | K5 |

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

**Recommended texts**


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

**Reference Books**


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


**Web resources**

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

**Mapping with Programme Outcomes:**

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

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

## CORE VIII- LABORATORY COURSE – 3

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Title of the Course** | | **LABORATORY COURSE – 3 COVERING CORE PAPER V** | | | | | |
| **Paper Number** | | **CORE VIII** | | | | | |
| **Category** | **Core** | **Year** | **I** | **Credits** | **2** | **Course Code** | |
| | | **Semester** | **II** | | | | |

| **Instructional Hours Per week** | **Lecture** | **Tutorial** | **Lab Practice** | **Total** |
|---|---|---|---|---|
| | - | 1 | **2** | **3** |

| | |
|---|---|
| **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. |
| | 5. Know about different vegetation sampling methods. |

| **UNIT** | **EXPERIMENTS** |
|---|---|
| **I** | **TAXONOMY AND ECONOMIC BOTANY OF ANGIOSPERMS**<br>Preparation of dichotomous key |
| **II** | Description of a species, live specimens of the families mentioned in the theory. |
| **III** | Study the products of plants mentioned in the syllabus of economic botany with special reference to the morphology, botanical name and family. |
| **IV** | Workout nomenclatural problems regarding priority and author citations.<br>Identification of Binomial using flora (J.S. Gamble). |
| **V** | Identification of common plants in the families mentioned in the theory |

**Field trip:**
A field trip at least 2-3 days to a floristically rich area to study plants in nature and field report submission of not less than 10 herbarium sheets representing the families studied.

**Course Outcomes**

| **CO** | **Course outcomes – on completion of this course, the students will be able to** | **Programme outcomes** |
|---|---|---|
| **CO 1** | To gain recent advances in plant morphological and floral characteristics. | K1 |
| **CO 2** | Understand about different floral characteristics and artificial key preparation which employed for plant identification and conservation. | K2 |
| **CO 3** | Identification of genus and species of locally available wild plants. | K4 & K5 |
| **CO 4** | Familiarize immense knowledge on economic importance of higher plants. | K3 |
| **CO 5** | Gain hands on experience on herbarium preparation techniques. | K3 |

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

**Recommended texts**


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.


**Reference Books**


1. Aler Gingauz.2001. Medicinal Chemistry. Oxford University Press & Wiley Publications.
2. Mann J. Davidson, R. Sand J.B. Hobbs, D.V. Banthorpe, J.B .Harborne. 1994. *Natural Products*.Longman Scientific and Technical Essex.
3. Gopalan,C., B.V. Ramasastriand S.C. Balasubramanian. 1985. Nutritive Value of Indian Foods. National Institute of Nutrition, Hyderabad.
4. Harborne. J.B. 1998. Phytochemical methods. A guide to modern techniques of Plant Analysis, Chapman and Hall publication, London.
5. Traditionalplantmedicinesassourcesofnewdrugs.P.JHoughtoninPharmacognosy.Treaseand Evan's.16Ed.2009.


**Web resources**

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

**Mapping with Programme Outcomes:**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 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)**

## CORE IX - LABORATORY COURSE - 4

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Title of the Course** | | **LABORATORY COURSE – 4<br>COVERING CORE PAPERS VI AND VII** | | | | | | |
| **Paper Number** | | **CORE IX** | | | | | | |
| **Category** | **Core** | **Year** | **I** | **Credits** | **1 + 1** | **Course Code** | | |
| | | **Semester** | **II** | | | | | |
| **Instructional Hours Per week** | | **Lecture** | **Tutorial** | | **Lab Practice** | | **Total** | |
| | | **-** | **-** | | **1 + 2** | | **3** | |
| **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. Classify meristems and identify their structures, functions and roles in monocot and dicot plants growth and secondary growth of woody plants | | | | | | |
| | | 2. Expedite skilled workers to carry out research in frontier areas of plant science. | | | | | | |
| | | 3. Learn the importance of plant anatomy in plant production systems. | | | | | | |
| | | 4. Know about different vegetation sampling methods. | | | | | | |
| | | 5. Know about the remote sensing techniques | | | | | | |

| **UNIT** | **EXPERIMENTS** |
|---|---|
| **I** | **ANATOMY**<br>1. Study of shoot apex of *Hydrilla*<br>2. Observation of cambial types.<br>3. Sectioning and observation of nodal types.<br>4. Study of anomalous secondary growth of the following<br>STEM - *Nyctanthus, Bignonia, Piper* and *Mirabilis*.<br>ROOT: *Acyranthus*<br>5. Observation of stomatal types by epidermal peeling.<br>6. Maceration of wood and observation of the components of xylem.<br>7. Double staining technique to study the stem anomali. |
| **II** | **EMBRYOLOGY**<br>1. Observation of T.S. of anther.<br>2. Observation of ovule types.<br>3. Observation of mature embryo sacs.<br>4. Dissection and observation of embryos (globular and cordate embryos).<br>5. Study of pollen morphology<br>6. Study of *in vitro* pollen germination.<br>7. Observation of endosperm types. |
| **III** | **ECOLOGY,**<br>1. Determination of the quantitative characters of a plant community by quadrat method, line transect method (abundance, density, dominance, species diversity, frequency), Raunkiaer's life forms method, Shannon-Weiner Index in vegetative lands. |

| | |
|---|---|
| | **2.** Estimation of above ground and below ground biomass in a grazing land employing minimum size of quadrat. |
| **IV** | **ECOLOGY,**<br>1. To determine soil moisture, porosity and water holding capacity of soil collected from varying depth at different locations.<br>2. Estimation of organic carbon (Walkley - Black method).<br>3. Determination of dissolved oxygen.<br>4. Estimation of carbonate.<br>5. Estimation of bicarbonate. |
| **V** | **PHYTOGEOGRAPHY, CONSERVATION BIOLOGY & INTELLECTUAL PROPERTY RIGHTS**<br>1. Mapping of world vegetation<br>2. Mapping of Indian vegetation.<br>3. Remote sensing – Analysing and interpretation of Satellite photographs-Vegetation/ weather.<br>4. Visit to remote sensing laboratory (Regional Meteorological Centre). |

**Course Outcomes**

| **CO** | **Course outcomes – on completion of this course, the students will be able to** | **Programme outcomes** |
|---|---|---|
| **CO 1** | Recall or remember the information including basic and advanced in relation with plant anatomy and embryology. | K1 & K2 |
| **CO 2** | Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development. | K1 & K4 |
| **CO 3** | Know about different vegetation sampling methods. | K2 & K6 |
| **CO 4** | Know about the water and soil analysing technique | K3 & K6 |
| **CO 5** | Gain knowledge about the remote sensing and mapping | K5 |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour) | |
| Skills acquired from this course | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | |

**Recommended texts**


1. 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.
2. Sundara, R. S. 2000. Practical manual of plant anatomy and embryology. Anmol Publ. PVT LTD, New Delhi.
3. 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.

4. Sharma, H.P. 2009. Plant Embryology: Classical and Experimental, Bombay Popular Prakashan, ISBN-8173199698, 9788173199691

**Reference Books**

1. Harborne. J.B. 1998. Phytochemical methods. A guide to modern techniques of Plant Analysis, Chapman and Hall publication, London.
2. Traditionalplantmedicinesassourcesofnewdrugs.P.JHoughtoninPharmacognosy.Treaseand Evan's.16Ed.2009.
3. Sundara Rajan, S, 2003. Practical Manual of Plant Anatomy and Embryology 1st ed, Anmol Publications, ISBN-812610668.
4. Katherine Esau. 2006. Anatomy of Seed Plants. 2nd edition, John Wiley and Sons.

**Web resources**

1. https://studyfrnd.com/pharmacognosy-and-phytochemistry-book/
2. https://www.youtube.com/watch?v=Inm5oE1U8qw
3. https://www.youtube.com/watch?v=GlCOQijkIKc
4. https://www.jove.com/science-education/11090/basic-plant-anatomy-roots-stems-and-leaves

**Mapping with Programme Outcomes:**

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

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

## ELECTIVE III – 1. MEDICINAL BOTANY

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Title of the Course** | | **MEDICINAL BOTANY** | | | | | |
| **Paper Number** | | **ELECTIVE III** | | | | | |
| **Category** | **Elective** | **Year** | **I** | **Credits** | **2** | **Course Code** | |
| | | **Semester** | **II** | | | | |
| **Instructional Hours Per week** | | **Lecture** | **Tutorial** | | **Lab Practice** | **Total** | |
| | | **2** | **1** | | **--** | **3** | |
| **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:** Scope and Importance of Medicinal Plants; Traditional systems of medicine - Definition and Scope. Classical health traditions - Naturopathy, Siddha, Ayurveda, Homeopathy, Unani and Materia Medica. Ayurveda: History, origin, panchama habhutas, 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:**<br>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:**<br>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 benefits sharing models. |

**Course Outcomes**

| CO | Course outcomes – on completion of this course, the students will be able to | Programme outcomes |
|---|---|---|
| **CO 1** | Recognize plants and relate to their medicinal uses. | K1 |
| **CO 2** | Explain about the phytochemistry, pharmacognosy and bioprospecting of medicinal plant extracts. | K2 |
| **CO 3** | Apply techniques for conservation and propagation of medicinal plants. | K3 |
| **CO 4** | Analyze and decipher the significance of various methods of harvesting, drying and storage of medicinal herbs. | K4 |
| **CO 5** | Develop new strategies to enhance growth and quality check of medicinal herbs considering the practical issues pertinent to India. | K5 & K6 |

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

**Recommended texts**


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. Vallabh Prakashan, 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
5. https://www.pdfdrive.com/medicinal-plants-books.html

**Mapping with Programme Outcomes:**

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

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

## ELECTIVE III – 2. PHYTOCHEMISTRY

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Title of the Course** | | **PHYTOCHEMISTRY** | | | | | |
| **Paper Number** | | **ELECTIVE II** | | | | | |
| **Category** | **Elective** | **Year** | **I** | **Credits** | **2** | **Course Code** | |
| | | **Semester** | **I** | | | | |

| **Instructional Hours Per week** | **Lecture** | **Tutorial** | **Lab Practice** | **Total** |
|---|---|---|---|---|
| | **2** | **1** | **--** | **3** |

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

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

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

**Course Outcomes**

| CO | Course outcomes – on completion of this course, the students will be able to | Programme outcomes |
|---|---|---|
| **CO 1** | Understand the role of plants in the survival of human beings and other Organisms. | K1 |
| **CO 2** | Recognition of the contribution made by primitive people in exploration of plant knowledge to alleviate common diseases and development of systems of medicine | K2 |
| **CO 3** | Gaining knowledge on different classes of phytochemicals present in higher and lower plants species. | K3 |
| **CO 4** | Demonstrate the various aspects of extraction, isolation and characterization of secondary metabolites | K4 & K5 |
| **CO 5** | Know the methods of screening of secondary metabolites for various biological properties. | K6 |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour) | |
| Skills acquired from this course | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | |

**Recommended texts**


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


**Reference Books**


1. Shah, B.N. 2005. Textbook of Pharmacognosy and Phytochemistry. CBS Publishers & Distributors, New Delhi.

2. Harshal A and Pawar. 2018. Practical book of Pharmacognosy and Phytochemistry-Everest Publishing house.
3. Varsha Tiwari and Shamim Ahmad. 2018. A practical book of Pharmacognosy and phytochemistry. Nirali prakashan advancement of knowledge.
4. Braithwaite, A and F.J. Smith. 1996. *Chromatographic Methods* ($5^{th}$ Edition) Blackie Academic & Professional London.
5. Wilson, K and J. Walker (Eds). 1994. Principles and Techniques of Practical Biochemistry ($4^{th}$ Edition) Cambridge University Press, Cambridge.
6. Harborne. J.B. 1998. Phytochemical methods. A guide to modern techniques of Plant Analysis, Chapman and Hall publication, London.

**Web resources**

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

**Mapping with Programme Outcomes:**

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

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

## ELECTIVE III - 3. RESEARCH METHODOLOGY, COMPUTER APPLICATIONS & BIOINFORMATICS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Title of the Course** | | **RESEARCH METHODOLOGY, COMPUTER APPLICATIONS & BIOINFORMATICS** | | | | | |
| **Paper Number** | | **ELECTIVE III** | | | | | |
| **Category** | **Elective** | **Year** | **I** | **Credits** | **2** | **Course Code** | |
| | | **Semester** | **II** | | | | |
| **Instructional Hours Per week** | | **Lecture** | **Tutorial** | | **Lab Practice** | **Total** | |
| | | **2** | **1** | | **--** | **3** | |
| **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 starts entrepreneurial ventures. | | | | | |
| | | 3. To develop interdisciplinary skills in using computers in botany to learn about the biological database. | | | | | |
| | | 4. Students aware with the most recent technologies for sequencing and bioinformatics analysis and is able to apply them to the structural and functional genomics of plants. | | | | | |
| | | **5.** Operate various software resources with advanced functions and its open office substitutes. | | | | | |

| UNIT | CONTENTS |
|---|---|
| **I** | Literature collection and citation: bibliography — bibliometrics (scientometrics): definition-laws — citations and bibliography - *biblioscape— plagiarism— project proposal writing — dissertation writing – paper presentation (oral/poster) - E-learning tools- monograph — introduction and writing-Standard operating procedure (SOP) – introduction and preparation — Research Institutions - National and International. |
| **II** | Basic principles and applications of pH meter, UV-visible spectrophotometer, centrifuge, lyophilizer, chromatography- TLC, Gas chromatography with mass spectrum (GC/MS), and HPLC-Scanning electron microscopy-Agarose gel Electrophoresis — Polyacrylamide Gel Electrophoresis – 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**

| CO | Course outcomes – on completion of this course, the students will be able to | Programme outcomes |
|---|---|---|
| **CO 1** | Realize the need of centrifuges and chromatography and their uses in research. | K1 |
| **CO 2** | Learn the principles and applications of electrophoresis | K2 |
| **CO 3** | Construct the phylogenetic trees for similar characteristic feature of \ plant genomes and study *de novo* drug design through synthetic biology. | K3 |
| **CO 4** | Understand the concept of pairwise alignment of DNA sequences using algorithms. | K4 & K5 |
| **CO 5** | Interpret the features of local and multiple alignments. | K6 |

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

**Recommended texts**


1. 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. Bioinformatics and functional genomics. Hoboken, NJ:Wiley-Blackwell.
3. Arthur Conklin W.M and Greg White, 2016. Principles of computer security. TMH. McGraw-Hill Education; 4 edition.
4. Irfan Ali Khan and Attiya Khanum (eds.). 2004. Introductory Bioinformatics. Ukaaz Publications, Hyderabad.
5. Arthur Conklin W.M., and Greg White. 2016. Principles of computer security. TMH., McGraw-Hill Education; 4th edition

6. Mishra Shanthi Bhusan. 2015. Handbook of Research Methodology - A Compendium for Scholars & Researchers, Ebooks2go Inc.
7. Narayana, P.S.D. Varalakshmi, T. Pullaiah. 2016. Research Methodology in Plant Science, Scientific Publishers, Jaipur, Rajasthan.

**Web resources**

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

**Mapping with Programme Outcomes:**

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

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

## ELECTIVE III – 4. BIOPESTICIDE TECHNOLOGY

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Title of the Course** | | **BIOPESTICIDE TECHNOLOGY** | | | | | |
| **Paper Number** | | **ELECTIVE III** | | | | | |
| **Category** | **Elective** | **Year** | **I** | **Credits** | **2** | **Course Code** | |
| | | **Semester** | **II** | | | | |
| **Instructional Hours Per week** | | **Lecture** | **Tutorial** | **Lab Practice** | **Total** | | |
| | | **2** | **1** | **--** | **3** | | |
| **Pre-requisite** | | Prior knowledge on impact of chemical pesticides on environment and biopesticides. | | | | | |
| **Learning Objectives** | | 1. To understand the value and applications of biopesticides. | | | | | |
| | | 2. To comprehend the various issues related to the use of chemical pesticides in 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**<br>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**<br>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**<br>*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**<br>Target pests and crops of important biopesticides and their mechanisms of action. Testing of quality parameters and standardization of biopesticides. |
| V | **FORMULATION**<br>Mass multiplication and formulation technology of biopesticides. Prospects and problems in commercialization and efficiacy of biopesticides. Commercial products of biopesticides. |

**Course Outcomes**

| CO | Course outcomes – on completion of this course, the students will be able to | Programme outcomes |
|---|---|---|
| **CO 1** | Understand the issues in use of chemical pesticides and their harmful effects on life. | K1& K2 |
| **CO 2** | Aware the significance of biopesticides and their beneficial role in controlling insect pests, diseases, nematodes and weeds. | K1 & K4 |
| **CO 3** | Knowledge on identification of promising biopesticides and their mechanisms of action against insect pests, diseases, nematodes and weeds. | K2 & K6 |
| **CO 4** | Learn the mass production and formulation technology of selected biopesticides using algorithms. | K3 & K6 |
| **CO 5** | Knowledge on product development for commercialization of biopesticides. | K5 |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour) | |

**Recommended texts**


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


**Reference Books**


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

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

**Web resources**

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

**Mapping with Programme Outcomes:**

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

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

## ELECTIVE IV- 1. APPLIED BIOINFORMATICS

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

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

**Course Outcomes**

| CO | Course outcomes – on completion of this course, the students will be able to | Programme outcomes |
|---|---|---|
| **CO 1** | Familiarize with the tools of DNA sequence analysis. | K1& K2 |
| **CO 2** | Use and explain the application of bioinformatics. | K1 & K4 |
| **CO 3** | Master the aspects of protein – protein interaction, BLAST and PSI - BLAST | K2 & K6 |
| **CO 4** | Describe the features of local and multiple alignments | K3 & K6 |
| **CO 5** | Interpret the characteristics of phylogenetic methods and Bioinformatics applications. | K5 |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour) | |
| Skills acquired from this course | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | |

**Recommended texts**


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


**Reference Books**


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


**Web resources**

1. Bioinformatics: Algorithms & Applications by Prof. M. Michael Gromiha IIT - Madras. https://nptel.ac.in/courses/102/106/102106065/#.

2. Christopher Burge, David Gifford, and Ernest Fraenkel. *7.91*. J Foundations of Computational and Systems Biology. Spring 2014. Massachusetts Institute of Technology: MIT Open Course Ware, https://ocw.mit.edu
3. https://link.springer.com/book/10.1007/978-3-540-72800-9.
4. https://www.amazon.in/Applied-Bioinformatics-Paul-Maria-Selzer-ebook/dp/B001AUOYY2.
5. https://books.google.co.in/books/about/Applied_Bioinformatics.html?id=PXZZDwAAQBAJ&redir_esc=y

**Mapping with Programme Outcomes:**

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

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

## ELECTIVE IV – 2. BIOSTATISTICS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Title of the Course** | | **BIOSTATISTICS** | | | | | |
| **Paper Number** | | **ELECTIVE IV** | | | | | |
| **Category** | **Elective** | **Year** | **I** | **Credits** | **2** | **Course Code** | |
| | | **Semester** | **II** | | | | |
| **Instructional Hours Per week** | | **Lecture** | | **Tutorial** | **Lab Practice** | | **Total** |
| | | **2** | | **1** | **--** | | **3** |
| **Pre-requisite** | | Fundamental knowledge on using in statistical tools and apply the tools to interpret the results. | | | | | |
| **Learning Objectives** | | 1. To provide the student with a conceptual overview of statistical methods. | | | | | |
| | | 2. To emphasis on usefulness of commonly used statistical software for analysis, research, and experimentation. | | | | | |
| | | 3. To understand and evaluate critically the acquisition of data and its representation. | | | | | |
| | | 4. To gain the knowledge about the probability and statistical inference are all topics that will be taught in order to obtain knowledge about the graphical representation of data. | | | | | |
| | | 5. To learn more about how to organize, create, and carry out the distribution of scientific knowledge. | | | | | |

| UNIT | CONTENTS |
|---|---|
| I | **INTRODUCTION TO STATISTICS**<br>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**<br>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**<br>Basic principles - types - Rules of probability - addition and multiplication rules.<br>**PROBABILITY DISTRIBUTION**<br>Patterns of probability distribution; binomial - Poisson and normal. |
| IV | **HYPOTHESIS TESTING**<br>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**<br>Correlation - types of correlation - methods of study of correlation - testing the significance of the coefficients of correlation. Regression and types. Sampling and experimental designs of research-Randomized block design and split plot design. |

**Course Outcomes**

| CO | Course outcomes – on completion of this course, the students will be able to | Programme outcomes |
|---|---|---|
| **CO 1** | Create and interpret visual representations of quantitative information, such as graphs or charts. | K5 & K6 |
| **CO 2** | Solve problems quantitatively using appropriate arithmetical, algebraic, or statistical methods | K3 & K5 |
| **CO 3** | Know the latest version using in statistical tools and apply the tools to interpret the results | K2 |
| **CO 4** | To develop their competence in hypothesis testing and interpretation | K4 |
| **CO 5** | Understand why biologists need a background in statistics | K1 |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour) | |
| Skills acquired from this course | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | |

**Recommended texts**


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.
6. Kothari, C.R and Garg, G. 2014. Research methodology –Method and techniques. New Age International (P) Ltd. New Delhi.


**Reference Books**


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

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

**Web resources**

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

**Mapping with Programme Outcomes:**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|
| **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)**

## ELECTIVE IV – 3. INTELLECTUAL PROPERTY RIGHTS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Title of the Course** | | **INTELLECTUAL PROPERTY RIGHTS** | | | | | |
| **Paper Number** | | **ELECTIVE IV** | | | | | |
| **Category** | **Elective** | **Year** | **I** | **Credits** | **2** | **Course Code** | |
| | | **Semester** | **II** | | | | |
| **Instructional Hours Per week** | | **Lecture** | **Tutorial** | | **Lab Practice** | **Total** | |
| | | **2** | **1** | | **--** | **3** | |
| **Pre-requisite** | | Intent to understand the legal systems governing the knowledge economy. Basic understanding of how laws are structured and interpreted. | | | | | |
| **Learning Objectives** | | 1. 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**<br>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**<br>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**<br>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**<br>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**<br>Geographical Indications of Goods (Registration and Protection) Infringement – Offences and Penalties Remedies. Plant Variety and Farmers Right Act (PPVFR). Plant variety protection: Access and Benefit Sharing (ABS). Procedure for registration, effect of registration and term of protection. Role of NBA. Filing procedure for Ordinary application. Convention application. PCT National Phase application. Process of Obtaining a Patent. Infringement and Enforcement. |

**Course Outcomes**

| CO | Course outcomes – on completion of this course, the students will be able to | Programme outcomes |
|---|---|---|
| **CO 1** | Recall the history and foundation of Intellectual Property. | K1 |
| **CO 2** | Understand the differences of Property and Assets and Various Categories of Intellectual Creativity. | K2 |
| **CO 3** | Apply the methods to protect the Intellectual Property. | K3 |
| **CO 4** | Differentiate if the Said Intangible property be protected under law or protected by strategy. | K4 |
| **CO 5** | Create a recommendation document on the methods and procedures of protecting the said IP and search documents to substantiate them. | K5 & K6 |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour) | |
| Skills acquired from this course | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | |

**Recommended Text:**


1. Kalyan, C.K.2010. Indian Patent Law and Practice, India, Oxford University Press.
2. Ahuja, V.K. 2017. Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
3. Arthur Raphael Miller, Micheal Davis H. 2000. Intellectual Property: Patents, Trademarks and .Copyright in 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.


**Reference Books**


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

2. Anant Padmanabhan. 2012. Intellectual Property Rights: Infringement and Remedies Lexis Nexis Butterworths Wadhwa.
3. Intellectual Property Law in the Asia Pacific Region. 2009. Kluwer Max Planck Series,
4. Pradeep, S. Mehta (ed.). 2005. Towards Functional Competition Policy for India, Academic Foundation, Related.
5. Ramakrishna B and Anil Kumar, H.S. 2017. Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers, Notion Press, Chennai.
6. James Boyle, Jennifer Jenkins. 2018. Intellectual Property: Law & the Information Society—Cases and Materials, Create space Independent Pub. North Charleston, USA.
7. Damodar Reddy, S.V. 2019. Intellectual Property Rights -- Law and Practice, Asia Law House, Hyderabad.

**Web resources:**

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

**Mapping with Programme Outcomes:**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|
| **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)**

## ELECTIVE IV – 4. NANOBIOTECHNOLOGY

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Title of the Course** | | **NANOBIOTECHNOLOGY** | | | | | |
| **Paper Number** | | **ELECTIVE IV** | | | | | |
| **Category** | **Elective** | **Year** | **I** | **Credits** | **2** | **Course Code** | |
| | | **Semester** | **II** | | | | |
| **Instructional Hours Per week** | | **Lecture** | **Tutorial** | | **Lab Practice** | **Total** | |
| | | **2** | **1** | | **-** | **3** | |

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

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

**Course Outcomes**

| CO | Course outcomes – on completion of this course, the students will be able to | Programme outcomes |
|---|---|---|
| **CO 1** | Recall the essential features of biology and nanotechnology that are converging to create the new area of bionanotechnology. | K1 |
| **CO 2** | Formulate procedures for the synthesis of nanoparticles which are of medical importance which could be used to treat specific diseases. | K2 |
| **CO 3** | Characterize the various types of nano particle synthesis and advocate promotes the use of nano materials and anno composites. | K3 |
| **CO 4** | Analyze and apply the important of nanoparticles in plant diversity. | K4 |
| **CO 5** | Construct various types of nanomaterial for application and evaluate the impact on environment. | K5 & K6 |

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

**Recommended Text:**


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


**Reference Books:**


1. Claudio Nicolini. 2009. Nanotechnology Nanosciences, Pon Stanford Pub.Pvt.Ltd,
2. Robert, A and Ferias, Jr. 1999.Nanomedicine, Volume I: Basic capabilities,Landes Bioscience.

3. Barbara Panessa-Warren. 2006 Understanding cell-nanoparticle interactions making nanoparticles more biocompatible. Brookhaven National Laboratory.
4. European Commission, SCENIHR. 2006. Potential risks associated with engineered and adventitious products of nanotechnologies, European Union.
5. Gysell Mortimer, 2011. The interaction of synthetic nanoparticles with biological systems PhD Thesis, School of Biomedical Sciences, Univ.of Queensland.
6. Murty, B.S., Shankar, P., Raj, B., Rath, B.B., Murday, J. 2013. Textbook of Nanoscience and Nanotechnology. Spirnger Publication.
7. Prashant Kesharwani. 2019. Nanotechnology-Based Targeted Drug Delivery Systems for Lung Cancer. Academic Press. An imprint of Elsevier.

**Web resources:**

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

**Mapping with Programme Outcomes:**

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

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

**SKILL ENHANCEMENT COURSE 1**
**AGRICULTURE AND FOOD MICROBIOLOGY**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Title of the Course** | | **AGRICULTURE AND FOOD MICROBIOLOGY** | | | | | |
| **Paper Number** | | **Skill Enhancement 1** | | | | | |
| **Category** | **Skill Enhancement** | **Year** | **I** | **Credits** | **2** | **Course Code** | |
| | | **Semester** | **II** | | | | |
| **Instructional Hours Per week** | | **Lecture** | **Tutorial** | | **Lab Practice** | | **Total** |
| | | **2** | **1** | | **--** | | **3** |
| **Pre-requisite** | | 1. To understand the benefits of microbes in agriculture and food industry. | | | | | |
| **Learning Objectives** | | 2. To provide comprehensive knowledge about plant – microbe interactions. | | | | | |
| | | 3. To provide basic understanding about factors affecting growth of microbes | | | | | |
| | | 4. To appreciate the role of microbes in food preservation. | | | | | |
| | | 5. To understand about the benefits of microbes in agriculture and food industry. | | | | | |
| | | 6. To gain knowledge about practices involved in food industry. | | | | | |

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

**Course Outcomes**

| CO | Course outcomes – on completion of this course, the students will be able to | Programme outcomes |
|---|---|---|
| **CO 1** | Recognize the general characteristics of microbes and factors affecting its growth | K1 |
| **CO 2** | Explain the significance of microbes in increasing soil fertility | K 2 |
| **CO 3** | Elucidate concepts of microbial interactions with plant and food. | K 3 |
| **CO 4** | Analyze the impact of harmful microbes in agriculture and food Industry. | K 4 |
| **CO 5** | Determine and appreciate the role of microbes in food preservation and as biocontrol. | K5 & K6 |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper) | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour) | |
| Skills acquired from this course | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill | |

**Recommended Text:**


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


**Reference Books:**


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

**Web resources:**

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

**Mapping with Programme Outcomes:**

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

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