# Holy Cross College (Autonomous), Nagercoil

**Kanyakumari District, Tamil Nadu.**
**Accredited with A$^+$ by NAAC - IV cycle – CGPA 3.35**

Affiliated to

**Manonmaniam Sundaranar University, Tirunelveli**

**Semester I - IV**

**Guidelines & Syllabus**

**DEPARTMENT OF BOTANY**

**2023-2026**

**(With effect from the academic year 2024-2025)**

**Issued from**

**THE DEANS' OFFICE**

**Vision**

To impart knowledge with professional zeal and devotion for plant science.

**Mission**

Providing student – centered and profession- oriented higher education that bestows academic environment to create intellectuals with scientific temperament, in the context of global issues and environmental challenges.

**Graduate Attributes**

Graduates of our College develop the following attributes during the course of their studies.

- **Creative thinking:**
  Equipping students with hands-on-training through skill based courses and promote startup.
- **Personality development:**
  Coping with increasing pace and change of modern life through value education, awareness on human rights, gender issues and giving counselling for the needful.
- **Environmental consciousness and social understanding:**
  Reflecting upon green initiatives and understanding the responsibility to contribute to the society; promoting social and cultural diversity through student training and service learning programmes.
- **Communicative competence:**
  Offering effective communication skills in both professional and social contexts through bridge courses and activities of clubs and committees.
- **Aesthetic skills:**
  Engaging mind, body and emotions for transformation through fine arts, meditation and exercise; enriching skills through certificate courses offered by Holy Cross Academy.
- **Research and knowledge enrichment:**
  Getting in-depth knowledge in the specific area of study through relevant core papers; ability to create new understanding through the process of critical analysis and problem solving.
- **Professional ethics:**
  Valuing honesty, fairness, respect, compassion and professional ethics among students. The students of social work adhere to the *National Association of Social Workers Code of Ethics*
- **Student engagement in the learning process:**
  Obtaining extensive and varied opportunities to utilize and build upon the theoretical and empirical knowledge gained through workshops, seminars, conferences, industrial visits and summer internship programmes.
- **Employability:**
  Enhancing students in their professional life through Entrepreneur development, Placement & Career guidance Cell.
- **Women empowerment and leadership:**
  Developing the capacity of self-management, team work, leadership and decision making through gender sensitization programmes.

**Programme Educational Objectives (PEOs)**

| PEOs | Upon completion of M. Sc. Botany Programme, the graduates will be able to: | Mapping with Mission |
|---|---|---|
| **PEO1** | apply scientific and computational technology to solve social and ecological issues and pursue research. | **M1, M2** |
| **PEO2** | continue to learn and advance their career in industry both in private and public sectors. | **M4 & M5** |
| **PEO3** | develop leadership, teamwork, and professional abilities to become a more cultured and civilized person and to tackle the challenges in serving the country. | **M2, M5 & M6** |

**Programme Outcomes (POs)**

| POs | Upon completion of M.Sc. Botany Programme, the graduates will be able to: | Mapping with PEOs |
|---|---|---|
| **PO1** | apply their knowledge, analyze complex problems, think independently, formulate and perform quality research. | **PEO1 & PEO2** |
| **PO2** | carry out internship programmes and research projects to develop scientific and innovative ideas through effective communication. | **PEO1, PEO2 &PEO3** |
| **PO3** | develop a multidisciplinary perspective and contribute to the knowledge capital of the globe. | **PEO2** |
| **PO4** | develop innovative initiatives to sustain ecofriendly environment | **PEO1, PEO2** |
| **PO5** | through active career, team work and using managerial skills guide people to the right destination in a smooth and efficient way. | **PEO2** |
| **PO6** | employ appropriate analysis tools and ICT in a range of learning scenarios, demonstrating the capacity to find, assess, and apply relevant information sources. | **PEO1, PEO2 &PEO3** |
| **PO7** | learn independently for lifelong executing professional, social and ethical responsibilities leading to sustainable development. | **PEO3** |

**Programme Specific Outcomes (PSOs)**

| Program Specific Outcomes (PSO) | |
|---|---|
| **On successful completion of the M.Sc. Botany programme, 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 variousecosystems. |
| **PSO3** | identify the potency of plant resources in contemporary research and visualize futurethrust areas in Botany. |
| **PSO4** | design scientific experiments independently and to generate useful information toaddress various issues in Botany. |

| | |
|---|---|
| **PSO5** | acquire basic knowledge on principles and applications of laboratory instruments andadequate skills to handle them. |
| **PSO6** | choose and apply appropriate tools, techniques, resources, etc. to perform variousexperiments 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 thebioethical norms. |
| **PSO10** | demonstrate proficiency in communicating with various stakeholders like students,teachers, scientists and society. |

**Mapping of PO'S and PSO'S**

| POs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **PO 1** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| **PO 2** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| **PO 3** | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **PO4** | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **PO5** | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 |
| **PO6** | 3 | 2 | 2 | 1 | 3 | 3 | 2 | 3 | 2 | 2 |
| **PO7** | 3 | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 3 | 2 |
| **Total** | 20 | 18 | 18 | 16 | 19 | 18 | 18 | 17 | 18 | 17 |
| **Average** | 3 | 2.7 | 2.7 | 2.4 | 2.8 | 2.5 | 2.5 | 2.5 | 2.7 | 2.5 |

**Eligibility**

**For Admission:** A candidate who is a graduate of this college or any other recognized University in the main subject/ subjects as given below against each or who has passed an examination accepted as equivalent by the Syndicate of Manonmaniam Sundaranar University, Tirunelveli, is eligible for admission.

**Components of M.Sc. Programme**

| | | |
|---|---|---|
| Core Course | 9x 100 | 900 |
| Core Lab Course | 4 x 100 | 400 |
| Elective Course | 7 x 100 | 700 |
| Core Research Project | 1 x 100 | 100 |
| **Total Marks** | | **2100** |

**Course Structure**

**(i) Curricular Courses**

**Distribution of Hours and Credits**

| Course | SEMESTER | | | | Total | |
|---|---|---|---|---|---|---|
| | I | II | III | IV | Hours | Credits |
| Core Course | 7(5) + 7(5) | 5(4)+ 5(4) +5(4) | 6(5) + 6(5) + | 6(5) + 6 (5)+ | **76** | **60** |
| Core Lab Course | 6(4) | 5(4) | 6(5) | 6(5) | | |
| Elective Course | 5 (3) + | 4 (2) + | 4(3) | 4 (3) | **30** | **19** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 5 (3) | 4 (2) | - | + 4(3) | | |
| Core Research Project | | - | 5(4) | | **5** | **4** |
| Skill Enhancement Course | | 2 (2) | 3 (2) | 4 (2) | **9** | **6** |
| Internship | | | (2) | | - | **2** |
| **Total** | **30 (20)** | **30 (22)** | **30 (26)** | **30 (23)** | **120** | **91** |

**Total Number of Hours =120**

**(ii) Co-curricular Courses**

| **Course** | **SEMESTER** | | | | **Total** |
|---|---|---|---|---|---|
| | **I** | **II** | **III** | **IV** | **Credits** |
| Life Skill Training –I | - | (1) | - | - | 1 |
| Life Skill Training –II | - | - | - | (1) | 1 |
| Field Project | (1) | - | - | | 1 |
| Specific Value-Added Courses | (1) | | (1) | | 2 |
| Generic Value-Added Courses | | (1) | | (1) | 2 |
| MOOC | | (1) | | (1) | 2 |
| Community Engagement Activity (UBA) | | (1) | | | 1 |

Total Number of Hours = 120

**Total Number of Credits = 91 + (10)**

**COURSES OFFERED**
**SEMESTER I**

| **Course Code** | **Title of the Course** | **Credits** | **Hours / Week** |
|---|---|---|---|
| BP231CC1 | Core Course I: Plant Diversity-I Algae, Fungi, Lichens and Bryophytes | 5 | 7 |
| BP231CC2 | Core Course II: Plant Diversity - II: Pteridophytes, Gymnosperms and Palaeobotany | 5 | 7 |
| BP231CP1 | Core Lab Course I: Laboratory course- I: Covering Core Papers - I and II | 4 (2+2) | 6 (3+3) |
| P231EC1 | Elective Course I: a) Microbiology, immunology and plant pathology | 3 | 5 |
| BP231EC2 | Elective Course I: b) Conservation of natural resources and policies | | |
| BP231EC3 | Elective Course I: c) Mushroom cultivation | | |
| BP231EC4 | Elective Course II: a) Ethnobotany, naturopathy and Traditional Healthcare | 3 | 5 |
| BP231EC5 | Elective Course II:b)Algal Technology | | |
| BP231EC6 | Elective Course II:c) Herbal Technology | | |
| | **Total** | **20** | **30** |

## SEMESTER II

| Course Code | Title of the Course | Credits | Hours / Week |
|---|---|---|---|
| BP232CC1 | Core Course III: Taxonomy of Angiosperms and Economic Botany | 4 | 5 |
| BP232CC2 | Core Course IV: Plant Anatomy and Embryology of angiosperms | 4 | 5 |
| BP232CC3 | Core Course V: Ecology, Phytogeography, Conservation Biology and Intellectual Property Rights | 4 | 5 |
| BP232CP1 | Core Lab Course II: Lab Course (for Core III, IV& V) | 4 | 5 |
| BP232EC1 | Elective Course III:a)Biostatistics | 2 | 4 |
| BP232EC2 | Elective Course III: b) Intellectual Property Rights | | |
| BP232EC3 | Elective Course III: c) Applied bioinformatics | | |
| BP232EC4 | Elective Course IV: a)Research methodology, computer applications & bioinformatics | 2 | 4 |
| BP232EC5 | Elective Course IV:b) Medicinal Botany | | |
| BP232EC6 | Elective Course IV:c) Phytochemistry | | |
| BP232SE1 | Skill Enhancement Course I: Nursery and Gardening | 2 | 2 |
| | **Total** | **22** | **30** |

## SEMESTER III

| Course Code | Title of the Course | Credits | Hours / Week |
|---|---|---|---|
| BP233CC1 | Core Course VI: Cell and Molecular biology | 5 | 6 |
| BP233CC2 | Core Course VII: Genetics, Plant breeding and Biostatistics | 5 | 6 |
| BP233CP1 | Core Lab Course III: Core Course VI and VII | 5 | 6 |
| BP233RP1 | Core Research Project | 4 | 5 |
| BP233EC1 | Elective Course V: a) Entrepreneurial Opportunities in Botany | 3 | 4 |
| BP233EC2 | Elective Course V: b) Secondary Plant Products and Fermentation Biotechnology | | |
| BP233EC3 | Elective Course V: c) Applied Plant Cell and Tissue Culture | | |
| BP233SE1 | Skill Enhancement Course II: Agriculture and Food Microbiology | 2 | 3 |
| BP233IS1 | Internship | 2 | - |
| | **Total** | **26** | **30** |

## SEMESTER IV

| Course Code | Title of the Course | Credits | Hours / Week |
|---|---|---|---|
| BP234CC1 | Core Course VIII: Plant Physiology and Plant Metabolism | 5 | 6 |
| BP234CC2 | Core Course IX: Biochemistry and Applied Biotechnology | 5 | 6 |
| BP234CP1 | Core Lab Course IV: Core Course VIII and IX | 5 | 6 |
| BP234EC1 | Elective Course VI: a) Forestry and Wood Technology | 3 | 4 |
| BP234EC2 | Elective Course VI: b) Organic farming | | |
| BP234EC3 | Elective Course VI: c) Gene Cloning and Gene Therapy | | |
| BP234EC4 | Elective Course VII: a) Industrial Botany | 3 | 4 |
| BP234EC5 | Elective Course VII: b) Farm Sciences: Green Wealth | | |

| | | | |
|---|---|---|---|
| BP234EC6 | Elective Course VII: c) Biopesticide Technology | | |
| BP234SE1 | Skill Enhancement Course III: Professional Competency in Biology | 2 | 4 |
| | **Total** | **23** | **30** |
| | **Total** | **91** | **120** |

**Specific Value Added Course**

| Semester | Title of the course | Course Code |
|---|---|---|
| I | Natural Resources and their Conservation | BP231V01 |
| I | Biofertilizers | BP231V02 |
| III | Wine Making | BP233V01 |
| III | Food Preservation | BP233V02 |

**Self Learning Course**

| Semester | Title of the course | Course Code |
|---|---|---|
| III | Principles of Plant Science | BP233SL1 |
| IV | NET/ SET for Botany students | BP234SL1 |

**Co-curricular Courses**

| Semester | Code | Title of the Course | Credit |
|---|---|---|---|
| I & II | PG23LST1 | Life Skill Training | 1 |
| II & IV | - | MOOC | 1+1 |
| II | PG232CE1 | Community Engagement Course (CEC) | 1 |
| III & IV | PG23LST2 | Life Skill Training | 1 |
| I | BP231FP1 | Field Project | 1 |
| I & III | BP231V01 / BP233V01 | Specific Value-added Course | 1+1 |
| II & IV | GVAC2401 - | Generic Value-added Course | 1+1 |
| | | **Total** | **10** |

**Examination Pattern**

Curricular Courses:

**i) Core Course / Elective Course**

Internal: External–25:75

Continuous Internal Assessment (CIA)

Internal Components and Distribution of Marks

| Components | Marks |
|---|---|
| Internal test (2) (40 marks) | 10 |
| Quiz (2) (20 marks) | 5 |
| Seminar (10 marks) | 5 |
| Assignment: (Model Making, Exhibition, Role Play, Group Discussion, Problem Solving, Class Test, Open Book Test (Minimum three items per course) (30 marks) | 5 |
| **Total** | **25** |

**Question Pattern**

| Internal Test | Marks | External Exam | Marks |
|---|---|---|---|
| Part A 4 x 1 (No choice) | 4 | Part A 10 x 1 (No choice) | 10 |
| Part B 2 x 6 (Internal choice) | 12 | Part B 5 x 6 (Internal choice) | 30 |
| Part C 2 x 12 (Internal choice) | 24 | Part C 5 x 12 (Internal choice) | 60 |
| **Total** | **40** | **Total** | **100** |

**ii) Core Lab Course:**

Ratio of Internal and External= 25:75

Total: 100 marks

Internal Components and Distribution of Marks

| Internal Components | Marks |
|---|---|
| Performance of the Experiments | 10 |
| Regularity in attending practical and submission of records | 5 |
| Record | 5 |
| Model exam | 5 |
| **Total** | **25** |

**Question pattern**

| External Exam | Marks |
|---|---|
| Major Practical | |
| Minor Practical / Spotters /Record | 75 |
| **Total** | **75** |

**iii) Core Research Project:**

Ratio of Internal and External 25: 75

| Internal | Marks |
|---|---|
| I Review | 5 |
| II Review | 5 |
| Report | 15 |
| **External** | |
| Report | 40 |
| Viva-voce (individual, open viva-voce) | 35 |
| **Total** | **100** |

**iv) Skill Enhancement Course**

Ratio of Internal and External = 25: 75

**Internal Components and Distribution of Marks**

| Components | Marks |
|---|---|
| Internal test (2) – (40 marks) | 10 |
| Quiz (2) – (20 marks) | 5 |
| Assignment: (Model Making, Exhibition, Role Play, Album, Group Activity (Mime, Skit, Song) (Minimum three items per course) | 10 |
| **Total** | **25** |

**Question Pattern**

| Internal Test | Marks | External Exam | Marks |
|---|---|---|---|
| Part A 2 x 2 (No Choice) | 4 | Part A 5 x 2 (No Choice) | 10 |
| Part B 3 x 4 (Open choice Three out of Five ) | 12 | Part B 5 x 4 (Open choice any Five out of Eight) | 20 |
| Part C 1 x 9 (Open choice One out of Three) | 9 | Part C 5 x 9 (Open choice any Five out of Eight) | 45 |
| **Total** | **25** | **Total** | **75** |

**Internship**

| Components | Marks |
|---|---|
| Industry Contribution | 50 |
| Report & Viva-voce | 50 |
| **Total** | **100** |

**Co-Curricular Courses:**

**(i) Life Skill Training**

**Internal Component**

| Components | | Marks |
|---|---|---|
| **Life Skill Training -I** | Album (20 pages) | 30 |
| | Group Activity (Group of 5 students) | 20 |
| | **Total** | **50** |
| **Life Skill Training -II** | Case Study (30 pages) | 50 |
| | **Total** | **50** |

**External Component**

| | | |
|---|---|---|
| Written Test | Five out of Seven (5 x 10) | 50 |
| | **Total** | **50** |

**(ii) Field Project:**

| Components | Marks |
|---|---|
| Field Work | 50 |
| Field Project Report & Viva-voce | 50 |
| **Total** | **100** |

**(iii) Specific Value-Added Courses & Generic Value-Added Courses:**

| Components | Marks |
|---|---|
| Internal | 25 |
| External | 75 |
| **Total** | **100** |

**(iv) Community Engagement Activity-UBA**

| **Internal Component** | |
|---|---|
| **Component** | **Marks** |
| Attendance (Field Work) | 30 |
| Participation | 20 |
| **Total** | **50** |

**External Component**

| Component | Marks |
|---|---|
| Group Project Report/ Case Study (10-15 pages in print) | 50 |
| **Total** | **50** |

**(v) Self Learning Course**

| Internal Test | Marks | External Exam | Marks |
|---|---|---|---|
| Part A 2 x 2 (No Choice) | 4 | Part A 5 x 2 (No Choice) | 10 |
| Part B 3 x 4 (Open choice Three out of Five ) | 12 | Part B 5 x 4 (Open choice any Five out of Eight) | 20 |
| Part C 1 x 9 (Open choice One out of Three) | 9 | Part C 5 x 9 (Open choice any Five out of Eight) | 45 |
| **Total** | **25** | **Total** | **75** |

**Outcome Based Education (OBE)**

(i) Knowledge levels for assessment of Outcomes based on Blooms Taxonomy

| S. No. | Level | Parameter | Description |
|---|---|---|---|
| 1 | KI | Knowledge/Remembering | It is the ability to remember the previously learned |
| 2 | K2 | Comprehension/Understanding | The learner explains ideas or concepts |
| 3 | K3 | Application/Applying | The learner uses information in a new way |
| 4 | K4 | Analysis/Analysing | The learner distinguishes among different parts |
| 5 | K5 | Evaluation/Evaluating | The learner justifies a stand or decision |
| 6 | K6 | Synthesis /Creating | The learner creates a new product or point of view |

**(ii) Weightage of K – levels in Question Paper**

Number of questions for each cognitive level:

| Assessment | Cognitive Level | KI | | | K2 | | | K3 | | | K4, K5, K6 | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Internal Test | Part | A | B | C | A | B | C | A | B | C | A | B | C | |
| | No. of Questions | 1 | 1 | - | - | - | - | 1 | - | 1 | 2 | 1 | 1 | **8** |
| External Examination | Part | A | B | C | A | B | C | A | B | C | A | B | C | |
| | No. of Questions | 3 | - | 1 | 3 | 1 | 1 | 1 | 2 | 1 | 3 | 2 | 2 | **20** |

**The levels of assessment are flexible and it should assess the cognitive levels and outcome attainment.**

**Evaluation**

i. The performance of a student in each Course is evaluated in terms of percentage of marks with a provision for conversion to grade points.

ii. Evaluation for each Course shall be done by a Continuous Internal Assessment (CIA) by the Course teacher as well as by an end semester examination and will be consolidated at the end of the semester.

iii. There shall be examinations at the end of each semester, for odd semesters in October / November;

for even semesters in April / May.

iv. A candidate who does not pass the examination in any course (s) shall be permitted to re-appear in such failed course (s) in the subsequent examination to be held in October / November or April / May. However, candidates who have arrears in Practical Examination(s) shall be permitted to re-appear for their arrears only along with Regular Practical examinations in the respective semester.

v. Viva- voce: Each candidate shall be required to appear for Viva-voce Examination in defense of the Project.

vi. The results of all the examinations will be published in the College website.

**Conferment of the Master's Degree**

A candidate shall be eligible for the conferment of the Degree of Master of Arts / Science/ Commerce only if the minimum required credits for the programme thereof (91 +10 credits) is earned.

**Grading System**

For a semester examination:

Calculation of Grade Point Average for End Semester Examination:

$$\text{GPA} = \frac{\text{Sum of the multiplication of grade points by the credits of the course}}{\text{Sum of the credits of the courses (passed) in a semester}}$$

For the entire programme:

Cumulative Grade Point Average (CGPA) $\Sigma_n\Sigma_i C_{ni}G_{ni} / \Sigma_{ni}\Sigma_i C_{ni}$

$$\text{CGPA} = \frac{\text{Sum of the multiplication of grade points by the credits of the entire programme}}{\text{Sum of the credits of the courses of the entire programme}}$$

where

$C_i$ - Credits earned for course i in any semester

$G_i$ - Grade point obtained for course i in any semester

n - semester in which such courses were credited

Final Result

**Conversion of Marks to Grade Points and Letter Grade**

| Range of Marks | Grade Points | Letter Grade | Description |
|---|---|---|---|
| 90-100 | 9.0-10.0 | O | Outstanding |
| 80-89 | 8.0-8.9 | D+ | Excellent |
| 75-79 | 7.5-7.9 | D | Distinction |
| 70-74 | 7.0-7.4 | A+ | Very Good |
| 60-69 | 6.0-6.9 | A | Good |
| 50-59 | 5.0-5.9 | B | Average |
| 00-49 | 0.0 | U | Re-Appear |
| ABSENT | 0.0 | AAA | ABSENT |

**Overall Performance**

| CGPA | Grade | Classification of Final Results |
|---|---|---|
| 9.5-10.0 | O+ | First Class – Exemplary* |
| 9.0 and above but below 9.5 | O | |
| 8.5 and above but below 9.0 | D++ | First Class with Distinction* |
| 8.0 and above but below 8.5 | D+ | |
| 7.5 and above but below 8.0 | D | |
| 7.0 and above but below 7.5 | A++ | First Class |

| | | |
|---|---|---|
| 6.5 and above but below 7.0 | A+ | |
| 6.0and above but below 6.5 | A | |
| 5.5and above but below 6.0 | B+ | Second Class |
| 5.0 and above but below 5.5 | B | |
| 0.0 and above but below 5.0 | U | Re-appear |

*The candidates who have passed in the first appearance and within the prescribed semester are eligible.

**SEMESTER I**
**CORE COURSE I: PLANT DIVERSITY- I:**
**ALGAE, FUNGI, LICHENS AND BRYOPHYTES**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP231CC1 | 5 | 2 | - | - | 5 | 7 | 105 | 25 | 75 | 100 |

**Prerequisite:**

Students should be familiar with the basics of algae, fungi, lichens and bryophytes.

**Learning objectives:**

1. To learn about the classification, distinguishing traits, geographic distribution, and reproductive cycle of algae, fungi, lichens, and bryophytes.
2. To gain knowledge about the ecological and economic importance of algae, fungi, lichens and bryophytes

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 1 | relate to the structural organizations of algae, fungi, lichens and Bryophytes | K1 |
| 2 | demonstrate both the theoretical and practical knowledge in understanding the diversity of basic life forms and their importance. | K2 |
| 3 | explain life cycle patterns in algae, fungi, lichens and Bryophytes | K3 |
| 4 | compare and contrast the mode of reproduction in diverse groups of basic plant forms. | K4 |
| 5 | discuss and develop skills for effective conservation and utilization of lower plant forms. | K5& K6 |

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

| Unit | Contents | No. of Hours |
|---|---|---|
| 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) & Silva (1982). Salient features of major classes: Cyanophyceae, Chlorophyceae, Xanthophyceae, Chrysophyceae, Cryptophyceae, Dinophyceae, Chloromonadineae, Euglenophyceae, Charophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae. Range of thallus organization, algae of diverse habitats, reproduction (vegetative, asexual and sexual) and life cycles. Phylogeny and inter-relationships of algae, origin and evolution of sex in algae. Structure, reproduction and life histories of the following genera: *Oscillatoria, Ulva, Diatoms* and*Dictyota*.. | 21 |
| 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, Para sexuality, sex hormones in fungi. Structure, reproduction and life histories of the following genera: *Plasmodiophora, Phytophthora*, *Rhizopus, Taphrina*, *Polyporus* and *Colletotrichum.* | 21 |

| | | |
|---|---|---|
| **III** | **LICHENS**<br>Introduction and Classification (Hale, 1969). Occurrence and inter-relationship of phycobionts and mycobionts, structure and reproduction in Ascolichens, Basiodiolichens and Deuterolichens.. | **21** |
| **IV** | **BRYOPHYTES**<br>General characters and Classification of Bryophytes by Watson (1971). Distribution, Structural variations and evolution of gametophytes and sporophytes in Bryopsida, Anthoceropsida and Mosses. General characters of major groups - Marchantiales, Jungermaniales, Anthocerotales, Sphagnales, Funariales and Polytrichales. Reproduction - Vegetative and sexual, spore dispersal mechanisms in bryophytes, spore germination patterns in bryophytes.<br>Structure, reproduction and life histories of the following genera: *Targionia, Porella*and *Polytrichum.* | **21** |
| **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. Culturing and cultivation of mushrooms *Pleurotus.* Lichen – economic importance and as indicator pollution. Bryophytes – Ecological and economic importance – industry, horticulture and medicine. | **21** |
| | **Total** | **105** |

| | |
|---|---|
| **Self -study** | Structure, reproduction and life histories of the genera:*Diatoms,* General characters of major groups – Marchantiales and Anthocerotales, Culturing and cultivation of mushrooms *Pleurotus.* |

**Textbooks**


1. Vashishta, D.R. 1988. Botany for degree students – Algae. S. Chand Publishing, New Delhi: pp.568.
2. Pandey, P.B. 2014. College Botany-1: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. 20th Edition, New Delhi:S. Chand Publishing, pp.936.
3. Kevin K. 2018. Fungi biology and Application. 3rd Edition, Wiley Blackwell, New Jersey pp. 416.
4. Sharma, O.P. 2014. Bryophyta. Published by McGraw Hill Education (India) Private Limited, pp.396.
5. Singh, Pandey and Jain. 2020. A text book of Botany. 5th Edition. Meerut: Rastogi Publication,pp.412

**Reference Books**


1. Sundaralingam,V. 1990. Marine Algae: Morphology, Reproduction and Biology. Lubrecht & Cramer Ltd, India,pp.258.
2. Nash, T.H. 2008. Lichen Biology (Second Edition), Cambridge University press, London, pp.477.
3. Malhotra,M and Pathak, C. 2012. A Textbook of Bryophyta. Dominant Publishers & Distributors Pvt., Ltd, New Delhi.
4. Alexopoulos, C.J. and Mims, M. Blackwell, M. 2007. Introductory Mycology(Fourth Edition), Wiley Publishers, New Delhi, pp.880.
5. Edward Lee, R. 2018.Phycology. (Fifth Edition),Cambridge University Press, London.


**Web Resources**

1. https://www.britannica.com/science/algae
2. https://www.livescience.com/53618-fungus.html.
3. http://www.uobabylon.edu.iq/eprints/paper_11_20160_754.pdf
4. https://www.youtube.com/watch?v=vcYPI6y-Udo
5. http://www-plb.ucdavis.edu/courses/bis/1c/text/Chapter22nf.pdf

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 1 | 2 | 2 | 1 | 2 |
| **CO3** | 3 | 3 | 3 | 1 | 2 | 1 | 2 |
| **CO4** | 3 | 3 | 1 | 2 | 1 | 2 | 2 |
| **CO5** | 3 | 3 | 2 | 1 | 2 | 2 | 2 |
| **Total** | **15** | **15** | **10** | **9** | **10** | **9** | **11** |
| **Average** | **3** | **3** | **2** | **1.8** | **2** | **1.9** | **2.2** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 2 | 1 | 2 | 2 | 2 | 1 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 3 | 2 | `1 | 2 | 3 |
| **CO3** | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| **Total** | **14** | **14** | **12** | **13** | **13** | **10** | **9** | **10** | **9** | **12** |
| **Average** | **2.8** | **2.8** | **2.4** | **2.6** | **2.6** | **2.0** | **1.8** | **2.0** | **1.8** | **2.4** |

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

**SEMESTER I**

**CORE COURSE II: PLANT DIVERSITY – II: PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP231CC2 | 5 | 2 | - | - | 5 | 7 | 105 | 25 | 75 | 100 |

**Pre-requisite:** Students should know about the fundaments of Pteridophytes, Gymnosperms and fossil records.

**Learning Objectives:**

1. To investigate the classification, distinctive traits, distribution and reproduction and life history of the various classes and major types of Pteridophytes and Gymnosperms.
2. To identify and characterize diversity of lower vascular plants in order to comprehend the dynamics of diversity to realize the importance of diversity.

**Course Outcomes**

| | On the successful completion of the course, student will be able to: | |
|---|---|---|
| **1** | recall classification, recent trends in phylogenetic relationship, general characters of Pteridophytes and Gymnosperms. | **K1 & K2** |
| **2** | learn the morphological/anatomical organization, life history of major types of Pteridophytes and Gymnosperms. | **K2 & K4** |
| **3** | comprehend the economic importance of Pteridophytes, Gymnosperms and fossils. | **K3 & K5** |
| **4** | understanding the evolutionary relationship of Pteridophytes and Gymnosperms. | **K4 & K6** |
| **5** | awareness on fossil types, fossilization and fossil records of Pteridophytes and Gymnosperms. | **K5 & K6** |

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

| Units | Contents | No. of Hours |
|---|---|---|
| **I** | **PTERIDOPHYTES:** General characteristics and classification (Reimer, 1954). Range of structure, reproduction and evolution of the gametophytes, Gametophyte types – sex organs. Apogamy and Apospory. Life cycles. Stellar evolution. Heterospory and seed habit, Telome theory, morphogenesis, Economic importance of Pteridophytes. | **21** |
| **II** | **PTERIDOPHYTES:** Structure, anatomy, reproduction and life histories of the following genera: *Equisetum*, *Angiopteris*, *Pteris* and *Azolla.* | **21** |
| **III** | **GYMNOSPERMS:** General characters - A general account of distribution of Gymnosperms. Morphology, anatomy, reproduction, phylogeny and classification (K.R.Sporne, 1965). Economic importance of Gymnosperms. | **21** |
| **IV** | **GYMNOSPERMS:** Structure (Exomorphic and endomorphic), anatomy, reproduction and life histories of the following genera: *Cedrus*, *Cupressus*, *Araucaria*, *Podocarpus*, *Gnetum* and *Ephedra*. | **21** |
| **V** | **PALEOBOTANY:** Geological Scale; Radiocarbon dating; Contribution of Birbal Sahni to Paleobotany. Gondwana flora of India. Study of fossils in understanding evolution. Fossilization and fossil types. Economic importance of fossils – fossil fuels and industrial raw | **21** |

| | | |
|---|---|---|
| | materials and uses. Study of organ genera: *Rhynia, Lepidocarpon, Calamites, Cordaites* and *Lyginopteris.* | |
| | **Total** | **105** |

| | |
|---|---|
| **Self Study** | Morphology Characters of Pteridophytes and Gymnosperms, Economic importance of Gymnosperms, Gondwana flora of India, Fossilization and fossil types. |

**Textbooks**


1. Vashishta, P.C. Sinha, A.K and Anil Kumar. (2016). Botany for Degree students. Gymnosperms. New Delhi: S. Chand and Company Ltd. Pp:592
2. Singh,V.,Pande,P.C andJain,D.K. (2021). A Text Book of Botany. Meerut: Rastogi Publications. Pp:1266.
3. Bhatnagar, S.P and Alok Moitra. (2020). Gymnosperms. Bengaluru: New Age International (P) Ltd., Publishers. Pp:470.
4. Sharma, O.P. (2017). Pteridophyta. New York: McGraw Hill Education. Pp:64.
5. Vashishta.P.C.,A.K.Sinha and AnilKumar. (2018).Botany for Degree students-Gymnosperms. New Delhi: S. Chand and Company Ltd. Pp:580


**Reference Books**


1. Parihar, N.S., 2019. An Introduction to Embryophyta, Pteridophytes (5th Edition). Surjeet Publication, New Delhi. Pp:377
2. Pandey, S.N., P.S. Trivedi, 2015. A Text Book of BotanyVol. II- (12 th edition). Vikas Publishing, New Delhi. Pp:752.
3. Rashid, A., 2013. An introduction to Pteridophyta – Diversity, Development and differentiation. (2nd edition). Vikas Publications. New Delhi.Pp:400
4. Arnold, A.C. 2005. An Introduction to Paleobotany. Agrobios (India). Jodhpur. Pp:212
5. Sporne, K.R. 2017. The morphology of Pteridophytes- The structure of Ferns and Allied Plants. Vikas Publications, New Delhi. Pp: 328.


**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/about/Botany_for_Degree_Gymnosperm_Multicolor.html?id=HTdFYFNxnWQC&redir_esc=y
4. https://books.google.co.in/books/about/Gymnosperms.html?id=4dvyNckni8wC
5. https://www.palaeontologyonline.com/

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 1 | 2 | 2 | 1 | 2 |
| **CO3** | 3 | 3 | 1 | 1 | 2 | 1 | 2 |
| **CO4** | 3 | 3 | 2 | 2 | 1 | 2 | 2 |
| **CO5** | 3 | 3 | 2 | 1 | 2 | 2 | 2 |
| **Total** | **15** | **15** | **9** | **9** | **10** | **9** | **11** |
| **Average** | **3** | **3** | **1.9** | **1.8** | **2** | **1.9** | **2.2** |

## MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 3 | 2 | 1 | 2 | 2 | 2 | 2 |
| **CO2** | 2 | 3 | 2 | 2 | 3 | 3 | 2 | `1 | 3 | 2 |
| **CO3** | 1 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 3 |
| **CO4** | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 |
| **CO5** | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| **Total** | **9** | **12** | **12** | **13** | **13** | **10** | **9** | **10** | **13** | **12** |
| **Average** | **1.8** | **2.4** | **2.4** | **2.6** | **2.6** | **2.0** | **1.8** | **2.0** | **2.6** | **2.4** |

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

**SEMESTER I**
**CORE LAB COURSE I: LABORATORY COURSE**
**COVERING CORE PAPERS- I AND II**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP231CP1 | - | - | 6 | | 4 | 6 | 90 | 25 | 75 | 100 |

**Pre requisite**

Students should be familiar with the fundamentals of algae, fungi, lichens, Bryophytes, Pteridophytes, Gymnosperms, Paleobotany and microbes in addition to essential laboratory techniques

**Learning Objectives :**

1. To learn how to employ the use of instruments, technologies and methodologies related to thallophytes and non-flowering plant groups.
2. To comprehend the fundamental concepts and methods used to identify Bryophytes, Pteridophytes and Gymnosperms through morphological changes and evolution, anatomy and reproduction.

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| **1** | recall and applying the basic keys to distinguish at species level identification of important algae and fungi through its structural organizations. | **K1&K4** |
| **2** | demonstrate practical skills in thallophytes, Pteridophytes and Gymnosperms. | **K2** |
| **3** | describe the structure of algae, fungi, lichens, Bryophytes, Pteridophytes and Gymnosperms. . | **K3** |
| **4** | determine the importance of structural diversity in the evolution of plant forms. | **K5** |
| **5** | formulate techniques to isolate and culture of alga and fungi as well as to understand the diversity of plant forms. | **K5&K6** |

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

| Units | Contents | No. of Hours |
|---|---|---|
| **1** | **ALGAE**<br>Study of algae in the field and laboratory of the genera included in theory.<br>External morphology and internal anatomy of the vegetative and reproductive structures of the following living forms: *Oscillatoria, Ulva, Diatoms, Dictyota, Padina and Gelidum* (depending on availability of the specimen).<br>To record the local algal flora–Study of their morphology and structure.<br>Identification of algae to species level (at least One).<br>Preparation of culture media and culture of green algae and blue green algae in the laboratory (Demonstration). | **18** |
| **II** | **FUNGI**<br>Study of morphological and reproductive structures of the following living forms: *Plasmodiophora, Phytophthora, Rhizopus,Taphrina, Polyporus* and *Colletotrichum* (depending on availability of the specimen).<br>Isolation and identification of fungi from soil, air, and Baiting method.<br>Preparation of culture media.<br>Cultivation of mushroom in the laboratory (Demonstration). | **18** |

| | | |
|---|---|---|
| | **LICHENS**<br>Study of morphological and reproductive structures of the genera *Usnea* | |
| **III** | **BRYOPHYTES**<br>External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Riccia, Targionia Anthoceros* and *Polytrichum* (depending on availability of the specimen). | **18** |
| **IV** | **PTERIDOPHYTES**<br>External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Isoetes, Pteris, Equisetum* and *Azolla* (depending on availability of the specimen).<br>Fossil slides observation: *Rhynia, Lepidocarpon, Calamites.* | **18** |
| **V** | **GYMNOSPERMS**<br>External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Cupressus, Araucaria, Podocarpus* (depending on availability of the specimen). Fossil slides observation*: Cordaites* and *Lyginopteris* | **18** |
| | **Total** | **90** |

| | |
|---|---|
| **Self Study Portion** | *Oscillatoria, Usnea, Anthoceros, Rhynia* (*(*Fossil), Araucaria |

**Textbooks**


1. Vashishta, D.R. 1988. Botany for degree students – Algae. S. Chand Publishing, New Delhi: pp -568.
2. Saha, R and Das, S.2020. Microbiology Practical Manual (First Edition), CBS Publishers and Distributors (P) Ltd, New Delhi.
3. Sharma, O.P. (2012). Pteridophyta. Tata McGraw-Hills Ltd, New Delhi.
4. Tyagi, K, Johri, R.M, Lata, S, 2005. A text book of Gymnosperms. Dominant Publishers & Distributors, New Delhi.
5. Sharma, O.P. and S, Dixit. (2002).Gymnosperms (Fifteen Edition), Pragati Prakashan Publishers, New Delhi. pp - 358


**Reference Books**


1. Chmielewski, J.G. and Krayesky, D. 2013. General Botany laboratory Manual. Author House, Bloomington, USA.pp-300
2. Webster,J and Weber, R. 2007. Introduction to Fungi. (Third Edition), Cambridge University, Cambridge, London. Press,pp- 867.
3. Sharma, O.P. (2017). Bryophyta, McGraw Hill Education, New York. pp-416.
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, . New Delhi.
5. Gangulee, H.C and A.K. Kar.2013. College Botany (Fifth Edition), S. Chand Publications, New Delhi


**Web Resources**

1. https://www.frontiersin.org/articles/10.3389/fmicb.2017.00923/full
2. https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf
3. http://www.cuteri.eu/microbiologia/manuale_microbiologia_pratica.pdf
4. https://www.amazon.in/Manual-Practical-Bryophyta-Suresh-Kumar/dp/B0072GNFX4
5. https://www.amazon.in/Paleobotany-Biology-Evolution-Fossil-Plants/dp/0123739721

**MAPPING WITH PROGRAMME OUTCOMES**

| **COs** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 1 | 1 | 2 | 2 | 1 | 1 |
| **CO3** | 3 | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO4** | 3 | 2 | 2 | 2 | 1 | 2 | 2 |
| **CO5** | 3 | 2 | 2 | 1 | 2 | 2 | 2 |
| **Total** | **15** | **9** | **9** | **9** | **10** | **9** | **9** |
| **Average** | **3** | **1.9** | **1.9** | **1.8** | **2** | **1.9** | **1.9** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| **COs** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** | **PSO10** |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 3 | 2 | 2 | 3 | 3 | 2 | `1 | 3 | 3 |
| **CO3** | 1 | 2 | 3 | 2 | 2 | 3 | 1 | 2 | 2 | 3 |
| **CO4** | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO5** | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| **Total** | **9** | **12** | **12** | **13** | **13** | **15** | **9** | **10** | **13** | **15** |
| **Average** | **1.8** | **2.4** | **2.4** | **2.6** | **2.6** | **3.0** | **1.8** | **2.0** | **2.6** | **3.0** |

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

**SEMESTER I**

**ELECTIVE COURSE I: a) MICROBIOLOGY, IMMUNOLOGY AND PLANT PATHOLOGY**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP231EC1 | 3 | 2 | - | - | 3 | 5 | 75 | 25 | 75 | 100 |

**Pre-requisite:**

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:**

1. To provide comprehensive knowledge about microbes and its effect on man and environment.
2. To provide comparative analysis of major groups of microbes.

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| **1** | recognize the general characteristics of microbes, plant defense and immune cells. | **K1** |
| **2** | explain about the stages in disease development and various defense mechanisms in plants and humans. | **K2** |
| **3** | elucidate concepts of microbial interactions with plant and humans | **K3** |
| **4** | analyze the importance of harmful and beneficial microbes and immune system | **K4** |
| **5** | determine and interpret the detection of pathogens and appreciate their adaptive strategies. | **K5 & K6** |

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

| Units | Contents | No. of Hours |
|---|---|---|
| **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: Haemo cytometer, 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. | **15** |
| **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. | **15** |
| **III** | **FOOD MICROBIOLOGY:**<br>Beneficial role of microbes – yoghurt, Olives, Cheese, Bread, Wine, Tempeh, Miso & Fermented green tea. Spoilage of fruits, vegetables, meats, poultry, eggs, bakery | **15** |

| | | |
|---|---|---|
| | 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. Immuno diagnosis –Blood Grouping, Widal test, Enzyme-Linked Immunosorbent Assay (ELISA), Immuno electrophoresis and Immunodiffusion. | **15** |
| **V** | **PLANT PATHOLOGY:**<br>**History and significance of plant pathology. Classification of plant diseases, Symptomology (important symptoms of** plant pathogens). 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. 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; Diagnostic technique to detect pest/pathogen infection - Immunofluorescence (IF). | **15** |
| | **Total** | **75** |

| | |
|---|---|
| **Self Study** | Genetic recombination- Transformation, Transduction and Conjugation. Isolation and cultivation of bacteria. Maintenance of bacterial culture, Bacteriophages- classification, replication of DNA and RNA phages -Lytic and Lysogenic cycle. Viroids and prions. |

**Textbooks**

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. New Delhi
4. Dube, H.C. 2010. A text Book of Fungi ISBN: 8188826383.
5. Vaman Rao, C. 2006. Immunology. 2nd Edition. Narosa Publisher.

**Reference Books**


1. Jeffery, C., Pommerville. 2014. Alcamos Fundamentals of Microbiology. 10th Edition. Johns and Bartlett Learning.
2. Pelczar, M. J. 2007. Microbiology. 35th Edition, Tata-McGraw Hill Publications, New York, ISBN: 0074623260.
3. Ravi Chandra, N.G. 2013. Fundamentals of Plant Pathology, Phi Learning, ISBN:812034703X.
4. Willie, J. and Sherwood, L. 2016. Prescott's Microbiology McGraw-Hill Education; 10th Edition, ISBN: 978-1259281594
5. Chaube, H.S. and Singh, R. 2015. Introductory Plant Pathology CBS Publishers, ISBN: 978-8123926704.


**Web Resources**

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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 1 | 2 | 1 | 2 |
| **CO 2** | 3 | 2 | 2 | 2 | 2 | 1 | 1 |
| **CO 3** | 3 | 3 | 2 | 1 | 2 | 2 | 2 |
| **CO 4** | 3 | 2 | 2 | 1 | 2 | 1 | 2 |
| **CO 5** | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| **Total** | **15** | **12** | **11** | **7** | **10** | **7** | **9** |
| **Average** | **3** | **2.4** | **2.2** | **1.4** | **2.0** | **1.4** | **1.8** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 |
| **CO 2** | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 2 |
| **CO 3** | 3 | 3 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1 |
| **CO 4** | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO 5** | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 |
| **Total** | **13** | **14** | **9** | **7** | **10** | **7** | **8** | **7** | **9** | **9** |
| **Average** | **2.6** | **2.8** | **1.8** | **1.4** | **2.0** | **1.4** | **1.6** | **1.4** | **1.8** | **1.8** |

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

**SEMESTER I**

**ELECTIVE COURSE I: b) CONSERVATION OF NATURAL RESOURCES AND POLICIES**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP231EC2 | 3 | 2 | - | - | 3 | 5 | 75 | 25 | 75 | 100 |

**Pre-requisite**

To create awareness of environmental problems and their consequences.

**Learning Objectives**

1. To know about natural resources.
2. To predict the reasons for degradation of natural resources and suggest measures to prevent these.

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 1 | understand the concept of different natural resources and their utilization. | **K1** |
| 2 | critically analyze the sustainable utilization land, water, forest and energy resources | **K2 & K6** |
| 3 | evaluate the management strategies of different natural resources | **K3** |
| 4 | reflect upon the different national and international efforts in resource management and their conservation. | **K4** |
| 5 | state the various environmental policy passed to conserve the natural resources | **K5** |

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

| Units | Contents | No. of hours |
|---|---|---|
| I | **NATURAL RESOURCES:** Definition – Importance – Classification – Human physiological socio-economic and cultural development – Human Population Explosion – Natural Resource Degradation – Concept of conservation – Value system – Equitable resource use for sustainable life system. | 15 |
| II | **FOREST RESOURCES:** Forest cover in India and the World – Importance – Desertification – Forest Wealth – Afforestation – Vanasamrakshna Samithi– Agroforestry – Social Forestry – Joint Forest Management Strategy for Forest Conservation. Wild Life: Resources – Importance – Benefits – Wild life Extinction – Causes for Extinction – List of Endanger species in India and in the World – Ecological approach in wild life management – Eco Tourism – Wild Life projects in India – Sanctuaries and National Parks In India – Man and Bio sphere Programme. | 15 |
| III | **LAND AND SOIL RESOURCES:** Soil, Complexity of soil nature, regional deposits, Land use and capability classification systems, Land use Planning models and their limitations. Impacts of natural and man-made activities on land characteristics and land use planning– Soil Erosion – Loss of Soil Nutrients – Restoration of Soil Fertility – Soil Conservation Methods and Strategies in India. Wet Land Conservation and Management – Ecological Importance of wet lands in India – Conservation Strategy and ecological Importance. Water Resources: Rivers and Lakes In India – Water Conservation and ground water level increase - Watershed Programme. | 15 |

| | | |
|---|---|---|
| **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. | **15** |
| **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. | **15** |
| | **Total** | **75** |

| | |
|---|---|
| **Self Study** | Equitable resource use for sustainable life system, Agroforestry – Social Forestry, Watershed Programme, Food Resources, National Land Use Policy 1988 – Industrial Policy 1991. |

**Textbooks**

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

**Reference Books:**

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

**Web resources:**

1. https://www.amazon.in/conservation-natural-resources-Gifford-Pinchot-ebook/dp/B07HX76TVN
2. https://books.google.co.in/books/about/Natural_Resource_Conservation_and_Enviro.html?id=T2SRuhxpUW8C&redir_esc=y
3. https://www.kobo.com/ww/en/ebook/natural-resources-conservation-law
4. https://www.scribd.com/book/552185119/Natural-Resources-Conservation-and-Advances-for-Sustainability
5. https://www.scribd.com/document/354699536/Conservation-of-Natural-Resources

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 2 | 1 | 2 |
| **CO2** | 3 | 2 | 2 | 2 | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 1 | 2 |
| **CO4** | 3 | 2 | 2 | 3 | 3 | 1 | 2 |
| **CO5** | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| **Total** | **15** | **13** | **11** | **11** | **13** | **7** | **11** |
| **Average** | **3** | **2.6** | **1.1** | **2.2** | **2.6** | **1.4** | **2.2** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 2 |
| **CO 2** | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 2 |
| **CO 3** | 3 | 3 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 1 |
| **CO 4** | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO 5** | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 1 | 2 |
| **Total** | **14** | **13** | **10** | **8** | **7** | **8** | **8** | **6** | **8** | **7** |
| **verage** | **2.8** | **2.6** | **2.0** | **1.6** | **1.4** | **1.6** | **1.6** | **1.2** | **1.6** | **1.4** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER I**

**ELECTIVE COURSE I: c) MUSHROOM CULTIVATION**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP231EC3 | 3 | 2 | - | - | 3 | 5 | 75 | 25 | 75 | 100 |

**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

**Course Outcomes**

| On the successful completion of this course the student will be able to: | | |
|---|---|---|
| 1 | knowledge on identification of edible and toxic mushrooms belonging to ascomycota and basidiomycota. | K1, K3 |
| 2 | outline the nutraceutical properties of edible mushrooms. | K2, K4 |
| 3 | knowledge on cultivation techniques of edible and medicinal mushrooms. | K3, K6 |
| 4 | understand the harvest and post-harvest techniques of mushroom crops. | K4 |
| 5 | knowledge on the production and marketing strategies for mushrooms. | K5 |

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

| Units | Contents | No. of Hours |
|---|---|---|
| I | **INTRODUCTION:** Mushroom, Edible Mushroom, commercial production, medicinal value ofmushrooms, nutraceuticals and dietary supplements | 15 |
| II | **MORPHOLOGICAL AND MICROSCOPICAL IDENTIFICATION OF EDIBLE AND POISONOUS MUSHROOMS**: Keys for identification of edible mushrooms: *Agaricus bisporus*, *Pleurotus sajorcaju*, *Volvariella volvcea* and *Calocybe indica.* Key for identifying hallucinogenic mushroom (*Psilocybe* sp.) Medicinal Mushroom – *Cordyceps, Ganoderma lucidum* and *Lentinus edodes.* | 15 |
| III | **CULTIVATION:** Substrate sterilization, bed preparation, cropping room and maintenance, raising of pure culture and spawn preparation, factors effecting button mushroom production (Temp, pH, air and water management, competitor moulds and other disease). | 15 |
| IV | **POST-HARVEST MANAGEMENT:** Harvest, storage, quality assurance of mushrooms. Pestmanagement. | 15 |
| 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. | 15 |
| | **Total** | 75 |

| Self study | Nutraceuticals and dietary supplements, Medicinal Mushroom – *Cordyceps, Ganoderma lucidum* and *Lentinus edodes,* Substrate sterilization |
|---|---|

**Textbooks**


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


**Reference books**


1. Tiwari., SC., Pandey K. 2018. Mushroom cultivation. Mittal publisher, New Delhi.
2. Philips, G., Miles, Chang, S-T. 2004. Mushrooms: Cultivation, nutritional value, medicinaleffect and environmental effect. 2nd ed. CRC Press.
3. Diego, C.Z., Pando-Gimenez, A. 2017. Edible and medicinal mushrooms: Technology 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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 2 | 1 | 2 |
| **CO 2** | 3 | 3 | 2 | 2 | 1 | 3 | 2 |
| **CO 3** | 2 | 3 | 2 | 3 | 1 | 2 | 2 |
| **CO 4** | 3 | 3 | 3 | 3 | 1 | 2 | 3 |
| **CO 5** | 3 | 3 | 2 | 3 | 2 | 3 | 2 |
| **Total** | **14** | **15** | **12** | **14** | **7** | **11** | **11** |
| **Average** | **2.8** | **3** | **2.4** | **2.8** | **1.4** | **2.2** | **2.2** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 3 | 3 | 1 | 2 | 1 | 1 |
| **CO 2** | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 1 | 3 |
| **CO 3** | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 1 | 2 |
| **CO 4** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 3 |
| **CO 5** | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 1 | 1 | 3 |
| **Total** | **15** | **14** | **12** | **11** | **15** | **15** | **10** | **8** | **5** | **12** |
| **Average** | **3** | **2.8** | **2.4** | **2.2** | **3** | **3** | **2** | **1.6** | **1** | **2.4** |

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

**SEMESTER I**

**ELECTIVE COURSE II: a) ETHNOBOTANY, NATUROPATHY AND TRADITIONAL HEALTH CARE**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP231EC4 | 4 | 1 | - | - | 3 | 5 | 75 | 25 | 75 | 100 |

**Prerequisite:**

The training imparts the knowledge and abilities required to conduct field studies on how humans use plants.

**Learning Objectives**

1. To understand the concept of ethnobotany and the life style and traditional practices of plants by Indian tribals.
2. To emphasize the importance of non-timber forest products for Indian tribal people livelihoods.

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 1 | recall or remember concept of ethnobotany. | K1 |
| 2 | understand the life style and traditional practices of plants by Indian tribals. | K2 & K6 |
| 3 | highlight the role of Non-Timber Forest products for livelihood of tribal people of India | K3 |
| 4 | assess the methods to transform ethnobotanical knowledge into value added products | K4 |
| 5 | build idea to make digitization of ethnobotanical knowledge. | K5 |

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

| Unit | Contents | No. of Hours |
|---|---|---|
| I | **ETHNOBOTANY:** Concept, important landmarks in the development, scope, sub disciplines of ethno botany. Interdisciplinary approaches. Knowledge of following sociological and anthropological terms: culture, values and norms, institutions, culture diffusion and ethnocentrism. History of ethnobotany: A brief history of ethno botanical studies in the world and in India. | 15 |
| II | **PLANTS USED BY TRIBALS OF INDIA:** Distribution of tribes in India. Basic knowledge of following tribes of Tamil Nadu: Irulas, Kanis, Paliyars Badagas, Kurumbres, Thodas and Malayalis. Plants used by tribals of Tamil Nadu. | 15 |
| III | **SOURCES OF ETHNOBOTANICAL DATA:** Primary - archeological sources and inventories, Secondary - travelogues, folklore and literary sources, herbaria, medicinal texts and official records. Methods in ethnobotanical research. Prior Informed Consent, PRA techniques, interviews and questionnaire methods, choice of resource persons. Folk taxonomy – plants associated with culture and socio- religious activities. Non – timber forest products (NTFP) and livelihood – Sustainable harvest and value addition. | 15 |
| IV | **NATUROPATHIC MEDICINE:** Role of plants in naturopathy- Importance and relevance of medicinal drugs in India. Indian Systems of Medicine (Ayurveda, Siddha, Allopathy, Homeopathy, | 15 |

| | | |
|---|---|---|
| | 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 and 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). | **15** |
| | **Total** | **75** |

**Textbooks**

1. Jain, A. and Jain, S.K. 2016, Indian Ethno botany- Bibliography of 21st Century (First Edition), Scientific Publishers, India, pp- 208.

| | |
|---|---|
| **Self study** | Sub disciplines of ethnobotany, Plants used by tribals of Tamilnadu, Non Timber Forest Products (NTFP), Indian systems of medicine, Traditional Knowledge Digital Library (TKDL) |

2. Gringauz, A. 2012, Introduction to Medicinal Chemistry: How Drugs Act & Why?, Wiley India Pvt Ltd, Noida. pp – 736.
3. Subramaniam, S.V , Madhavan. V.R.1983. Heritage of the Tamil Siddha Medicine, International Institute of Tamil Studies, Madras, pp -128.
4. Joshi, S.G. 2018, Medicinal Plants (First Edition),Oxford & IBH Publishing Co Pvt., Ltd, New Delhi, pp -491.

**Reference Books**

1. CSIR (1940-1976). The Wealth of India: A Dictionary of Indian Raw Materials and Industrial Products, CSIR Publication, New Delhi, pp -483.
2. Gokhale, S.B., Kokate, C.K. and Gokhale, A, 2016, Pharmacognosy of Traditional Drugs(First Edition), Nirali Prakashan, Pune, pp – 192.
3. Laird, S.A. 2002. Biodiversity and Traditional knowledge equitable partnerships in Practice (First Edition), Earths can Publications Ltd, London, pp- 546.
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, pp -68.
5. Kumar, N. 2018, A Textbook of Pharmacognosy (Third Edition), Aitbs Publishers, India.

**Web Resources**

1. https://shodhganga.inflibnet.ac.in/bitstream/10603/116454/7/07_chapter%201.pdf
2. https://www.cell.com/action/showPdf?pii=S1360-1385%2817%2930001-8 5
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3465383/pdf/pnas.201202242.pdf 6
4. http://www.plantsjournal.com/archives/2017/vol5issue3/PartB/5-3-8-217.pdf 3
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3465383/pdf/pnas.201202242.pdf 6

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 1 | 3 | 2 | 3 |
| **CO2** | 3 | 2 | 3 | 1 | 3 | 2 | 3 |
| **CO3** | 2 | 3 | 3 | 2 | 2 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 2 | 2 | 3 |
| **Total** | **14** | **13** | **15** | **8** | **12** | **12** | **13** |
| **Average** | **2.8** | **2.6** | **3** | **1.6** | **2.4** | **2.4** | **2.6** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 |
| **CO 2** | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 |
| **CO 3** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 3 | 3 | 2 |
| **CO 4** | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 |
| **CO 5** | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 |
| **Total** | **15** | **15** | **14** | **14** | **13** | **12** | **7** | **15** | **13** | **12** |
| **Average** | **3** | **3** | **2.8** | **2.8** | **2.6** | **2.6** | **1.4** | **3** | **2.6** | **2.4** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER I**

**ELECTIVE COURSE II: b) ALGAL TECHNOLOGY**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP231EC5 | 4 | 1 | - | - | 3 | 5 | 75 | 25 | 75 | 100 |

**Pre-requisite**

Students should be familiar with the basic and applied knowledge on algal biotechnology.

**Learning Objectives**

1.To provide a basic overview of algae cultivation techniques and resource potentials.

2.To educate people about the widespread commercial uses of algae

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 1 | understand the applied facet of botany and acquire a complete knowledge about the cultivation methods in algae. | **K1& K3** |
| 2 | realization of the commercial potential of algal products. | **K5** |
| 3 | analyze emerging areas of algal biotechnology for identifying therapeutic importance of algal products and their uses. | **K2 & K4** |
| 4 | gain more information about algae genetics. | **K4** |
| 5 | translate various algal technologies for the benefit of the ecosystem. | **K3 & K6** |

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

| Unit | Contents | No. of hours |
|---|---|---|
| I | **SCOPE OF ALGAL TECHNOLOGY:** Scope of algal technology – Commercial potential and utility of algae. Algae as sources for food, feed, pigments, Pharmaceuticals and neutraceuticals, fine chemicals, fuel, biofertilizers and hormones. Economic importance of algae in India. | **15** |
| II | **ALGAL PRODUCTS:** Industrial application of algae - fuel, algal lipids - transesterification to ester fuel - substitutes for petroleum derived fuel. Algal products - Spirulina mass cultivation and its applications. Mass cultivation of micro-algae as source of protein and as feed. Liquid seaweed fertilizers - method of preparation, applications and its advantages over inorganic fertilizers. | **15** |
| III | **ALGAL PRODUCTION AND UTILIZATION:** Algal production systems; Strain selection; Algal growth curve; Culture media; cultivation methods – small scale and Large-scale cultivation of algae. Harvesting and packing. Therapeutic uses - antioxidant, anti-ulcerogenic, antifungal, antibiotics, antitumor and antiviral compounds. Production of pigments and their utilization. | **15** |
| IV | **IMMOBILIZATION AND RDNA TECHNOLOGY IN ALGAE:** Algal immobilization and its applications - culturing for metabolite production and natural compounds. Methods of immobilization - alginate beads-extraction of compounds. Recombinant DNA technology in algae - Transformation systems in algae. Isolation of protoplasts, regeneration of fusion of macro algae. Role of algae in nanobiotechnology. | **15** |
| V | **ROLE OF ALGAE IN ENVIRONMENT MANAGEMENT:** Role of algae in environmental health - Sewage treatment, treating industrial effluent, Phytoremediation- heavy metal removal, algae as indicators in assessing water quality and pollution; Saprobic index; Monitoring, assessment, restoration and management of coastal and marine ecosystem environment. Algal culture collection centers in India and abroad and their importance. | **15** |
| | **Total** | **75** |

| | |
|---|---|
| **Self study** | Economic importance of algae in India, Mass cultivation of micro-algae as source of protein and as feed, Recombinant DNA technology in algae, Algal culture collection centers in India and abroad and their importance. |

**Textbooks**


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.


**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.


**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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 1 | 2 | 2 | 1 | 2 |
| **CO3** | 3 | 3 | 3 | 1 | 2 | 1 | 2 |
| **CO4** | 3 | 3 | 1 | 2 | 1 | 2 | 2 |
| **CO5** | 3 | 3 | 2 | 1 | 2 | 2 | 2 |
| **Total** | **15** | **15** | **10** | **9** | **10** | **9** | **11** |
| **Average** | **3** | **3** | **2** | **1.8** | **2** | **1.9** | **2.2** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 2 | 1 | 2 | 2 | 2 | 1 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 3 | 2 | `1 | 2 | 3 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO3** | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| **Total** | **14** | **14** | **12** | **13** | **13** | **10** | **9** | **10** | **9** | **12** |
| **Average** | **2.8** | **2.8** | **2.4** | **2.6** | **2.6** | **2.0** | **1.8** | **2.0** | **1.8** | **2.4** |

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

**SEMESTER I**

**ELECTIVE COURSE II: c) HERBAL TECHNOLOGY**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP231EC6 | 4 | 1 | - | - | 3 | 5 | 75 | 25 | 75 | 100 |

**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.

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 1 | recollect the importance of herbal technology. | K1 |
| 2 | understand the classification of crude drugs from various botanical sources. | K2 |
| 3 | analyze on the application of secondary metabolites in modern medicine. | K3 |
| 4 | create new drug formulations using therapeutically valuable phytochemical compounds for the healthy life of society. | K4 |
| 5 | comprehend the current trade status and role of medicinal plants in socio economic growth. | K5 & K6 |

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

| UNIT | CONTENTS | No of hours |
|---|---|---|
| I | **PHARMACOGNOSY:** Pharmacognosy scope and importance - source - Crude Drugs – Scope and Importance, Classification (Taxonomical, Morphological Chemical, Pharmacological); Cultivation, Collection and processing of crude drugs. Cultivation and utilization of medicinal and aromatic plants in India. | 15 |
| II | **PLANT TISSUE CULTURE AS SOURCE OF MEDICINES:** Plant tissue culture as source of medicines, Role of plant tissue culture in enhancing secondary metabolite production (*Withania somnifera, Rauwolfia serpentina, Catheranthus roseus, Andrographis paniculata* and *Dioscorea sp*) - Elicitation - Biotransformation, Hairy root culture. Factors affecting secondary metabolites production. Biogenesis of phytopharmaceuticals. | 15 |
| III | **PLANT PROPAGATION ANALYSIS OF PHYTOCHEMICALS:** Methods of Drug evaluation (Morphological, microscopic, physical and chemical). Phytochemical investigations – standardization and quality control of herbal drugs. Preliminary screening, Assay of Drugs - Biological evaluation/assays, Microbiological methods - Chemical Methods of Analysis, Detection of Adulterants: Chemical estimations, Spectrophotometry and fluorescence analysis. Drug adulteration - Types of adulterants. | 15 |
| IV | **GENERAL METHODS OF PHYTOCHEMICAL AND BIOLOGICAL SCREENING:** Carbohydrates and derived products: Glycosides - extraction methods (*Digitalis, Dioscorea*); Tannins (Hydrolysable and Condensed types); Volatile oils - extraction methods (Clove, Mentha). Study of some herbal formulation techniques as drug cosmetics. | 15 |
| | **TYPES OF PHYTOCHEMICALS :**Alkaloids - extraction methods (*Taxus, Cinchona*); Flavonoids- extraction methods, Resins- extraction method: Application of phytochemicals in phytopharmacueticals; Biocides, Biofungicides, Biopesticides. Women entrepreneurship | 15 |

| | | |
|---|---|---|
| **V** | development – marketing cultivated medicinal plants – National Medicinal Plants Board of India. | |
| | **Total** | **75** |

| | |
|---|---|
| **Self study** | Collection and processing of crude drugs, Biogenesis of phytopharmaceuticals, Microbiological methods - Chemical Methods of Analysis, Detection of Adulterants, Women entrepreneurship development – marketing cultivated medicinal plants – National Medicinal Plants Board of India. |

**Textbooks**


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. Trease and Evans.


**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.


**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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 1 | 3 | 2 | 3 |
| **CO2** | 3 | 2 | 3 | 1 | 3 | 2 | 3 |
| **CO3** | 2 | 3 | 3 | 2 | 2 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 2 | 2 | 3 |
| **Total** | **14** | **13** | **15** | **8** | **12** | **12** | **13** |
| **Average** | **2.8** | **2.6** | **3** | **1.6** | **2.4** | **2.4** | **2.6** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 |
| **CO 2** | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 |
| **CO 3** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 |
| **CO 4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Total** | **15** | **15** | **14** | **14** | **13** | **12** | **3** | **15** | **15** | **12** |
| **Average** | **3** | **3** | **2.8** | **2.8** | **2.6** | **2.6** | **15** | **3** | **3** | **2.4** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER I**
**SPECIFIC VALUE-ADDED COURSE**
**NATURAL RESOURCES AND THEIR CONSERVATION**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP231V01 | 2 | - | - | - | 1 | 2 | 30 | 25 | 75 | 100 |

**Pre requisite**

Understanding the basics of natural resources and their conservation strategies.

**Objectives**

1. To provide students with the basic knowledge on resources available for present and future generations.
2. To explain the conservation strategies of natural resources.

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 1 | explain the natural resources | K1 |
| 2 | recognize the critical role natural resources play in supporting life and ecosystems. | K2 |
| 3 | distinguish between various natural resource categories, including energy resources, and biological resources | K3 |
| 4 | analyze the consequences of the over-exploitation of non renewable resources. | K4 |
| 5 | evaluate the impacts of climate change on natural resources and ecosystems | K5 |

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

| Unit | Contents | No of hours |
|---|---|---|
| 1 | Introduction to Natural Resources and Conservation- Definition and classification of natural resources Importance of natural resources for human well-being and ecosystem functioning, Overview of conservation goals and strategies, Introduction to ecological principles and systems thinking. | 6 |
| 2 | Renewable Resources - Study of renewable resources: water, forests, wildlife, fisheries, and soil,, Sustainable management practices for renewable resources, Case studies of successful renewable resource conservation projects. | 6 |
| 3 | Non-Renewable Resources - Exploration of non-renewable resources: minerals, fossil fuels, Environmental impacts of non-renewable resource extraction and utilization, Transitioning to alternative energy sources and sustainable mining practices, Biodiversity and Ecosystem services. | 6 |
| 4 | Understanding biodiversity and its importance, Ecosystem services provided by diverse ecosystems, Threats to biodiversity and strategies for biodiversity conservation. | 6 |
| 5 | Climate Change and Resource Conservation- Impacts of climate change on natural resources and ecosystems- Mitigation and adaptation strategies for resource conservation in a changing climate, International agreements and policies addressing climate change and resource conservation. | 6 |
| | **Total** | 30 |

**Textbooks**

1. R.G. Buckley, 2019Environmental Microbiology,CBS Publishers.
2. E.P. Odum and G.W. Barrett . 2005. Fundamentals of Ecology, 5th edition, Cengage Learning

**Reference Books**

1. Daniel D.Chiras & John P.Regnold 2016 Text book of Natural Resource Conservation: Management for a Sustainable future, 2nd Edition. Narosa Publisher.
2. Elements of Ecology, T.M. Smith and R.L. Smith, 8th edition, 2012, Pearson India Education.

**Web Resources**

1. https://nios.ac.in/media/documents/SrSec314NewE/Lesson-26.pdf
2. https://rightsofnature.org.ph/ways-to-conserve-natural-resources/
3. https://www.turito.com/learn/earth-and-science-space/conservation-of-natural-resources
4. https://www.embibe.com/exams/conservation-of-natural-resources/
5. https://www.geeksforgeeks.org/natural-resources-definition-types-and-examples/

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 3 | 3 | 2 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 | 2 | 3 |
| **CO3** | 2 | 3 | 3 | 2 | 2 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 2 | 3 |
| **Total** | **14** | **13** | **15** | **14** | **12** | **12** | **13** |
| **Average** | **2.8** | **2.6** | **3** | **1.6** | **2.4** | **2.4** | **2.6** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 |
| **CO 2** | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 3 |
| **CO 3** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO 4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Total** | **15** | **15** | **14** | **14** | **15** | **12** | **15** | **15** | **13** | **15** |
| **Average** | **3** | **3** | **2.8** | **2.8** | **3** | **2.6** | **3** | **3** | **2.6** | **3** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER I**

**SPECIFIC VALUE-ADDED COURSE: BIOFERTILIZERS**

| Course code | L | T | P | S | Credit | Inst. hours | Total hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **BP231V02** | **2** | **-** | **-** | **-** | **1** | **2** | **30** | **25** | **75** | **100** |

**Pre requisite**

Understanding of fundamental biological concepts such as photosynthesis, plant anatomy, and plant physiology.

**Learning Objectives**

1.To provide students with a comprehensive understanding of what biofertilizers are, their types, and their role in sustainable agriculture.

2.To explain the mechanisms through which biofertilizers enhance soil fertility, improve plant growth, and increase crop yield.

**Course outcomes**

| **On the successful completion of the course, student will be able to:** | | |
|---|---|---|
| **1** | explain the importance and role of biofertilizers in sustainable agriculture. | K1 |
| **2** | identify different types of biofertilizers, such as nitrogen-fixing, phosphate-solubilizing, and potassium-mobilizing biofertilizers. | K2 |
| **3** | understand the formulation and application methods of biofertilizers for different crops and soil types. | K3 |
| **4** | demonstrate skills in the proper application, storage, and management of biofertilizers. | K4 |
| **5** | evaluate the economic implications of adopting biofertilizers in agricultural systems | **K5** |

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

| Unit | Contents | No. of hours |
|---|---|---|
| **I** | General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis. | **6** |
| **II** | *Azospirillum:* isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. *Azotobacter:* classification, characteristics – crop response to *Azotobacter* inoculum, maintenance and mass multiplication. | **6** |
| **III** | Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation | **6** |
| **IV** | Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants. | **6** |
| **V** | Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application. | **6** |
| | **Total** | **30** |

**Textbooks**

1. P.K. Gupta, 2005. *Molecular Biology and Genetic Engineering*. Rastogi Publications, New Delhi.
2. Dubey, R.C., 2005. *A Text book of Biotechnology*. S.Chand& Co, New Delhi.

**Reference Books**

1. Kumaresan, V. 2005, *Biotechnology*, Saras Publications, New Delhi.
2. John Jothi Prakash, E. 2004. *Outlines of Plant Biotechnology*, Emkay Publication, Valiyoor.
3. Subba Rao N.S. 2017. *Biofertilizers in Agriculture and Forestry*. (4th Ed.).Medtech. Mumbai.
4. NIIR Board. 2012. *The complete Technology Book on Biofertilizer and organic farming*. (2nd Ed.). NIIR Project Consultancy Services, New Delhi
5. Tolanur, S. 2018. *Fundamentals of Soil Science.* (2nd Ed.). CBS Publishers , New Delhi

**Web Resources**

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8724949/
2. https://www.peptechbio.com/blog-biofertilizers/
3. https://www.iffcobazar.in/en/organic-products/bio-fertlizers
4. https://vikaspedia.in/agriculture/agri-inputs/bio-inputs/bioinputs-for-nutrient-management/biofertilizers
5. https://link.springer.com/article/10.1007/s11356-016-8104-0

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 3 | 3 | 2 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 2 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 2 | 3 |
| **Total** | 15 | 13 | 14 | 14 | 12 | 12 | 15 |
| **Average** | 3 | 2.6 | 2.8 | 1.6 | 2.4 | 2.4 | 3 |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 |
| **CO 2** | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 3 |
| **CO 3** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO 4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Total** | 15 | 15 | 14 | 14 | 15 | 12 | 15 | 15 | 13 | 15 |
| **Average** | 3 | 3 | 2.8 | 2.8 | 3 | 2.6 | 3 | 3 | 2.6 | 3 |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER II**

**CORE COURSE III: TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP232CC1 | 2 | 3 | - | - | 4 | 5 | 75 | 25 | 75 | 100 |

**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 systematic.

2.To develop a suitable method for correct characterization and identification of plants.

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 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 K3** |
| 2 | explain the principles of taxonomy. summarize the taxonomic hierarchy. define binomial nomenclature. group activity – construct key preparation | **K1, K2 K5, K6** |
| 3 | explain the various types of classification. distinguish its advantages and disadvantages construction of floral formula and floral diagram. | **K1, K2 K3, K4** |
| 4 | illustrate and explain the characteristic features and list out the economic importance of the families field trip to local botanical garden and regional botanical garden. | **K1, K2 K3, K4** |
| 5 | illustrate and explain the characteristic features and list out the economic importance of the families. | **K1, K2 K3, K5** |

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

| Unit | Contents | No. of hours |
|---|---|---|
| I | **TAXONOMY AND SYSTEMATICS:** Botanical exploration and contribution with special reference to India by William Roxburgh, J.D. Hooker, Robert Wright, Nathanial Wallich and Gamble, J.S. Principles of classification as proposed – Artificial – Linnaeus, Natural – Bentham and Hooker, Phylogenetic system - Hutchinson, Modern – Takhtajan. Botanical gardens and herbaria of world, preparation and maintenance of Herbarium, Botanical survey of India – its organization and role. | **15** |
| II | **MODERN TRENDS IN TAXONOMY:** Modern trends in taxonomy, chemotaxonomy, numerical taxonomy, biosystemics. ICBN uninominal systems- genesis binomial nomenclature, importance and principle. Important articles, typification, principles of priority, effective and valid publication, author citation, recommendations and amendents of code. Glossories and dictionaries, Taxonomic literature (Index Kewensis) | **15** |
| III | **SYSTEMATIC ANALYSIS OF PLANTS-I:** Polypetalae – Nympheaceae, Sterculiaceae, Portulaceae, Rhamnaceae, Vitaceae, Sapindaceae, Combretaceae, Turneraceae. | **15** |
| | **SYSTEMATIC ANALYSIS OF PLANTS-II:** Gamopetalae – Sapotaceae, Oleaceae, Boraginaceae, Scrophulariaceae, Bignoniaceae, | **15** |

| | | |
|---|---|---|
| **IV** | Convolvulaceae, Acanthaceae, Verbenaceae. Monochlamydeae – Nyctaginaceae, Aristolochiaceae, Casuarinaceae. 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. | **15** |
| | **Total** | **75** |

| | |
|---|---|
| **Self study** | Botanical gardens and herbaria of world, preparation and maintenance of Herbarium. Taxonomic literature (Index Kewensis).<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). |

**Textbooks**


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. 2017. 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.


**Reference Books:**


1. Wallis, T.E. 1999. Text book of Pharmacognosy. CBS Publishers and Distributors, New Delhi.
2. Kumaresan, V and Annie Regland. 2013. Taxonomy of Angiosperms systematic Botany, Economic Botany, Botany & Ethnobotany.
3. Anonymous, 2004. Cultivation of Selected Medicinal Plants. National Medicinal Plants Board, Govt. of India, New Delhi.
4. Vallabh. 2000. Practical Pharmacognosy, Kolkata. New Delhi.
5. Acharya Vipul Rao. 2000. Herbal cure for common diseases. Diamond books, Pvt. Ltd.


**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

## MAPPING WITH PROGRAMME OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | 1 | 2 | 2 | 1 | 2 |
| **CO 2** | 3 | 2 | 2 | 1 | 2 | 2 | 1 |
| **CO 3** | 3 | 3 | 2 | 2 | 2 | 2 | 1 |
| **CO 4** | 3 | 1 | 3 | 2 | 2 | 2 | 2 |
| **CO 5** | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| **Total** | **15** | **10** | **10** | **9** | **10** | **9** | **8** |
| **Average** | **3** | **2** | **2** | **1.8** | **2** | **1.8** | **1.6** |

## MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | 3 | 1 | 2 | 2 | 2 | 3 |
| **CO 2** | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 |
| **CO 3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| **CO 4** | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 3 |
| **CO 5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 |
| **Total** | **15** | **14** | **15** | **13** | **15** | **10** | **11** | **11** | **12** | **15** |
| **Average** | **3.0** | **2.8** | **3** | **2.6** | **3.0** | **2** | **2.2** | **2.2** | **2.4** | **3.0** |

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

**SEMESTER II**

**CORE COURSE IV: PLANT ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP232CC2 | 2 | 3 | - | - | 4 | 5 | 75 | 25 | 75 | 100 |

**Pre-requisite**

To acquire knowledge on the anatomical structure and reproductive phase of angiosperms.

**Learning Objectives**

1. To learn the importance of plant anatomy in plant production systems.
2. To classify meristems and identify their structures, functions and roles in monocot and dicot plants growth and secondary growth of woody plants.

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 1 | learn the structures, functions and roles of apical *vs* lateral meristems in monocot and dicot plant growth. | **K1& K2** |
| 2 | study the function and organization of woody stems derived from secondary growth in dicot and monocot plants. | **K1&K4** |
| 3 | apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development. | **K2& K6** |
| 4 | understand the various concepts of plant development and reproduction. | **K3& K6** |
| 5 | profitably manipulate the process of reproduction in plants with a professional and entrepreneurial mindset. | **K5** |

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

| Unit | Contents | No. of hours |
|---|---|---|
| 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. | **15** |
| 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 | **15** |

| | | |
|---|---|---|
| | 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. | **15** |
| **IV** | **MEGASPORANGIUM AND FEMALE GAMETOPHYTE:** Structure and development of Megasporangium; Types of ovules, Endothelium, obturator and nucellus. Megasporogenesis: Female gametophyte: Structure, types, haustorialbehavior and Nutrition of embryo sacs. Fertilization: Double fertilization and triple fusion; Endosperm: Development of endosperm, types, physiological efficiency of endosperm haustoria and functions; Ruminate endosperm. Embryogeny: Development of monocot (Grass) and dicot (Crucifer) embryos. | **15** |
| **V** | **POLYEMBRYONY:** Causes of Polyembryony, classification, induction and practical application. Apomixis and its significance. Seed and Fruit development and role of growth substances. Parthenocarpy and its importance. | **15** |
| | **Total** | **75** |

| | |
|---|---|
| **Self study** | Theories of shoot and root apices, Cytological zonation in shoot apex, Anomalous secondary growth in Dicots (Amaranthaceae, Aristolochiaceae, Bignoniaceae, pollen sterility, Types of ovules, Parthenocarpy and its importance. |

**Textbooks**


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


**Reference Books:**


1. Krishnamurthy, K.V. 1988. Methods in Plant Histochemistry. S. Viswanathan & Co., Madras.
2. Swamy, B.G.L and Krishnamurthy. K.V 1990. From flower to fruits, Tata – McGraw Hill publishing Co Ltd, New Delhi.
3. Pullaiah, T., Lakshiminarayana, K and Hanumantha Rao, B. 2006. Text book of Embryology of Angiosperms. Regency Publications, New Delhi.
4. Bierhorst, D.W. 1971. Morphology of Vascular Plants. Macmillan publishers, New York.
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.


**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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | 3 | 3 | 2 | 1 | 2 |
| **CO 2** | 3 | 2 | 3 | 3 | 2 | 3 | 1 |
| **CO 3** | 3 | 3 | 3 | 3 | 2 | 3 | 1 |
| **CO 4** | 3 | 1 | 3 | 3 | 2 | 3 | 2 |
| **CO 5** | 3 | 2 | 3 | 3 | 2 | 3 | 2 |
| **Total** | **15** | **10** | **15** | **15** | **10** | 3 | **8** |
| **Average** | **3** | **2** | **3** | **3** | **2** | **15** | **1.6** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 3 | 2 | 3 |
| **CO 2** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 3 |
| **CO 3** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 |
| **CO 4** | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| **CO 5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **Total** | **14** | **15** | **15** | **13** | **11** | **10** | **11** | **15** | **12** | **15** |
| **Average** | **2.8** | **3** | **3** | **2.6** | **2.2** | **2** | **2.2** | **3** | **2.4** | **3** |

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

**SEMESTER II**

**CORE COURSE V: ECOLOGY, PHYTOGEOGRAPHY, CONSERVATION BIOLOGY & INTELLECTUAL PROPERTY RIGHTS**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP232CC3 | 2 | 3 | - | - | 4 | 5 | 75 | 25 | 75 | 100 |

**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 (Knowledge).
2. To study the plant communities and plant succession stages (Skill).

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 1 | understand the scope and importance of population ecology, plant communities and ecosystemecology. | **K1 & K2** |
| 2 | understand the applied aspect of environmental botany. | **K1 & K4** |
| 3 | spot the sources and pollution and seek remedies to mitigate and rectify them. | **K2 & K6** |
| 4 | identify different plant communities, categorize plant biomes and identify threatened, endangered plant species and create awareness program in protection of biodiversity. | **K3 & K6** |
| 5 | analyze insight into the vegetation types, species interaction and their importance and the factors influencing the environmental conditions. | **K5** |

| Unit | Contents | No. of hours |
|---|---|---|
| I | **ECOLOGICAL PRINCIPLES:** Introduction – History, scope, concepts. Diversity of plant life; growth form, life form. Basic concepts of population ecology– population dynamics – Regulation of population density. Basics concepts of community – characteristics, composition, structure, origin and development – community dynamics – trends of succession. | **15** |
| II | **ECOSYSTEM ECOLOGY AND RESOURCE ECOLOGY:**Introduction – kinds – major types – functional aspects of ecosystem: Food chain and food web, energy flow, laws of thermodynamics. Productivity – primary and secondary productivity – GPP & BPP.<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 | **15** |
| III | **PHYTOGEOGRAPHY:** Phytogeographical Zones - Vegetation types of India and Tamil Nadu, Distribution: Continuous, Discontinuous and Endemism. Theories of discontinuous distribution: Continental drift, Age and area | **15** |

| | | |
|---|---|---|
| | hypothesis. Geographical Information System (GIS) Principles of remote sensing and its applications. | |
| **IV** | **BIODIVERSITY AND CONSERVATION ECOLOGY:** Definition, types of biodiversity – values of biodiversity – Hot spots – Threats to biodiversity: habitat loss. Poaching of wild life – Invasion of exotic species, man and wild life conflicts - endangered and endemic plant species of India, Red list categories of IUCN, Biotechnology assisted plant conservation- *in situ* and *ex situ* methods. | **15** |
| **V** | **INTELLECTUAL PROPERTY RIGHTS:** Intellectual Property Rights – Introduction, Kinds of Intellectual Property Rights- Patents, Trademarks, Copyrights, Trade Secrets. Need for intellectual property right, Advantages and Disadvantages of IPR. International Regime Relating to IPR – TRIPS, WIPO, WTO, GATTS. IPR in India genesis and development. Geographical Indication – introduction, types. Patent filing procedure for ordinary application. | **15** |
| | **Total** | **75** |

| | |
|---|---|
| **Self study** | Basics concepts of community, Food chain and food web, energy flow, laws of thermodynamics, Vegetation types of India and Tamil Nadu, Red list categories of IUCN, Regime Relating to IPR – TRIPS, WIPO, WTO, GATTS. |

**Textbooks:**


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.


**Reference books**


1. Keddy, P.A. 2017. Plant Ecology: Origins, processes, consequences. 2nd ed. Cambridge University Press. ISBN. 978-1107114234.
2. Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity- Principles and
3. Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.

4.Ahuja, V.K. 2017. Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.


**MAPPING WITH PROGRAMME OUTCOMES:**

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| **Total** | **14** | **14** | **12** | **13** | **12** | **14** | **14** |
| **Average** | **2.8** | **2.8** | **2.4** | **2.6** | **2.4** | **2.8** | **2.8** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PS10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 3 | 2 | 1 | 2 | 2 | 3 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 2 |
| **CO3** | 2 | 3 | 3 | 3 | 1 | 2 | 1 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 2 |
| **Total** | **13** | **14** | **12** | **13** | **12** | **11** | **9** | **14** | **13** | **13** |
| **Average** | **2.6** | **2.8** | **2.4** | **2.6** | **2.4** | **2.2** | **1.8** | **2.8** | **2.6** | **2.6** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER II**

**CORE LAB COURSE-II: LAB COURSE (FOR CORE III, IV & V)**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP232CP1 | - | 2 | 3 | - | 4 | 5 | 75 | 25 | 75 | 100 |

**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.

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| **1** | gain recent advances in plant morphological and floral characteristics. | **K1** |
| **2** | understand about different floral characteristics and artificial key preparation which employed for plant identification and conservation. | **K2** |
| **3** | recall or remember the information including basic and advanced in relation with plant anatomy and embryology. | **K4 & K5** |
| **4** | apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development. | **K3** |
| **5** | know about different vegetation sampling methods. | **K3** |

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

| UNIT | EXPERIMENTS |
|---|---|
| **I** | **TAXONOMY AND ECONOMIC BOTANY OF ANGIOSPERMS**<br>Preparation of artificial keys.<br>Description of a species, based on virtual herbarium and live specimens of the families mentioned in the theory.<br>Study the products of plants mentioned in the syllabus of economic botany with special reference to the morphology, botanical name and family.<br>Solving nomenclature problems.<br>**Field trip:**<br>A field trip at least 3-4 days to a floristically rich area to study plants in nature and field report submission of not less than 20 herbarium sheets representing the families studied. |
| **II** | **ANATOMY**<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, Bouerhhavia, Bignonia, Piper betal* 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. |

| | |
|---|---|
| **III** | **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. |
| **IV** | **ECOLOGY**<br>1. Determination of the quantitative characters of a plant community by random quadrat method (abundance, density, dominance, species diversity, frequency) in grazing land, forests.<br>2. Estimation of above ground and below ground biomass in a grazing land employing minimum size of quadrat.<br>3. To determine soil moisture, porosity and water holding capacity of soil collected from varying depth at different locations.<br>4. Determination of pH of soil and water by universal indicator (or) pH meter.<br>5. Determination of dissolved oxygen.<br>6. Estimation of carbonate.<br>7. 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 – Analyzing and interpretation of Satellite photographs- Vegetation/ weather.<br>4. Visit to remote sensing laboratory (at Anna University, Regional Meteorological Centre at Numgambakkam). |

**Textbooks**

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

**Reference books**

1. Sathya, S., Jaiganesh, K.P and Sudha. T,2019. Current Trends in Herbal Drug Technology. Pharmacy Council of India New Delhi..
2. Mann J. Davidson, R.S and J.B. Hobbs, D.V. Banthorpe, J.B. Harborne.,1994. *Natural Products*. Longman Scientific and Technical Essex.
3. Gopalan, C., B.V. Ramasastri and S.C. Balasubramanian, 1985. NutritiveValue of Indian Foods. National Institute of Nutrition, Hyderabad.

4. Harborne. J.B, 1998. Phytochemical methods. A guide to modern techniques of Plant Analysis, Chapman and Hall publication, London.
5. Traditional plant medicines as sources of new drugs. P.J Houghton in Pharmacognosy. Trease and Evan's.16 Ed, 2009.

**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 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 1 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 2 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| **Total** | **15** | **14** | **15** | **15** | **14** | **10** | **13** |
| **Average** | **3** | **2.8** | **3** | **3** | **2.8** | **2.0** | **2.6** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 1 |
| **CO2** | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 1 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 1 | 2 | 1 |
| **CO4** | 3 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 1 | 2 |
| **Total** | **15** | **15** | **13** | **12** | **10** | **15** | **15** | **8** | **9** | **9** |
| **Average** | **3** | **3** | **2.6** | **2.4** | **2** | **3** | **3** | **1.6** | **1.8** | **1.8** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER II**

**ELECTIVE COURSE III: a) BIOSTATISTICS**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP232EC1 | 2 | 2 | - | - | 2 | 4 | 60 | 25 | 75 | 100 |

**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.

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 1 | create and interpret visual representations of quantitative information, such as graphs or charts. | **K5 & K6** |
| 2 | solve problems quantitatively using appropriate arithmetical, algebraic, or statistical methods | **K3 & K5** |
| 3 | know the latest version using in statistical tools and apply the tools to interpret the results | **K2** |
| 4 | develop their competence in hypothesis testing and interpretation. | **K4** |
| 5 | understand why biologists need a background in statistics. | **K1** |

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

| UNIT | CONTENTS | No. of hours |
|---|---|---|
| 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. | **12** |
| 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. | **12** |
| 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. | **12** |
| 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). | **12** |
| 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. | **12** |
| | **Total** | **60** |

| | |
|---|---|
| **Self Study** | Classification and tabulation of Data – Diagrams, graphs and presentation., Mean, median and mode, Rules of probability, Student 't' test – paired sample and mean differences, Correlation - types of correlation |

**Textbooks**


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.


**Reference books**


1. Crang, R., Lyons-Sobaski, S and Wise, R. 2018. Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants. Springer International Publishing.
2. 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.


**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 1 | 1 | 2 | 2 | 1 |
| **CO2** | 2 | 3 | 1 | 2 | 2 | 2 | 1 |
| **CO3** | 3 | 3 | 2 | 1 | 1 | 3 | 1 |
| **CO4** | 2 | 3 | 2 | 1 | 1 | 2 | 1 |
| **CO5** | 2 | 3 | 1 | 2 | 2 | 2 | 2 |
| **Total** | **11** | **15** | **7** | **7** | **8** | **11** | **6** |
| **Average** | **2.2** | **3** | **1.4** | **1.4** | **1.6** | **2.2** | **1.2** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO4** | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |
| **CO5** | 3 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 |
| **Total** | **15** | **10** | **10** | **12** | **12** | **14** | **9** | **10** | **15** | **15** |
| **Average** | **3** | **2** | **2** | **2.4** | **2.4** | **2.8** | **1.8** | **2** | **3** | **3** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER II**

**ELECTIVE COURSE III: b) INTELLECTUAL PROPERTY RIGHTS**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP232EC2 | 2 | 2 | - | - | 2 | 4 | 60 | 25 | 75 | 100 |

**Pre-requisite**

Intent to understand the legal systems governing the knowledge economy. Basic understanding of how laws are structured and interpreted.

**Learning Objectives**

1. To cater the needs of the stakeholders of knowledge economy is designed for those interested in managers and similar individuals.
2. To create awareness of current IPR and innovation trends.

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 1 | recall the history and foundation of Intellectual Property. | **K1** |
| 2 | understand the differences of Property and Assets and Various categories of Intellectual Creativity. | **K2** |
| 3 | apply the methods to protect the Intellectual Property. | **K3** |
| 4 | differentiate if the Said Intangible property be protected under law or protected by strategy. | **K4** |
| 5 | create a recommendation document on the methods and procedures of protecting the said IP and search documents to substantiate them. | **K5 & K6** |

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

| UNIT | CONTENTS | No. of hours |
|---|---|---|
| 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. | **12** |
| 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. | **12** |
| 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. | **12** |

| | | |
|---|---|---|
| **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. | **12** |
| **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. | **12** |
| | **Total** | **60** |

| | |
|---|---|
| **Self study** | Ownership of copyright, Assignment and license of copyright, Subject matter of Design – Exclusion of Designs – Novelty and originality – Rights in Industrial Design, Criteria for registration, Non Registrable Trademarks, Registration of Trademarks. Infringement: Remedies and Penalties, Drafting of complete specifications. Drafting of claims, Process of Obtaining a Patent. Infringement and Enforcement |

**Textbooks**


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.


**Reference Books**


1. World Intellectual Property Organization, 2004. WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub _489.pdf Journal of Intellectual Property Rights (JIPR): NISCAIR.
2. Anant Padmanabhan, 2012. Intellectual Property Rights: Infringement and Remedies LexisNexis Butterworths Wadhwa.
3. Nithyananda, K.V, 2019. Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
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.


**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 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 1 | 2 | 3 | 2 |
| **CO2** | 3 | 2 | 3 | 2 | 2 | 3 | 2 |
| **CO3** | 3 | 2 | 3 | 1 | 2 | 3 | 2 |
| **CO4** | 3 | 2 | 3 | 1 | 2 | 3 | 3 |
| **CO5** | 3 | 1 | 3 | 2 | 2 | 3 | 2 |
| **Total** | **15** | **9** | **15** | **7** | **12** | **15** | **11** |
| **Average** | **3** | **1.8** | **3** | **1.4** | **2.4** | **3** | **2.2** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| **CO2** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| **CO3** | 2 | 2 | 3 | 1 | 2 | 3 | 1 | 3 | 2 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| **Total** | **14** | **13** | **15** | **12** | **13** | **15** | **11** | **15** | **9** | **15** |
| **Average** | **2.8** | **2.6** | **3** | **2.4** | **2.6** | **3** | **2.2** | **3** | **1.8** | **3** |

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

**SEMESTER II**

**ELECTIVE COURSE III: c) APPLIED BIOINFORMATICS**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP232EC3 | 2 | 2 | - | - | 2 | 4 | 60 | 25 | 75 | 100 |

**Pre-requisite**

Basic knowledge in molecular biology. Familiarity with operations of computersand MS office tools.

**Learning Objectives**

1. To learn about the bioinformatics databases, databanks, data format and data retrieval from theonline sources.
2. To explain the essential features of the interdisciplinary field of science for better understandingbiological data.

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 1 | familiarize with the tools of DNA sequence analysis. | K1 & K2 |
| 2 | use and explain the application of bioinformatics. | K2 & K3 |
| 3 | master the aspects of protein-protein interaction, BLAST and PSI-BLAST. | K3 & K4 |
| 4 | describe the features of local and multiple alignments. | K3 & K4 |
| 5 | interpret the characteristics of phylogenetic methods and bioinformatics applications. | K4 & K5 |

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

| UNIT | CONTENTS | No.of hours |
|---|---|---|
| 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. | 12 |
| 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. | 12 |
| 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. | 12 |
| IV | **SEQUENCE ALIGNMENT AND DATABASE SEARCHING:** Introduction - Evolutionary Basis of SequenceAlignment - Modular Nature of Proteins - Optimal Alignment Methods - Substitution Scores and Gap Penalties- Database Similarity Searching - FASTA – BLAST (Blast P, Blast N, etc.,) - Position SpecificScoring Matrices, Spliced Alignments. | 12 |

| | | |
|---|---|---|
| **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. | **12** |
| | **Total** | **60** |

| | |
|---|---|
| **Self study** | Biosequence sets – Sequence annotation – Sequence description, Genome Centers - Contact points for submission of sequence data to DBJ/EMBL/Genbank., Advanced Structure Modeling - Structure Similarity Searching., Spliced Alignments, Secondary Structure and Folding Classes - Specialized Structures or Features - Tertiary Structure. |

**Textbooks**


1. Baxevanis, A. D. & Ouellette, B. F, 2021. Bioinformatics: A practical guide to the analysis ofgenes and proteins. New York: Wiley-Interscience.
2. Bourne, P. E., & Gu .J, 2009. Structural bioinformatics. Hoboken, NJ: Wiley-Liss.
3. Lesk, A. M. 2002. Introduction to bioinformatics. Oxford: Oxford University Press.
4. Mount, D. W, 2001. Bioinformatics: Sequence and genome analysis. Cold Spring Harbor, NY:Cold Spring Harbor Laboratory Press.
5. Pevsner. J, 2015. Bioinformatics and functional genomics. Hoboken, NJ: Wiley-Blackwell.


**Reference books**


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


**Web resources:**

1. Bioinformatics: Algorithms & Applications by Prof. M. Michael Gromiha IIT-Madras. https://nptel.ac.in/courses/102/106/102106065/#.
2. Christopher Burge, David Gifford, and Ernest Fraenkel. *7.91*.J Foundations of Computational 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

## MAPPING WITH PROGRAMME OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 1 | 2 | 3 | 2 |
| **CO 2** | 2 | 3 | 3 | 2 | 3 | 3 | 1 |
| **CO 3** | 3 | 3 | 3 | 1 | 2 | 3 | 2 |
| **CO 4** | 3 | 2 | 3 | 2 | 3 | 3 | 2 |
| **CO 5** | 3 | 3 | 3 | 1 | 2 | 3 | 2 |
| **Total** | **14** | **13** | **15** | **7** | **12** | **15** | **9** |
| **Average** | **2.8** | **2.6** | **3** | **1.4** | **2.4** | **3** | **1.8** |

## MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 2 | 1 | 3 |
| **CO 2** | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 1 | 3 |
| **CO 3** | 3 | 2 | 1 | 3 | 1 | 1 | 2 | 1 | 2 | 3 |
| **CO 4** | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 |
| **CO 5** | 3 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 1 | 3 |
| **Total** | **15** | **12** | **9** | **15** | **7** | **8** | **7** | **9** | **7** | **15** |
| **Average** | **3** | **2.4** | **1.8** | **3** | **1.4** | **1.6** | **1.4** | **1.8** | **1.4** | **3** |

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

**SEMESTER II**

**ELECTIVE COURSE IV: a) RESEARCH METHODOLOGY, COMPUTER APPLICATIONS & BIOINFORMATICS**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP232EC4 | 2 | 2 | - | - | 2 | 4 | 60 | 25 | 75 | 100 |

**Pre-requisite**

To impart expertise about analysis and research.

**Learning Objectives**

1. To equip students to collect, analyze and evaluate data generated by their own inquiries in a scientific manner.
2. To provide an overview on modern equipments that they would help students gain confidence to instantly commence research careers and/or start entrepreneurial

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 1 | realize the need of centrifuges and chromatography and their uses in research | **K1 & K2** |
| 2 | learn the principles and applications of electrophoresis | **K2 & K3** |
| 3 | construct the phylogenetic trees for similar characteristic feature of plant genomes and study *de novo* drug design through synthetic biology. | **K5 & K6** |
| 4 | understand the concept of pairwise alignment of DNA sequences using algorithms. | **K2** |
| 5 | interpret the features of local and multiple alignments. | **K4 & K5** |

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

| Unit | Contents | No. of hours |
|---|---|---|
| **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. | **12** |
| **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 | **12** |
| **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. | **12** |
| **IV** | Public biological databases, searching biological databases. Use of nucleic acid and protein data banks. | **12** |
| **V** | NCBI, EMBL, DDBJ, SWISSPORT, Protein prediction and Gene finding tools. Techniques in Bioinformatics- BLAST, FASTA, Multiple Sequence Analysis **.** | **12** |

| | | |
|---|---|---|
| | **Total** | **60** |

| | |
|---|---|
| **Self study** | Techniques in Bioinformatics- BLAST, FASTA, Multiple Sequence Analysis **.** |

**Textbooks**


1. Veerakumari, L,2017. Bioinstrumentation. MJP Publisher, India. p578.
2. Sree Ramulu, V.S, 2019. 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. Narayana, P.S.D. Varalakshmi, T. Pullaiah, 2016. Research Methodology in Plant Science, Scientific Publishers, Jaipur, Rajasthan.
2. Pevsner. J, 2015.Bio informatics 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


**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

**MAPPING WITH PROGRAMME OUTCOMES**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** |
|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 3 | 1 | 2 | 1 | 3 |
| **CO2** | 2 | 3 | 3 | 1 | 3 | 1 | 3 |
| **CO3** | 3 | 3 | 3 | 1 | 2 | 1 | 2 |
| **CO4** | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 1 | 2 | 3 |
| **Total** | **13** | **14** | **15** | **8** | **10** | **7** | **13** |
| **Average** | **2.6** | **2.8** | **3** | **1.6** | **2** | **1.4** | **2.6** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| **COs** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** | **PSO10** |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 2 | 2 | 3 | 2 | 1 | 2 | 3 |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 3 | 1 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 2 | 3 | 3 | 1 | 1 | 2 | 3 |
| **CO4** | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| **Total** | **13** | **13** | **11** | **11** | **11** | **14** | **8** | **9** | **11** | **14** |
| **Average** | **2.6** | **2.6** | **2.2** | **2.2** | **2.2** | **2.8** | **1.6** | **1.8** | **2.2** | **2.8** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER II**

**ELECTIVE COURSE IV: b) MEDICINAL BOTANY**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP232EC5 | 2 | 2 | - | - | 2 | 4 | 60 | 25 | 75 | 100 |

**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.

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 1 | recognize plants and relate to their medicinal uses | K1 |
| 2 | explain about the phytochemistry, pharmacognosy and bioprospecting of medicinal plant extracts. | K2 |
| 3 | apply techniques for conservation and propagation of medicinal plants. | K3 |
| 4 | analyze and decipher the significance of various methods of harvesting, drying and storage of medicinal herbs. | K4 |
| 5 | develop new strategies to enhance growth and quality check of medicinal herbs considering the practical issues pertinent to India. | K5 & K6 |

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

| Unit | Contents | No. of Hours |
|---|---|---|
| I | **HISTORY AND TRADITIONAL SYSTEMS OF MEDICINE:** Historical Perspectives – European, African, American, Southeast Asian Practices. Scope and Importance of Medicinal Plants; Traditional systems of medicine - Definition and Scope. Classical health traditions - Naturopathy, Siddha, Ayurveda, Homeopathy, Unani and MateriaMedica. Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in Ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e-tabiya, tumors treatments/ therapy, polyherbal formulations. | 12 |
| 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. | 12 |
| | **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 | 12 |

| | | |
|---|---|---|
| **III** | Poppy for analgesic and antitussive, *Salix* for analgesic, *Cinchona* and *Artemisia* for Malaria, *Rauwolfia*as tranquilizer, *Belladona* as anticholinergic, *Digitalis* as cardiotonic, *Podophyllum* as antitumor, *Stevia rebaudiana* for antidiabetic, *Catharanthus roseus* for anticancer. Bioprospecting, drug discovery from plants with reference to diabetes and cancer. Product development and quality control. | |
| **IV** | **CONSERVATION AND AUGMENTATION:** Significance of Cultivation, management, policies for conservation and sustainable use of medicinal plants. Conservation of endemic and endangered medicinal plants, Red list criteria; *In situ* conservation: Biosphere reserves, sacred groves, National Parks; *Ex situ* conservation: Botanic Gardens, Ethno medicinal plant Gardens. Propagation of Medicinal Plants: seeds, cuttings, layering, grafting and budding. | **12** |
| **V** | **ETHNO BOTANY AND FOLK MEDICINE:** Concepts and definition of Ethno botany and folk medicines. A brief history of ethnobotanical studies – globally & locally. Methods to study ethno botany; Applications of Ethno botany: Folk medicines of ethno botany, ethno medicine, ethno ecology, ethnic communities of India. Understanding the traditions of tribes in Tamil Nadu – Irulas and Kanis. Repository of Ethnobotanical data – Archeology, inventories, folklore and literature. Traditional Knowledge Sharing - Prior information consent, interviews, questionnaires and knowledge partners.Plants associated with culture, social, religious and medicinal purposes.Commercial use of traditional knowledge – ethics, IPR, biopiracy, equitable benefit sharing models. | **12** |
| | **Total** | **60** |

**Textbooks**


1. AYUSH (www.indianmedicine.nic.in), 2022. *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.


**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.

**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 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 1 | 2 | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 1 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 1 | 2 | 3 | 2 |
| **CO4** | 3 | 2 | 3 | 3 | 2 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 1 | 3 | 3 |
| **Total** | **15** | **14** | **15** | **8** | **10** | **15** | **13** |
| **Average** | **3** | **2.8** | **3** | **1.6** | **2** | **3** | **2.6** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 3 |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO4** | 3 | 1 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **Total** | **15** | **13** | **15** | **11** | **11** | **14** | **15** | **15** | **11** | **14** |
| **Average** | **3** | **2.6** | **3** | **2.2** | **2.2** | **2.8** | **3** | **3** | **2.2** | **2.8** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER II**

**ELECTIVE COURSSE IV: c) PHYTOCHEMISTRY**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP232EC6 | 2 | 2 | - | - | 2 | 4 | 60 | 25 | 75 | 100 |

**Pre-requisite**

Basic understanding of plant metabolites.

**Learning Objectives**

1. To comprehend the various classes of phyto chemicals present in the plant kingdom
2. To understand the biosynthetic processes through which diverse phytochemicals are synthesized and to study their structural and functional characteristics

**Course Outcomes**

| On the successful completion of the course, student will be able to: | | |
|---|---|---|
| 1 | understand the role of plants in the survival of human beings and other organisms. | **K1** |
| 2 | recognition of the contribution made by primitive people in exploration of plantknowledge to alleviate common diseases and development of systems of medicine. | **K2** |
| 3 | gaining knowledge on different classes of phytochemicals present in higher andlower plants species. | **K3** |
| 4 | demonstrate the various aspects of extraction, isolation and characterization of secondary metabolites. | **K4 & K5** |
| 5 | know the methods of screening of secondary metabolites for various biological properties. | **K6** |

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

| UNIT | CONTENTS | No. of hours |
|---|---|---|
| **I** | **SECONDARY METABOLITES AND CLASSIFICATION :** Phytochemistry: Definition, history, principles. Secondary metabolites: definition, classification, occurrence and distribution in plants, functions, chemical constituents. Alkaloids, terpenoids, flavonoids, steroids, and coumarins. | **12** |
| **II** | **ISOLATION AND QUANTIFICATION OF PHYTOCHEMICALS:** Techniques for isolation of medicinally important biomolecules: solvent extraction, chemical separations, steam distillation, soxhlet extraction. Purification, concentration, determination and quantification of compounds (TLC, Column, HPLC). Characterization of phytochemicals: spectroscopic methods. | **12** |
| **III** | **BIOSYNTHETIC PATHWAYS AND APPLICATION OF PHYTOCHEMICALS :** Biosynthetic pathways of secondary compounds: Shikimic pathway; Mevalonic Acid Pathway; Pathways for commercially important phytochemicals: Taxol and *Vinca* alkaloids. Applications of phytochemicals in medicine, pharmaceuticals, food, flavour and cosmetic industries. | **12** |

| | | |
|---|---|---|
| **IV** | **HERBALISM AND ETHNOBOTANY:** Herbs and healing: Historical perspectives: local, national and global level; Herbalcultures: 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. | **12** |
| **V** | **TRADITIONAL SYSTEM OF MEDICINE:** Classical health traditions: Systems of medicine: origin and development of biomedicine; Indian Systems of Medicine (Ayurveda, Siddha, Unani, Tibetan, Yoga 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.* | **12** |
| | **Total** | **60** |

**Textbooks**


1. Kokate, C.K., Purohit, A.P and Gokhale, S.B, 2020. Pharmacognosy. Vol. I & II. NiraliPrakashan, Pune.
2. Mohamed Ali, 2022. 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.
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.


## MAPPING WITH PROGRAMME OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO4** | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 2 | 3 | 3 | 3 | 3 | 2 | 2 |
| **Total** | **13** | **15** | **15** | **14** | **13** | **12** | **13** |
| **Average** | **2.6** | **3** | **3** | **2.8** | **2.6** | **2.4** | **2.6** |

MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 |
| **CO 2** | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 3** | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 1 | 2 | 3 |
| **CO 4** | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO 5** | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| **Total** | **8** | **10** | **13** | **11** | **14** | **13** | **14** | **11** | **13** | **14** |
| **Average** | **1.6** | **2** | **2.6** | **2.2** | **2.8** | **2.6** | **2.8** | **2.2** | **2.6** | **2.8** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER I & II**
**LIFE SKILL TRAINING – I ETHICS**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| PG23LST1 | 1 | - | - | - | 1 | 1 | 15 | 50 | 50 | 100 |

**Prerequisites:**
Value education-its purpose and significance in the present world

**Learning Objectives**

1. To familiarize students with values of the individual, society, culture, one's own health and life philosophy,
2. To impart knowledge of professional ethical standards, codes of ethics, obligations, safety, rights, and other worldwide challenges.

| COs | On the successful completion of the course, student will be able to: | |
|---|---|---|
| 1 | understand deeper insight of the meaning of their existence. | K1 |
| 2 | recognize the philosophy of life and individual qualities | K2 |
| 3 | acquire the skills required for a successful personal and professional life. | K3 |
| 4 | develop as socially responsible citizens. | K4 |
| 5 | create a peaceful, communal community and embrace unity. | **K3** |

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

| Unit | Contents | No. of Hours |
|---|---|---|
| I | **Goal Setting:** Definition - Brainstorming Session – Setting Goals – Few components of setting goals. | 3 |
| II | **Group Dynamics:** Definition - Nature of Groups – Types of Groups – Determinants of group behavior | 3 |
| III | **Conflict Resolution:** Definition – What is a conflict resolution – Why should conflicts be resolved? - Lessons for life | 3 |
| IV | **Decision Making:** Definition – 3C's of decision making – Seven Steps to effective decision making – Barriers in effective decision making | 3 |
| V | **Anger Management:** Effects of anger – Tips to reduce anger – Anger warning signs – Identify your triggers – Ways to cool down your anger. | 3 |
| **TOTAL** | | **15** |
| **Self-Study Portion:** Salient values for life, Human Rights, Social Evils and how to tackle them, Holistic living, Duties and responsibilities. | | |

**Textbooks**

Life Skill Training – I Ethics, Holy Cross College (Autonomous), Nagercoil

**Reference Books**

1. Holy Cross College (Autonomous), Nagercoil (2007). Foundation Course Life's Challenges. Sipca Computers.

2. Mathew, Sam (2010). Self Help Life Book. Opus Press Publisher.
3. Swati Mehrotra. (2016). Inspiring Souls Moral Values and Life Skills (1st ed.) [English]. Acevision Publisher Pvt. Ltd.
4. Irai Anbu, v. (2010, August). Random Thoughts (1st ed.) [English]. THG Publishing Privat Limited, 2019.
5. Holy Cross College (Autonomous), Nagercoil (2007). Foundation Course Life's Challenge Sipca Computers.

**Web Resources**

1. https://positivepsychology.com/goal-setting-exercises/
2. https://www.gov.nl.ca/iet/files/CCB_GroupDynamicsGuide.pdf
3. https://en.wikipedia.org/wiki/Conflict_resolution
4. https://asana.com/resources/decision-making-process
5. https://www.mayoclinic.org/healthy-lifestyle/adult-health/in-depth/anger-management/art-20045434

**SEMESTER III**

**CORE COURSE VI: CELL AND MOLECULAR BIOLOGY**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP233CC1 | 4 | 2 | - | - | 5 | 6 | 90 | 25 | 75 | 100 |

**Pre-requisite:**

Knowledge on cell and fundamentals of the various techniques used in molecular studies.

**Learning Objectives:**

1. To understand the cell division and its molecular mechanism so as to appreciate and manipulate normal and abnormal cell and tissue growth.
2. To examine the DNA structure, replication process, transcription process and translation processes.

**Course Outcomes**

| On the successful completion of the course, the students will be able to: | | |
|---|---|---|
| 1 | recall a plant cell structure and explain its function. | **K1** |
| 2 | illustrate and explain the structure of various cell organelles. | **K2** |
| 3 | explain the structure and functional significance of nucleic acid. | **K3** |
| 4 | compare and contrast the DNA replication (prokaryotes and eukaryotes), enzymes involved in replication, DNA repair. | **K4** |
| 5 | discuss and develop skills for DNA/gene manipulating and enzymes involved. | **K5 & K6** |

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

| Unit | Contents | No. of hours |
|---|---|---|
| I | Concept of prokaryote and Eukaryote. Structural organization of plant cell, specialized plant cell types chemical foundation. Cell wall- Structure and functions, Plasma membrane; structure, models and functions, site for ATPase, ion carriers channels and pumps, receptors. Plasmodesmata and its role in movement of molecule. | **18** |
| II | Chloroplast-structure and function, genome organization, gene expression, Mitochondria; structure, genome organization, biogenesis. Plant Vacuole - Tonoplast membrane, ATPases transporters as a storage organelle. Structure and function of other cell organelles- Golgi apparatus, lysosomes, endoplasmic reticulum and microbodies. | 18 |
| III | Nucleus: Structure and function, nuclear pore, Nucleosome organization, euchromatin and heterochromatin. Ribosome- Structure and functional significance. RNA and DNA Structure. A, B and Z Forms. DNA damage and repair (Thymine dimer, photoreactivation, excision repair). Cell cycle and Apoptosis; Control mechanisms. Cytokinesis and cell plate formation, mechanisms of programmed cell death. | **18** |
| IV | DNA replication (prokaryotes and eukaryotes), enzymes involved in replication, DNA repair. DNA sequencing. Transcription, enzymes involved in transcription, post transcription changes, reverse transcription, Translation (prokaryotes and eukaryotes.), overlapping genes. | **18** |
| | DNA/gene manipulating enzymes: endonuclease, ligase, polymerase, phosphatase, transcriptase, transferase, topoisomerase. Gene cloning: cloning vectors, molecular | **18** |

| | | |
|---|---|---|
| V | cloning and DNA libraries, transposons. Recombinant DNA. Direct and indirect gene transfer. Detection of recombinant molecule, production of gene products from cloned genes. Genome library, cDNA library. | |
| | **Total** | **90** |

| | |
|---|---|
| **Self-Study** | Plasmodesmata and its role in movement of molecule. Golgi apparatus, DNA damage and repair , Genome library, cDNA library. |

**Textbooks**:

1. Geoffrey M, Cooper.I, 2019.*The Cell :A Molecular Approach*, Oxford University Press.
2. William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino , Darrell Killian, 2019. *Concepts of Genetics*. Eleventh Edition, Pearson Education publications, New Delhi.

**Reference Books:**

1. David Freifelder. 2008. *Essentials of Molecular Biology*. Narosa Publishing house. New Delhi.
2. Neena Grover. 2022. *Fundamentals of RNA Structure and Function -Learning Materials in Biosciences*. Springer Nature, Switzerland.
3. Jocelyn E. Krebs , Elliotes Goldstein, Stephen T.Kilpatrick.2009.Lewin's.*Genes X.* Jones and Bartlett Publishers, USA.
4. Watson, J.D, Baker T.A., Bell S.P., Gann A., Levine M., Losick R. 2014. *Molecular Biology of the Gene*, Pearson Education publications, New Delhi.
5. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons, USA.

**Web Resources**:

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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 2 | 1 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 1 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 1 | 2 |
| **Total** | **15** | **15** | **15** | **15** | **12** | **7** | **11** |
| **Average** | **3** | **3** | **3** | **3** | **2.4** | **1.4** | **2.2** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 2 | 1 | 2 | 3 | 1 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| **Total** | **15** | **13** | **13** | **12** | **13** | **15** | **11** | **15** | **15** | **15** |
| **Average** | **3** | **2.6** | **2.6** | **2.4** | **2.6** | **3** | **2.2** | **3** | **3** | **3** |

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

**SEMESTER III**

**CORE COURSE VII: GENETICS, PLANT BREEDING AND BIOSTATISTICS**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP233CC2 | 4 | 2 | - | - | 5 | 6 | 90 | 25 | 75 | 100 |

**Pre-requisite:**

Knowledge on genetic traits and plant breeding techniques for crop improvement.

**Learning Objectives:**

1. To have conceptual understanding of laws of inheritance, genetic basis of loci and alleles and their linkage.
2. To develop critical understanding of chemical basis of genes and their interactions at population and evolutionary levels.

**Course Outcomes**

| On the successful completion of the course, students will be able to: | | |
|---|---|---|
| **1.** | understand the Mendal's Law of inheritance and gene interactions | **K1** |
| **2.** | analyse the various factors determining the heredity from one generation to another. | **K2** |
| **3.** | explain Gene mapping methods: Linkage maps. | **K3** |
| **4.** | compare and contrast the genetic basis of breeding self and cross – pollinated crops. | **K4** |
| **5.** | discuss and develop skills for statistical analysis of biological problems | **K5 & K6** |

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

| Units | Contents | No. of Hours |
|---|---|---|
| **I** | Mendal's Law of inheritance. Gene interactions and modified dihybrid ratios. Quantitative inheritance. Sex determination in plants and theories of sex determination. Sex linked characters. Structure of Gene , Gene function and regulation in prokaryotes with reference to Lac operon and trp operon. Producer gene , structural gene and integrator gene. Gene Regulation eukaryotes –Britten and Davidson model, Arabidopsis- gene regulation in flowering. | **18** |
| **II** | Recombination: Homologous and non-homologous recombination, site-specific recombination. Holiday model of recombination. Transposable genetic elements: transposase, transposon, simple transposon, composite transposon. Transposons in *Zea mays*. Transposable elements in prokaryotes. UV induced mutation and its repair mechanism. Mismatch DNA repair mechanism. Mutation types- frame shift mutation, addition, deletion, substitution, transition and transversion. | **18** |
| **III** | ABO blood group in humans. QTL mapping, Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers ,mapping by using somatic cell hybrids. Extra chromosomal inheritance, maternal inheritance. | **18** |
| **IV** | **PLANT BREEDING**:<br>Objectives of plant breeding, characteristics improved by plant breeding, Genetic basis of breeding self and cross – pollinated crops. Pure line theory, pure line selection and mass selection, clonal selection methods. Hybridization ,Genetics and physiological basis of heterosis. | **18** |

| | | |
|---|---|---|
| **V** | **BIOSTATISTICS:**<br>Measures of central tendency (Mean , Median , Mode) and dispersal (Mean deviation , standard deviation) , standard errors ANOVA (One way). Sampling distribution; levels of significance; regression and correlation; t-test; analysis of variance; X2 test. | **18** |
| | **Total** | **90** |

| | |
|---|---|
| **Self-study** | Mendal's Law of inheritance. Gene interactions and modified dihybrid ratios. ABO blood group in humans. Measures of central tendency (Mean, Median, Mode) |

**Textbooks:**


1. Gupta, P.K. 2009. *Genetics*. Rastogi publications, Meerut, New Delhi.
2. Gupta, S.C. 2013. *Fundamentals of statistics*, Himalaya Publishers, Mumbai.


**Reference Books**:


1. James D, Watson. 2003. *Molecular Biology of the Gene*. Fourth Edition. The Benjamin Cummings Publishers, USA.
2. Strickberger, M.W. 2005. *Genetics (III* Ed). Prentice Hall, New Delhi, India.
3. Allard, R.W. 2010. *Principles of Plant Breeding*. 2nd ed. John Wiley and Sons, New Jersey, US.
4. Zar, J.K. 2011. *Biostatistical Analysis*, Fourth Edition, Prantice-Hall International, New Jersey, USA.
5. Friefelder,D. 2005. *Molecular Biology*. Second Edition. Narosa Publishing House, New Delhi.


**Web Resources**:

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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 2 | 1 | 2 |
| **CO2** | 3 | 2 | 2 | 2 | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 1 | 2 |
| **CO4** | 3 | 2 | 2 | 3 | 3 | 1 | 2 |
| **CO5** | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| **Total** | 15 | 13 | 11 | 11 | 13 | 7 | 11 |
| **Average** | 3 | 2.6 | 1.1 | 2.2 | 2.6 | 1.4 | 2.2 |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 2 | 3 | 3 | 1 | 1 | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 1 | 3 | 3 | 1 | 2 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 1 | 3 | 3 | 2 | 1 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **Total** | **15** | **13** | **15** | **8** | **15** | **15** | **8** | **6** | **15** | **15** |
| **Average** | **3** | **2.6** | **3** | **1.6** | **3** | **3** | **1.6** | **1.2** | **3** | **3** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER III**

**CORE LAB COURSE III: CORE COURSE VI AND VII**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP233CP1 | | - | 6 | - | 5 | 6 | 90 | 25 | 75 | 100 |

**Pre-requisite**:

Knowledge on overall cell structure, cellular organelles, staining procedures and fundamental principles of genetics and plant breeding.

**Learning Objectives:**

1. To observe the different stages of mitosis and chromosome behaviour and organization during various stages and to learn staining techniques of various plant tissues.
2. To understand the principles of rDNA techniques.

**Course outcomes**

| On the successful completion of this course, the students will be able to: | | |
|---|---|---|
| **1.** | recall or remember the various aspects of cell biology, genetics, molecular biology, plant breeding and tissue culture. | **K1** |
| **2.** | understand various concepts of cell biology, genetics, plant breeding and tissue culture. | **K2** |
| **3.** | apply the theory knowledge gained into practical mode in order to acquire applied knowledge by day-to-day hands-on experiences. | **K3** |
| **4.** | analyze or interpret the results achieved in practical session in the context of existing theory and knowledge. | **K4** |
| **5.** | evaluate the theory and practical skills gained during the course. | **K5 &K6** |

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

| Unit | Experiments | No. of Hours |
|---|---|---|
| **I** | **CELL AND MOLECULAR BIOLOGY**<br>1. Identification of different stages of mitosis from suitable plant material. (Onion root tips/ garlic root tips).<br>2. Identification of meiosis from suitable plant material. (Onion /*Tradeschantia* floral buds).<br>3. Isolation of cell organelles: Mitochondria, Chloroplast, Nucleus, Lysosomes (Demo)<br>4. Study of mitotic index from suitable plant material. | **18** |
| **II** | 5. To study plant vacuole in cells of onion leaf peel.<br>6. Restriction digestion of DNA samples using restriction endonucleases (RE). (Demo)<br>7. To study the structure and organization of plant cell in various tissues of various plants (incl. leaf, stem and roots). | **18** |
| **III** | **GENETICS**<br>1. Problem solving on dihybrid phenotypic, genotypic and test cross ratios.<br>2. Incomplete dominance in plants.<br>3. Interactions of factors and modified dihybrid ratios.<br>4. Multiple alleles in plants, blood group inheritance in human.<br>5. Sex linked inheritance in Drosophila and plants. | **18** |

| | | |
|---|---|---|
| **IV** | 6. Quantitative inheritance in plants.<br>7. Chromosome mapping from three-point test cross data. Calculation of chiasmatic interference.<br>8. Calculate gene and genotypic frequency by Hardy- Weinberg equation. | **18** |
| **V** | **PLANT BREEDING**<br>1. Techniques in plant hybridization. | **18** |
| | **Total** | **90** |

| | |
|---|---|
| **Self-Study** | Multiple alleles in plants, blood group inheritance in human. |

**Textbooks**

1. Gupta P.K. 2017. *Cell and Molecular Biology* (5th ed.), Rastogi Publications, Meerut.
2. George M Malacinski. 2015. Freifelders *Essentials of Molecular Biology* (4th ed.). Jones & Bartlett.

**Reference Books:**

1. De Robertis E.D.P. and De Robertis E.M.P. 2017. *Cell and Molecular Biology*, Lea and Febiger, Philadelphia, USA.
2. Jackson, S.A., Kianian, S.F., Hossain, K.G., and Walling, J. G. 2012. *Practical laboratory exercises for plant molecular cytogenetics. In Plant Cytogenetics*, Springer, New York.
3. Gardener, J, Simmons, H.J and Snustad, D.P. 2006. *Principle of Genetic*s, John Wiley & Sons, New York.
4. Gelvin, S.B., Schilperoort, R.A. 2000. *Plant Molecular Biology-Manual*. Springer publishers, New York
5. Krebs, J.E., Goldstein E.S. and Kilpatrick S.T. 2017. *Lewin's GENES XII*. Jones & Bartlett Learning. Book and Periodical Publishing, Massachusetts

**Web Resources**

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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 3 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| **Total** | **14** | **14** | **11** | **14** | **11** | **14** | **11** |
| **Average** | **2.8** | **2.8** | **2.2** | **2.8** | **2.2** | **2.8** | **2.2** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 2 |
| **CO2** | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 |
| **CO3** | 2 | 1 | 3 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| **CO4** | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 1 | 2 |
| **Total** | **11** | **11** | **14** | **11** | **11** | **11** | **11** | **6** | **8** | **7** |
| **Average** | **2.2** | **2.2** | **2.8** | **2.2** | **2.2** | **2.2** | **2.2** | **1.2** | **1.6** | **1.4** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER III**
**CORE RESEARCH PROJECT**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| **BP233RP1** | **-** | **-** | **5** | **-** | **4** | **5** | **75** | **25** | **75** | **100** |

**Pre-requisite:** Knowledge on plants and their growing environment

**Learning Objectives**

1.To enable students to design experiment, analyse data and interpret results.

**2.**To develop skills to identify subject related problems in the neighbourhood and report to thescientific community.

**Course Outcome**

| **On the successful completion of this course the students will be able to:** | | |
|---|---|---|
| **1** | explore new areas of research in Botany and allied field of life science. | **K3** |
| **2** | analyze a research problem and construct tools for data collection. | **K4** |
| **3** | write research reports and present results in the scientific community. | **K3** |
| **4** | develop skills to serve in Life science related industries and agencies. | **K5** |
| **5** | develop skills to publish articles in reputed journals. | **K6** |

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

**Guidelines**

- All the students must undertake dissertation work at the final year (III semester).
- The students, with the consent of the Supervisor, HOD and the Principal can pursue theirproject in another institution, especially with MoU/ Collaboration for the successful completion of the project work.
- Evaluation

| Evaluation | Marks | Month/ Date | Evaluator |
|---|---|---|---|
| Proposed title, review of literature and objectives. | - | 3rd Week of III Semester | - |
| I Review | 5 | July | Supervisor |
| II Review | 5 | August | Supervisor |
| Final- Internal | 15 | September/ October | Supervisor |
| External – Dissertation<br>*Viva-voce (individual & open) | 40<br>35 | October /November | Ext. examiner |
| Total marks | 100 | | |

* Mode of presentation by
Power Point
Dissertation framework
I. The dissertation format should be in:
  - Font - Times New Roman
  - Heading - Font size 14 (Bold) - Uppercase
  - Sub headings - Font size 12 (Bold) – Lowercase; should be numbered.

1. (Eg: Introduction 1; Subheading 1.1; 1.2 ….)
  - Text, the content of the dissertation – Font size -12 (Normal).

- Citation - Any works of other researchers, if used either directly or indirectly should be indicated at appropriate places in the text.

The citation may assume any one of the following forms:

i) A paper, a monograph or a book with single author may be designated by the name of the first author followed by the year of publication, placed inside brackets at the appropriate places in the text.

ii) A paper, a monograph or a book with two authors may be designated by the name of the first and second author followed by the year of publication, placed inside brackets at the appropriate places in the text.

iii) A paper, a monograph or a book with more than two authors may be designated by the name of the first author followed by et al, and the year of publication, placed inside brackets at the appropriate places in the text.

- Line space - 1.5
- Margin - 2" on the left and 1" on the right, Gutter -0.5.
- Page Numbering – Bottom middle alignment; excluding initial pages and reference
- Total number of pages - Minimum 30 - Maximum 50 (excluding initial pages and reference).
- The Tables and Figures should be included subsequently after referring them in the text of the Thesis.
- The thesis from Chapters should be printed on both sides.

II. Dissertation must be completed within the stipulated time.

III. Submission of Dissertation:

- one soft copy (PDF format in CD)
- three hard copies (soft binding) duly signed and endorsed by the Supervisor and the Head.

The report - dissertation will have three main parts:

I. Initial Pages - in the following sequence

i. Title Page
ii. Certificate from the Supervisor
iii. Declaration by the candidate endorsed by the Supervisor and HOD.
iv. Acknowledgement (within one page - signed by the candidate).
v. Table of Contents
vi. List of abbreviations
vii. Abstract

**II. Main body of the dissertation**

i) Introduction with Literature review and Objectives
ii) Methodology
iii) Results
iv) Discussion
v) Summary
vi) References (DOI number of the journals can be included)

**The guidelines for reference:**

**Journal Article : with Single Author**

Waldron, S 2008, "Generalized Welch bound equality sequences are tight frames", IEEE Transactions on Information Theory, vol. 49, no. 9, pp. 2307-2309.

**Journal Article : with Two Authors**

Conley, TG & Galeson, DW 1998, "Nativity and wealth in mid-nineteenth century cities", Journal of Economic History, vol. 58, no. 2, pp. 468-493.

**Journal Article : with more than two Authors**

Alishahi, K, Marvasti, F, Aref, VA & Pad, P 2009, „Bounds on the sum capacity of synchronous binary CDMA channels", Journal of Chemical Education, vol. 55, no. 8, pp. 3577-3593.

**Books**

Holt, DH 1997, Management Principles and Practices, Prentice-Hall, Sydney. Centre for Research, M S University - Ph.D. Revised Guidelines Page | 39 / 41

**E-book**

Aghion, P &Durlauf, S (eds.) 2005, Handbook of Economic Growth, Elsevier, Amsterdam. Available from: Elsevier books. [4 November 2004].

**Conference Proceeding Paper with editors**

Riley, D 1992, „Industrial relations in Australian education", in Contemporary Australasian industrial relations: proceedings of the sixth AIRAANZ conference, ed. D. Blackmur, AIRAANZ, Sydney, pp. 124-140.

**Conference Proceeding Paper without editors**

Fan, W, Gordon, MD & Pathak, R 2000, "Personalization of search engine services for effective retrieval and knowledge management", Proceedings of the twenty-first international conference on information systems, pp. 20-34.

**Website**

Australian Securities Exchange 2009, Market Information. Available from: . [5 July 2009]. **Thesis**

Unpublished Hos, JP 2005, Mechano chemically synthesized nano materials for intermediate temperature solid oxide fuel cell membranes. Ph.D. thesis, University of Western Australia.

Newspaper Print Ionesco, J 2001, 'Federal election: new Chip in politics', The Advertiser 23 October, p. 10.

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 3 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| **Total** | **14** | **14** | **11** | **14** | **11** | **14** | **11** |
| **Average** | **2.8** | **2.8** | **2.2** | **2.8** | **2.2** | **2.8** | **2.2** |

## MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 2 |
| **CO2** | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 |
| **CO3** | 2 | 1 | 3 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| **CO4** | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 1 | 2 |
| **Total** | **11** | **11** | **14** | **11** | **11** | **11** | **11** | **6** | **8** | **7** |
| **Average** | **2.2** | **2.2** | **2.8** | **2.2** | **2.2** | **2.2** | **2.2** | **1.2** | **1.6** | **1.4** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER III**

**ELECTIVE COURSE V: a) ENTREPRENEURIAL OPPORTUNITIES IN BOTANY**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| **BP233EC1** | 4 | - | - | - | 3 | 4 | **60** | **25** | **75** | **100** |

**Pre-requisite**

To understand the importance of floriculture and nursery management.

**Learning Objectives**

1. To understand the different classifications of horticultural crops, nursery management, and use of technology in horticulture.
2. To evaluate the importance of floriculture and contribution spices and condiments on economy.

**Course outcomes**

| **On completion of this course, the students will be able to:** | | |
|---|---|---|
| **1** | students can acquire knowledge about organic farming and their advantages | **K1** |
| **2** | understand both the theoretical and practical knowledge in understanding various horticultural techniques. | **K2** |
| **3** | to develop kitchen garden or terrace garden in their living area. | **K3** |
| **4** | evaluate the horticultural techniques to students can develop self-employment and economical improvement. | **K4** |
| **5** | create and develop skills for mushroom cultivation. | **K5 & K6** |

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

| Units | Contents | No.of hours |
|---|---|---|
| **I** | Organic manures and fertilizers. Composition of fertilizer, NPK content of various fertilizers. Common organic manures bone meal, cow dung, poultry waste, oil cakes, organic mixtures and compost. Preparation of compost, aerobic and anaerobic – advantages. Vermicompost preparation, Panchakaviyam. | **12** |
| **II** | Common garden tools. Methods of plant propagation by seeds. Vegetative propagation, cutting, grafting, budding and layering. Use of growth regulators for rooting. | **12** |
| **III** | Gardening – types of gardens, ornamental, indoor garden, kitchen garden, terrace garden, vegetable garden for marketing. Rockery and artificial ponds. Ornamental garden designing, garden components flower beds, borders, hedges, edges, drives, paths, garden adornments. | **12** |
| **IV** | Packaging of fruits, vegetables. Preservation techniques drying, heat treatment, low temperature storage and by chemicals. Preparation of wine, vinegar and dairy products. | **12** |
| **V** | Significance of mushrooms. Types of mushrooms (button mushroom, oyster mushroom). Spawn isolation and preparation. Cultivation. Value added products from mushroom – pickles, candies and dried mushrooms. | **12** |
| | **Total** | **60** |

| **Self-study** | Panchakaviyam, Common garden tools, Ornamental garden designing, Preparation of wine, Value added products from mushroom – pickles, |
|---|---|

**Textbooks:**

1. Chmielewski, J.G and Krayesky,D. 2013.*Genera lBotany laboratory Manual*. Bloomington, USA.
2. Bendre,M.AshokandAshokKumar,A.2020.*Text Book of Practical Botany*-1 ( 10th ed). Rastogi Publications, Meerut.

**Reference books:**

1. Sathe,T.V. 2004. *Vermiculture and Organic farming*, Daya Publishers, Kolkata.
2. Peter, K.V. 2017. *Basic Horticulture*.New India Publishing Agency, New Delhi.
3. Bhukiya,B.and Anjana D, T. 2021. *Microbial Biotechnology*, Apple Academic Press, Canada.
4. Gupta. P.K.,2008. *Elements of Biotechnology*. Rastogi publications, Meerut.
5. Swatantra, Y, Pandey, A. Lal, M. Kumar, D. 2022. *Recent Advances in Horticulture*, Rubicon Publications, London.

**Web resources:**

1. https://www.kobo.com/in/en/ebook/composting-process-organic-manures-through-ecofriendly-waste-management-practices
2. https://books.google.co.in/books/about/Plant_Propagation.html?id=KgQh6OI7GcC&redir_es=y
3. https://www.ebooks.com/en-us/subjects/gardening/
4. https://www.amazon.in/Preservation-Techniques-Publishing-Technology-Nutrition ebook/dp/B00RXCXB3Q
5. https://www.elsevier.com/books/food-preservation-techniques/zeuthen/978-1-85573-530-9

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 3 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| **Total** | **14** | **14** | **11** | **14** | **11** | **14** | **11** |
| **Average** | **2.8** | **2.8** | **2.2** | **2.8** | **2.2** | **2.8** | **2.2** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 3 | 2 | 1 | 2 | 1 | 3 | 2 |
| **CO2** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO3** | 2 | 1 | 3 | 3 | 1 | 2 | 1 | 1 | 3 | 1 |
| **CO4** | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 |
| **Total** | **11** | **11** | **14** | **14** | **11** | **11** | **11** | **6** | **14** | **11** |
| **Average** | **2.2** | **2.2** | **2.8** | **2.8** | **2.2** | **2.2** | **2.2** | **1.2** | **2.8** | **2.2** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER III**

**ELECTIVE COURSE V: b) SECONDARY PLANT PRODUCTS AND FERMENTATION BIOTECHNOLOGY**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP233EC2 | 4 | - | - | - | 3 | 4 | 60 | 25 | 75 | 100 |

**Pre-requisite:** To know about the microbial culture in the manufacture of value-added products

**Learning Objectives:**

1. To familiar with the basics of biochemistry and fermentation
2. To understand secondary metabolites

**Course Outcomes**

| On the successful completion of the course, students will be able to: | | |
|---|---|---|
| **1.** | critically analyze the types of bioreactors and the fermentation process. | **K1** |
| **2.** | study the role of microorganisms in industry. | **K2** |
| **3.** | analyze the types of bioreactors. | **K3** |
| **4.** | create to understand the significance of intrinsic and extrinsic factors on growth of microorganism. | **K4** |
| **5.** | evaluate the concept of downstream processing. | **K5 & K6** |

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

| Units | Contents | No. of Hours |
|---|---|---|
| **I** | **SECONDARY METABOLITES:** A brief account of acetate malonate, acetate mevalonate and shikimic acid pathways. Categories of phytochemicals – Phenols, alkaloids, flavonoids, terpenoids, steroids, glycosides, carbohydrates, proteins, amino acids, lipids, pigments, vitamins and other related compounds | **12** |
| **II** | **MICROBIAL GROWTH:** Factors affecting microbial growth; Stoichiometry: mass balances; Stoichiometry: energy balances; Growth kinetics; Measurement of growth. | **12** |
| **III** | **BIOREACTORS:** Introduction to bioreactors; Batch and Fed-batch bioreactors, Continuous bioreactors; Immobilized cells; Bioreactor operation; Sterilization; Aeration; Sensors; Instrumentation; Culture-specific design aspects: plant/mammalian cell culture reactors. Bioseparations: Biomass removal; Biomass disruption; Membrane-based techniques; Extraction; Adsorption and Chromatography Industrial Processes and Process economics: Description of industrial processes; Process flow sheeting; Process economics. | **12** |
| **IV** | **DOWNSTREAM PROCESSING:** Biomass removal and disruption; Centrifugation; sedimentation; Flocculation; Microfiltration; Sonication; Bead mills; Homogenizers; Chemical lysis; Enzymatic lysis; Membrane based purification: Ultrafiltration ; Reverse osmosis; Dialysis ; Diafiltration ; Pervaporation; Perstraction; Adsorption and chromatography: size, charge, shape, hydrophobic interactions, Biological affinity; Process configurations (packed bed, expanded bed, simulated moving beds); Precipitation (Ammonium Sulfate, solvent); Electrophoresis(capillary); Crystallization; Extraction (solvent, aqueous two phase, super critical), Drying; Case studies. | **12** |
| **V** | **IMPORTANT PRODUCTS THROUGH FERMENTATION:** Organic acids citric acid acetic acid, enzymes – amylase, protease, lipase, antibiotics | **12** |

| | | |
|---|---|---|
| | – penicillin, vitamins – B12, amino acids – glycine, glutamic acid, organic solvent – ethanol, butanol, acetone, alcoholic beverages – wine, beer, biomass –baker's yeast, biosurfactants, biopesticides, biopolymers. | |
| | **Total** | **60** |

| | |
|---|---|
| **Self-study** | Organic acids citric acid acetic acid, enzymes – amylase, protease, lipase, antibiotics – penicillin, vitamins – B12 |

**Textbooks**:


1. Shuler, M. L and F. Kargi. 2002. *Bioprocess Engineering*, Prentice Hall Inc. USA.
2. Casia, J.R.L.E. 2009. *Industrial Microbiology*. New Age International (P) Ltd. Publisher, New Delhi.


**Reference Books:**


1. Frazier, W.C. and Weshoff, D.C. 2015. *Food Microbiology* (5th edition) Mcgraw Hill Publishers, New York.
2. Kumari, S. 2012. Basics of Food Biochemistry and Microbiology. Koros Press. London.
3. Whitaker. J.R. 2016. *Handbook of Food Enzymology*. CRC press, USA.
4. Shewfelt, R.L.2013. *Introducing Food Science*. CRC Press, USA
5. Smith, J.S and Hui, Y.H.2014. *Food Processing*. Wiley Publishing company, USA.


**Web Resources**:

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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| **Total** | **14** | **14** | **11** | **14** | **11** | **14** | **14** |
| **Average** | **2.8** | **2.8** | **2.2** | **2.8** | **2.2** | **2.8** | **2.8** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 3 | 2 | 1 | 2 | 2 | 3 | 2 |
| **CO2** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| **CO3** | 2 | 1 | 3 | 3 | 1 | 2 | 1 | 3 | 3 | 1 |
| **CO4** | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 |
| **Total** | **11** | **11** | **14** | **14** | **11** | **11** | **11** | **14** | **14** | **11** |
| **Average** | **2.2** | **2.2** | **2.8** | **2.8** | **2.2** | **2.2** | **2.2** | **2** | **3** | **2.2** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER III**

**ELECTIVE COURSE V: c) APPLIED PLANT CELL AND TISSUE CULTURE**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP233EC3 | 4 | - | - | - | 3 | 4 | 60 | 25 | 75 | 100 |

**Pre-requisite:** The course will equip students to either obtain employment in the field or start their own business there, depending on the needs of the industry.

**Learning Objectives:**

1. To comprehend the basic principles and methodologies of plant tissue culture.
2. To acquire knowledge on in vitro cultivation techniques to develop protocols targeted towards commercialization.

**Course Outcomes**

| On the successful completion of the course, students will be able to: | | |
|---|---|---|
| **1.** | recall the principles and culture techniques of cells, callus, organs, pollen, anthers, embryos and protoplasts. | **K1** |
| **2.** | understand the techniques used in plant growth and regeneration under *in vitro* conditions. | **K2** |
| **3.** | apply the role plant tissue culture techniques in the production some secondary metabolites and planting stock in horticulture. | **K3** |
| **4.** | analyze the conditions that are suitable for direct and indirect plant regeneration. | **K4** |
| **5.** | evaluate the self-skills obtained during the course thorough internal and external assessment systems | **K5** |

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

| Units | Contents | No. of Hours |
|---|---|---|
| I | **BASIC PLANT TISSUE CULTURE:** Totipotency and concepts of plant tissue culture – Laboratory organization – Design of different laboratories and management - Aseptic techniques - Plant culture media – Inorganic nutrients – Macronutrients – Micronutrients - Carbon and energy sources – Organic supplements – Growth regulators – Solidifying agent – MS medium and B5 medium – Explant preparation - Methods of sterilization – Transfer and incubation of culture – Transplantation area. | 12 |
| **II** | **MICROPROPAGATION:** Micropropagation – Stages of micropropagation - Multiplication by axillary and apical shoots – Multiplication by adventitious shoots – Multiplication through callus culture – Organogenesis and somatic embryogenesis – Multiplication and Rooting - Hardening - Factors effecting micropropagation – Technical problems in micropropagation - Practical applications of micropropagation – Somaclonal & gametoclonal variation – synthetic seed technology - Shoot tip/Meristem culture for virus free plants. | **12** |
| **III** | **CELL AND PROTOPLAST CULTURES AND HAPLOID PRODUCTION:** Single cell and cell suspension culture – Applications - Production of haploids - Anther culture and pollen culture – Induction of haploids from un-pollinated ovaries and ovules – Role of haploids in Plant breeding - Protoplast culture: Protoplast isolation, purification – regeneration – culturing. Protoplast fusion techniques – somatic hybridization and cybridization - Applications of protoplast culture and hybridization. | **12** |

| | | |
|---|---|---|
| **IV** | **METABOLIC ENGINEERING:** Application of cell culture systems in metabolic engineering - advantages of cell, tissue and organ culture as a source of secondary metabolites - Hairy root culture - Screening of high yielding cell lines - Procedures for extraction of high value industrial products – Alkaloids, food additives and insecticides in *in vitro* system. | **12** |
| **V** | **CRYOPRESERVATION AND BIOREACTORS:** Germplasm storage and conservation – Methods of in vitro conservation – Cryopreservation and steps involved in cryopreservation of plant materials - Types of bioreactors (Stirred tank and airlift) and their uses - Industrial scaling – Upstream and downstream processing - Manipulation in production profile by biotic and abiotic elicitation – Biotransformation – Food vaccines, bioplastics, plantibodies, plantigens - Applications of tissue culture in agriculture, Horticulture and forestry. | **12** |
| | **Total** | **60** |

| | |
|---|---|
| **Self-study** | Macronutrients – Micronutrients - Carbon and energy sources – Organic supplements – Growth regulators – Solidifying agent – MS medium |

**Textbooks:**


1. Vinay Sharma and Afroz Alam. 2019. *Plant Tissue Culture*. Wiley Publishing company, USA.
2. Pullaiah, E., Rao, T., M.V. Subba, Sreedev. 2017. *Plant Tissue Culture: Theory and Practicals*. Scientific Publishers, Rajasthan.


**Reference Books:**


1. Mba, C., Afza, R., Bado, S., and Jain, S.M. 2010. *Plant Cell Culture: Essential Methods*, John Wiley & Sons, UK.
2. Abdin, M.Z., Kiran, U., Kamaluddin, M., Ali, A. (Eds.). 2017. *Plant Biotechnology: Principles and Applications,* Springer publishers, New York.
3. Fett-Neto, Arthur Germano (Ed.). 2016. *Biotechnology of Plant Secondary Metabolism: Methods and Protocols*, Springer publishers, New York.
4. Smith, R.H. 2012. Plant tissue culture: techniques and experiments. Academic Press, UK.
5. Trigiano, R. N., and Gray, D. J. 2011. *Plant tissue culture, development, and biotechnology*. CRC Press, USA.


**Web Resources:**

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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 1 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 2 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| **Total** | **15** | **15** | **12** | **13** | **11** | **11** | **11** |
| **Average** | **3** | **3** | **2.4** | **2.6** | **2.2** | **2.2** | **2.2** |

## MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 3 | 1 | 3 | 2 | 1 | 2 | 1 | 3 |
| **CO2** | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| **Total** | **14** | **11** | **14** | **11** | **14** | **14** | **11** | **14** | **11** | **14** |
| **Average** | **2.8** | **2.2** | **2.8** | **2.2** | **2.8** | **2.8** | **2.2** | **2.8** | **2.2** | **2.8** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER III**

**SKILL ENHANCEMENT COURSE II: AGRICULTURE AND FOOD MICROBIOLOGY**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP233SE1 | 3 | - | - | - | 2 | 3 | 45 | 25 | 75 | 100 |

**Pre-requisite:** To understand the benefits of microbes in agriculture and food industry.

**Learning Objectives:**

1.To provide comprehensive knowledge about plant – microbe interactions.

2.To provide basic understanding about factors affecting growth of microbes

**Course Outcomes**

| On the successful completion of the course, students will be able to: | | |
|---|---|---|
| 1. | recognize the general characteristics of microbes and factors affecting its growth | **K1** |
| 2. | explain the significance of microbes in increasing soil fertility | **K2** |
| 3. | elucidate concepts of microbial interactions with plant and food. | **K3** |
| 4. | analyze the impact of harmful microbes in agriculture and food Industry. | **K4** |
| 5. | determine and appreciate the role of microbes in food preservation and as biocontrol. | **K5 & K6** |

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

| Units | Contents | No. of Hours |
|---|---|---|
| I | **ROLE OF MICROORGANISMS IN AGRICULTURE :** Role of symbiotic and free-living bacteria and cyanobacteria in agriculture., Mycorrhiza, Plant Growth Promoting Micro-organism (PGPM) and Phosphate Solubilizing Micro-organism (PSM). | 9 |
| II | **BIOCONTROL AND BIOFERTILIZATION :** Biocontrol of plant pathogens, pests and weeds, Restoration of waste and degraded lands, Biofertilizers: Types, technology for their production and application, vermi-compost. | 9 |
| III | **FOOD MICROBIOLOGY:** Intrinsic and extrinsic factors influencing growth of microorganisms in food, Microbes as source of food: Mushrooms, single cell protein. | 9 |
| IV | **FOOD MICROBIOLOGY :** Microbial spoilage of food and food products: Cereals, vegetables, prickles, fish and dairy products. Food poisoning and food intoxication. Food preservation processes. Microbes and fermented foods: Butter, cheese and bakery products. | 9 |
| V | **PREDICTIVE METHODS:** Food quality control Act and Regulations , Food safety, trade regulation of Food materials, Instrumentation in food analysis. | 9 |
| | **Total** | 45 |
| **Self-study** | Biocontrol of plant pathogens, pests and weeds, Restoration of waste and degraded lands, Biofertilizers: Types, technology for their production and application, vermi-compost | |

**Textbooks:**

1. Rangaswami, G. and Bagyaraj, D.J. 2006. *Agricultural Microbiology*, PHI Learning, New Delhi,India.
2. Prescott, L.M., HarleyJ.P.,Klein D. A. 2005.*Microbiology*,McGrawHill,India.

**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.andSaha,R.2020.*MicrobiologyPracticalManual*.CBSPublishersandDistributors(P) Ltd., New Delhi, India.


**Web Resources:**

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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 1 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 2 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| **Total** | **14** | **14** | **11** | **14** | **11** | **11** | **11** |
| **Average** | **2.8** | **2.8** | **2.2** | **2.8** | **2.2** | **2.2** | **2.2** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 1 | 2 | 1 | 3 | 3 | 1 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| **Total** | **14** | **11** | **11** | **11** | **14** | **14** | **11** | **14** | **14** | **14** |
| **Average** | **2.8** | **2.2** | **2.2** | **2.2** | **2.8** | **2.8** | **2.2** | **2.8** | **2.8** | **2.8** |

**3 -Strong 2 - Medium 1 – Low**

**SEMESTER III**

**SPECIFIC VALUE-ADDED COURSE: WINE MAKING**

| Course code | L | T | P | S | Credit | Inst. hours | Total hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **BP233V01** | **2** | **-** | **-** | **-** | **1** | **2** | **30** | **25** | **75** | **100** |

**Pre requisite**

Familiarize yourself with the different types of wines, grape varieties, and wine regions to gain a basic understanding of wine.

**Objectives**

1. To understand the history and evolution of wine making.
2. To learn the fundamental processes involved in wine making, including harvesting, crushing, fermentation, aging, and bottling.

**Course outcomes**

| **On completion of the course the students will be able to:** | | |
|---|---|---|
| 1 | learn different fermentation vessels and the importance of temperature control during fermentation. | **K1** |
| 2 | understand the history and significance of wine making, including its cultural and economic impact. | **K2** |
| 3 | explore various crushing techniques and equipment used in wine making. | **K3** |
| 4 | develop wine tasting techniques to evaluate wine quality and characteristics. | **K4** |
| 5 | gain skills in evaluating wine quality, aroma, taste, and appearance, to make wine. | **K5** |

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

| Unit | Contents | No. of hours |
|---|---|---|
| **I** | Introduction to Wine Making: History and significance of wine making. Overview of the wine making process. Common grape varieties used in wine making. Basics of vineyard establishment and management. | **6** |
| **II** | Determining grape ripeness. Methods of grape harvesting and sorting. Crushing and Pressing-Crushing techniques and equipment. Pressing methods and juice extraction. | **6** |
| **III** | Fermentation: Introduction to yeast and its role in fermentation. Fermentation vessels and temperature control. Malolactic Fermentation and Aging: Understanding malolactic fermentation. Aging wine in barrels and tanks. | **6** |
| **IV** | Wine Clarification and Filtration: Methods of wine clarification, Wine filtration techniques. Blending and Wine Stabilization. Importance of blending for wine consistency. Wine stabilization methods. | **6** |
| **V** | Bottling and Packaging: Bottling processes and equipment, Wine packaging and labelling. Wine Tasting and Evaluation. Wine tasting techniques. Evaluating wine quality and characteristics. | **6** |

**Textbooks**

1. Jack Keller, B. 2021.*Home Winemaking: The Simple Way to Make Delicious Wine,* Adventure Publications, Minnestota

2. Pambianchi, D 2021. *Modern Home Winemaking: A Guide to Making Consistently Great Wines*, Véhicule Press, Quebec.

**Reference books**

1. Roger B. Boulton, Vernon L. Singleton, Linda F. Bisson Ralph E. Kunkee.1999. Principles and Practices of Winemaking**.** Springer Publications.
2. Patrick Iland. 2004. *Chemical Analysis of Grapes and Wine: Techniques and Concepts*. Patrick Iland Wine Promotions and publications.
3. Hugh Johnson and Jancis Robinson. 2019. *World Atlas of Wine.* Mitchell Beazley, USA.
4. Jay Mclnerney 2013. *The Juice: Vinous Veritas.* Bloomsbury Publishing PLC, UK.
5. Hugh Johnson and Margaret Rand. 2023. Pocket Wine Book. Mitchell Beazley, USA.

**Web Resources**

1. https://www.winemonthclub.com/the-wine-making-process
2. https://www.vinovest.co/blog/wine-making
3. https://extension.uga.edu/publications/detail.html?number=C717&title=winemaking-at-home
4. https://finding.wine/blogs/blog-posts/basic-steps-of-the-winemaking-process
5. https://courses.iid.org.in/course/wine-production

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 3 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| **Total** | **14** | **14** | **11** | **14** | **11** | **14** | **11** |
| **Average** | **2.8** | **2.8** | **2.2** | **2.8** | **2.2** | **2.8** | **2.2** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2 |
| **CO2** | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 |
| **CO3** | 2 | 1 | 3 | 2 | 1 | 2 | 1 | 3 | 2 | 1 |
| **CO4** | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Total** | **11** | **11** | **14** | **11** | **11** | **11** | **11** | **14** | **11** | **11** |
| **Average** | **2.2** | **2.2** | **2.8** | **2.2** | **2.2** | **2.2** | **2.2** | **2.8** | **2.2** | **2.2** |

**3 -Strong 2 - Medium 1 – Low**

**SEMESTER III**

**SPECIFIC VALUE-ADDED COURSE:FOOD PRESERVATION**

| Course code | L | T | P | S | Credit | Inst. hours | Total hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **BP233V02** | **2** | **-** | **-** | **-** | **1** | **2** | **30** | **25** | **75** | **100** |

**Pre requisite**

Understanding the composition of foods, including carbohydrates, proteins, fats, vitamins, minerals, and water activity, is crucial.

**Learning Objectives**

1. To understand the prevention of growth of microorganisms in the food.
2. To delay of enzymic spoilage, self-decomposition of the food by naturally occurring enzymes within it.

**Course Outcome**

| **On the successful completion of the course the student will be able to:** | | |
|---|---|---|
| **1** | understand the fundamental concepts and importance of food preservation. | **K1** |
| **2** | identify various methods and techniques used in preserving different types of foods. | **K2** |
| **3** | gain practical knowledge in preparing jams, jellies, marmalades, squashes, cordials, pickles, sauces. | **K3** |
| **4** | recognize the role and control of microorganisms in food preservation. | **K4** |
| **5** | apply preservation techniques to ensure food safety and extend the shelf life of food products. | **K5** |

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

| UNIT | CONTENTS | No. of hours |
|---|---|---|
| **I** | Fundamentals of food. Definition, Concept, Importance of food preservation, Principles of food preservation, Methods used for food preservation, Techniques of food preservation . Introduction. Microorganism in food. Types of food microorganism – virus, bacteria, Yeast, Fungi, Mold and Bacteria, Conditions of growth, Food spoilage and their control. | **6** |
| **II** | Preservation by adding sugar and chemical preservatives: Preparation of Jam – Apple jam, papaya Jam and Mixed fruit Jam. Preparation of Jellies – Grape Jelly and Guava Jelly. Preparation of Marmalade –Orange marmalade. | **6** |
| **III** | Preservation by Adding Sugar: Preparation of Fruit Squash – Orange squash, Lime – Ginger Squash and Pineapple Squash, Preparation of Cordials - Lime Cordial and water melon cordial. | **6** |
| **IV** | Preservation by Adding Salt and , Sil and spices: Preparation of Pickle - Lemon Pickle, Ginger Pickle, Tomato Pickle, Mango Pickle and Garlic pickle. Preparation of sauces and ketchup- Tomato Sauces, and Green Sauces. | **6** |
| **V** | Preparation By Drying and Dehydration and Instant Powders: Preparation of salted, dehydrated vegetable preserve – Vathal: lady's finger vathal, Green chilli vathal, Mango vathal and Cluster Beans vathal, Preparation by dehydrated cereal and pulse product – | **6** |

| | | |
|---|---|---|
| | vadam- sago vadam, rice vadam, Raw rice vadam. Preparation of masala powder - Soup masala, tamarind bath powder, lemon rice powder, rasam powder and Garam masala powder. | |

**Text books**


1. Deepak Mudgil & ShewetaMudgil. 2021.*Food Preservation and Processing*. Scientific Publishers, Rajasthan.
2. W.C. Frazier and D.C. Westhoff, 2015. *Food Microbiology* McGraw-Hill Education, New York.


**Reference books**


1. Weiser H.H. 2018. *Food Microbiology and Technology*, Scientific International Pvt. Ltd, New Delhi.
2. Potter N.N. and Hotchkiss J.H. 2007. *Food Science*, (5th Ed.), CBS publishers, New Delhi.
3. El-Mansi, E.M.T and Bryce, C.F.A. 2002. *Fermentation Microbiology and Biotechnology*. Taylor and Francis Group, USA.
4. Srilakshmi, B. 2010. *Food Science*. (5th ed.). New Age International Pvt. Ltd., New Delhi.
5. Sumathi R. Mudambi and Rajagopal, M.V. 2012. *Fundamentals of Food and Nutrition.* New Age Publishers, Kochi.


**Web Resources**

1. https://agricultureandfoodsecurity.biomedcentral.com/articles/10.1186/s40066-017-0130-8
2. https://www.geeksforgeeks.org/what-is-food-preservation-definition-importance-objective-methods/
3. https://fhafnb.com/glossary/food-preservation/
4. https://www.canr.msu.edu/food_preservation
5. https://www.nios.ac.in/media/documents/srsec321newE/321-E-Lesson-9.pdf

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 1 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 2 | 3 | 3 | 1 | 2 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| **Total** | **15** | **14** | **11** | **14** | **11** | **11** | **11** |
| **Average** | **3** | **2.8** | **2.2** | **2.8** | **2.2** | **2.2** | **2.2** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 2 |
| **CO3** | 3 | 2 | 1 | 2 | 1 | 3 | 2 | 1 | 3 | 1 |
| **CO4** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Total** | **14** | **11** | **11** | **11** | **11** | **14** | **11** | **11** | **14** | **11** |
| **Average** | **2.8** | **2.2** | **2.2** | **2.2** | **2.2** | **2.8** | **2.2** | **2.2** | **2.8** | **2.2** |

**3 -Strong 2 - Medium 1 - Low**

## SEMESTER III
## SELF LEARNING COURSE: PRINCIPLES OF PLANT SCIENCE

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP233SL1 | - | - | - | - | 1 | - | - | 25 | 75 | 100 |

**Pre-requisite:** To understand the foundational biological concepts of cell structure, cellular processes, and basic genetic.

**Learning Objectives:**

1. To understand the fundamental principles of plant anatomy, morphology, and taxonomy.
2. To understand the ethical considerations and controversies related to plant biotechnology and genetic modification.

**Course Outcomes**

| On the successful completion of the course, the students will be able to: | | |
|---|---|---|
| **1.** | understand principles of plant sciences including plant biology, plant development, anatomy, physiology and plant genetics | **K1** |
| **2.** | demonstrate competency in the application of plant sciences including agronomic techniques and pest management | **K2** |
| **3.** | evaluate the various contributions of plant-based systems from local to global systems. | **K3** |
| **4.** | learn professional skills using experience based knowledge to develop a practical skill set | **K4** |
| **5.** | interpret and critically evaluate scientific information as it applies to the field of Plant Sciences | **K5 & K6** |

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

| UNIT | CONTENTS |
|---|---|
| I | **INTRODUCTION TO PLANT SCIENCE**<br>Overview of plant science: history, significance, and scope, basic plant anatomy and morphology, plant classification and taxonomy. plant cells: structure and function, Introduction to plant physiology: photosynthesis, respiration, and transpiration. |
| II | **PLANT GROWTH AND DEVELOPMENT**<br>Plant growth processes: germination, growth phases, and factors influencing growth. Plant hormones and their roles in growth and development. Reproduction in plants: sexual and asexual reproduction. Pollination mechanisms and fertilization. Seed development and dispersal |
| III | **PLANT ECOLOGY AND DEVELOPMENT**<br>Plant environment interactions. Ecological relationships: symbiosis, competition, and predation. Adaptations of plants to different environments. Environmental factors affecting plant growth: light, temperature, water, and soil. Conservation of plant biodiversity. |
| IV | **PLANT GENETICS AND BIOTECHNOLOGY**<br>Principles of plant genetics: Mendelian genetics, genetic variation, and heredity. Plant breeding techniques: conventional breeding and hybridization. Introduction to plant biotechnology: genetic engineering and GMOs. Application of biotechnology in agriculture and horticulture. Ethical considerations and controversies in plant |

| | |
|---|---|
| | biotechnology |
| **V** | **PLANT NUTRITION AND CROP MANAGEMENT**<br>**ESSENTIAL** plant nutrients and their functions. Soil-plant interactions: nutrient uptake and soil fertility. Plant nutrient deficiencies and disorders. Sustainable crop management practices. Integrated pest management (IPM) and disease control strategies. |

**Textbooks**

1. Barton Rendle, Alfred. 2012. *Flowering Plants and Their Classification.* Biotech Books, New Delhi.
2. Ahmad Khan, Manzoor. 2013. *Plant Breeding.* Biotech Books, New Delhi.

**Reference books**

1. Charles B. Beck. 2013. *An Introduction to Plant Structure and Development.* Rastogi Pub.Meerut.
2. Brian Thomas, Denis J. Murphy, Brian G. Murray. 2016. *Encyclopaedia of Applied Plant Sciences.* John Wiley & Sons. Inc, USA.
3. Taiz, L., Zeiger, E. Mollar, I. M. and Murphy, A. 2015. *Plant physiology and Development* (6th ed.) Sinauer Associates Inc., USA.
4. Pelzar, M.H, Chan, E.C.S and Erieg, N.R. 1993.*Text Book on Microbiology*. Tata McGraw Hill Pub. Co. Ltd., NewDelhi.
5. Campbell, P.N. and Smith, A.D. 2011. *Biochemistry* (4th ed.). Churchill Livingstone Publishers, New York.

**Web resources:**

1. https://www.nature.com/scitable/topic/cell-biology
2. https://plato.stanford.edu/entries/molecular-biology/
3. https://.britannica.com/technology/biotechnolog/
4. https://nptel.ac.in/courses/102/107/102107075/
5. https://ifasonline.com/csir-net/life-science-study-material/6539046e640e05d28fe8dd

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 1 | 3 |
| **CO2** | 3 | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 1 | 1 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 2 | 3 |
| **Total** | 15 | 14 | 11 | 15 | 11 | 10 | 15 |
| **Average** | 3 | 2.8 | 2.2 | 3 | 2.2 | 2 | 3 |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 3 | 3 | 1 | 1 | 2 | 1 | 3 | 1 |
| **CO2** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| **CO3** | 2 | 1 | 3 | 3 | 1 | 2 | 1 | 2 | 3 | 1 |
| **CO4** | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 |
| **Total** | **11** | **10** | **15** | **14** | **10** | **11** | **10** | **11** | **14** | **10** |
| **Average** | **2.2** | **2** | **3** | **2.8** | **2** | **2.2** | **2** | **2.2** | **2.8** | **2** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER IV**

**CORE COURSE VIII: PLANT PHYSIOLOGY AND PLANT METABOLISM**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP234CC1 | 4 | 2 | - | - | 5 | 6 | 90 | 25 | 75 | 100 |

**Pre-requisite:** Basic knowledge on physiological processes in plants

**Learning Objectives:**

1. To acquire knowledge on the functional aspects of plants
2. To understand the biophysical and biochemical processes of plants.

**Course Outcomes**

| On the successful completion of the course, students will be able to: | | |
|---|---|---|
| 1 | relate understand properties and importance of water in biological system, nutrients and its translocation. | **K1** |
| 2 | demonstrate the importance of light in plant growth and the harvest of energy. | **K2** |
| 3 | explain the energy requirement and nitrogen metabolism. | **K3** |
| 4 | compare the various growth regulators that influence plant growth. | **K4** |
| 5 | discuss the senescence and plant response to environmental stress. | **K5 &K6** |

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

| Units | Contents | No. of Hours |
|---|---|---|
| **I** | Water Relations: Physical and chemical properties of water –Components of water potential - Plasmolysis - water absorption by roots – Apoplast and Symplast concept - water transport through the xylem — Transpiration and evapotranspiration- stomatal structure and function – mechanism of stomatal opening and closing – mineral nutrition – essential nutrients – macro and micro nutrients – deficiencies and plant disorders – absorption of solutes – translocation of solutes – pathways and mechanisms. | 18 |
| **II** | Photosynthesis: The physical nature of light – the absorption and fate of light energy – absorption and action spectra- photoreceptors- Ultrastructure and biochemical compartmentation of Chloroplast; Photosynthetic Electron Transport and Photophosphorylation (cyclic and noncyclic): Photosystems and reaction centres - Light Harvesting complexes - Photosystem I & II and Oxidation of Water; Carbon metabolism: C3, C4 and CAM pathways and their distinguishing features - photorespiration and its significance. | **18** |
| **III** | An overview of plant respiration – Glycolysis – TCA cycle– Electron Transport – oxidative phosphorylation and ATP synthesis – Chemiosmotic Theory - Pentose Phosphate Pathway– Respiration and its significance in crop improvement. Nitrogen fixation (Biological - symbiotic and non-symbiotic), | **18** |
| **IV** | Growth and development – Phases of plant growth – growth types- Growth substances - Auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassino steroids - physiological effect and mechanism of action in agricultural and horticultural crops –Photoperiodism – Classification of plants and mechanism of | **18** |

| | | |
|---|---|---|
| | flowering – Phytochrome and their action on flowering – Vernalization- Mechanism and its practical application, biological rhythms and movements. Seed dormancy and causes and Seed germination and their biochemical changes. | |
| **V** | Plant senescence –Types and Mechanism of senescence- Abscission: Morphological and biochemical changes – Significance. Fruit ripening- Biochemical, Physiological changes and control of fruit ripening. Plant response to environmental stress: Biotic and Abiotic stress – Water, temperature, light and salinity- | **18** |
| | **Total** | **90** |

| | |
|---|---|
| **Self-study** | Photosynthesis: The physical nature of light, Seed germination and their biochemical changes. |

**Textbooks:**

1. Pandey, N.S and Pandey, P. 2016. *Textbook of Plant Physiology*. Daya Publishing House, New Delhi.
2. Taiz, L. Zeiger, E., Moller, I.M and Murphy, A. 2015. *Plant Physiology and Development* 6th Edition. Sinauver Associates Inc. Publishers, Sunderland, Massachusetts. USA.

**Reference Books**:

1. Jain, V.K. 2017. *Fundamentals of Plant Physiology*. Chand & Company Ltd., New Delhi.
2. Gontia. 2016. *A textbook of Plant Physiology*. Satish Serial publishing House, New Delhi.
3. Arun Chandra Sahu, 2016. *Plant Physiology and Metabolism*, Kalyani Publishers, New Delhi.
4. Lincoln Taiz., 2014. *Plant Physiology and Development*. Sinauver Associates Inc. Publishers, Sunderland, Massachusetts. USA.
5. Panda, S.K, 2005. *Advances in Stress Physiology of Plants*. Scientific Publishers India, Jodhpur

**Web Resources**:

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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 3 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 3 | 2 |
| **Total** | **14** | **14** | **11** | **14** | **11** | **14** | **11** |
| **Average** | **2.8** | **2.8** | **2.2** | **2.8** | **2.2** | **2.8** | **2.2** |

## MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 3 | 2 | 1 | 2 | 1 | 1 | 1 |
| **CO2** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 2 | 1 | 3 | 3 | 1 | 2 | 1 | 2 | 2 | 1 |
| **CO4** | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 |
| **Total** | **12** | **11** | **14** | **14** | **11** | **12** | **11** | **11** | **12** | **10** |
| **Average** | **2.4** | **2.2** | **2.8** | **2.8** | **2.2** | **2.4** | **2.2** | **2.2** | **2.4** | **2** |

**3 -Strong 2 - Medium 1 - Low**

## SEMESTER IV
## CORE COURSE IX: BIOCHEMISTRY AND APPLIED BIOTECHNOLOGY

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| **BP234CC2** | 4 | 2 | - | - | **5** | **6** | **90** | **25** | **75** | **100** |

**Pre-requisite:** Basic knowledge on primary and secondary plant metabolites and enzymes

**Learning Objectives:**

1. To study the fundamentals and significance of Plant Biochemistry
2. To know the structure and properties of plant biomolecules

### Course Outcomes

| **On the successful completion of the course, students will be able to:** | | |
|---|---|---|
| 1. | knowledge on the fundamentals and significance of Plant Biochemistry | **K1** |
| 2. | understanding on the structure and properties of plant biomolecules. | **K2** |
| 3. | explain the role of enzymes in plants. | **K3** |
| 4. | compare and contrast the methods of transgenic plants production and natural plants. | **K4** |
| 5. | discuss and develop skills for effective utilization of microbial/plant enzymes and their role in biological cells | **K5 & K6** |

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

| Units | Contents | No. of Hours |
|---|---|---|
| I | Atomic structure: chemical bonds - ionic bond, covalent bond, coordinate covalent bond, hydrogen bond, hydrogen ion concentration (pH), buffers. Thermodynamics principle, First Law of Thermodynamics a) energy (b) Enthalpy (ii) second law of thermodynamics (a) entropy (c) free energy, redox potential. | 18 |
| **II** | Classification of carbohydrates; Structure and properties of monosaccharides, Oligosaccharides, Polysaccharides – Glycoproteins. Protein and Amino acids: Structure, Classification and properties; Peptides - Structure: Primary, secondary, Ramachandran plot, tertiary and quaternary structures. Classification of Lipids: Structure and properties of fatty acids, phospholipids, glycolipids, lipoproteins, cholesterol - structure and functions. | **18** |
| **III** | Enzymes- Classification and nomenclature chemical nature of enzymes – factors affecting enzyme action – Michaelis – Menton constant, Secondary Metabolites: Structure, classification and properties of alkaloids, steroids, terpenoids, flavonoids. Glycosides - their chemical nature and role. | **18** |
| **IV** | Transgenic plants - pest resistance, herbicidal resistance, Disease resistant, abiotic and biotic stress tolerant, in improving crop yield, food quality- Golden rice, Edible vaccines, Cytoplasmic male sterility and fertility restoration, terminator Seed technology, antisense technology for Delayed fruit ripening, | **18** |

| | | |
|---|---|---|
| **V** | Fermentation techniques- Types. Industrial Production of enzymes- amylase, protease & lipase and their applications. Immobilization for enzymes production. Antibiotic - Penicillin production. Amino acid - Glutamic acid production. Bioreactors for culturing Plant cells and production of Secondary metabolites, Super bug and its role in biodegradation. Bioremediation - *In situ* and *Ex situ*. | **18** |

| | |
|---|---|
| **Self-study** | Classification and properties; Peptides, Bioremediation - *In situ* and *Ex situ*. |

**Textbooks:**

**1.**Kumar, Pradeep. 2018. Advances in Microbial Biotechnology: Current Trends and Future Prospects. Apple Academic Press, Canada.

**2.**Satyanarayana, U and chakrapani, U. 2005. *Biochemistry*, Books and Allied (P) Ltd. Calcutta

**Reference Books:**

1. Gupta, S.N. 2016. *Biochemistry*. Rastogi Publications, Meerut.
2. Satyanarayana, U. and Chakkrapani, U. 2013. *Biochemistry*. Elsevier India Pvt Ltd, New Delhi.
3. Nelson, D.L. and Cox, M.M. 2017. Lehninger's *Principles of Biochemistry*, Prentice Hall, Publishers, USA.
4. Heldt, H-W. 2005. *Plant Biochemistry*, 3rd Edition. Elsevier Academic Press. USA.
5. Buchanan, B.B., Grissem, W. and Jones, R.L. 2000. *Biochemistry and molecular biology of plants*. John Wiley & Sons, USA.

**Web Resources:**

1. http://priede.bf.lu.lv/grozs/AuguFiziologijas/Augu_biokimija/Plant%20Biochemistry 204.pdf
2. http://www.brainkart.com/subject/Plant-Biochemistry_257/
3. https://swayam.gov.in/nd2_cec20_bt12/preview
4. https://www.biorxiv.org/content/10.1101/660639v2
5. https://www.scribd.com/document/378882955/

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 1 | 3 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 3 | 2 |
| **Total** | **15** | **14** | **11** | **14** | **11** | **15** | **11** |
| **Average** | **3** | **2.8** | **2.2** | **2.8** | **2.2** | **3** | **2.2** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 3 | 1 | 1 | 2 | 1 | 3 | 2 |
| **CO2** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO3** | 2 | 1 | 3 | 3 | 1 | 2 | 1 | 3 | 3 | 1 |
| **CO4** | 2 | 3 | 1 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 1 | 3 | 2 | 3 | 3 | 2 | 3 | 2 |
| **Total** | **11** | **10** | **10** | **14** | **10** | **11** | **10** | **11** | **14** | **11** |
| **Average** | **2.2** | **2** | **2** | **2.8** | **2** | **2.2** | **2** | **2.2** | **2.8** | **2.2** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER IV**

**CORE LAB COURSE IV: CORE COURSE VIII AND IX**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP234CP1 | - | - | 6 | - | 5 | 6 | 90 | 25 | 75 | 100 |

**Pre-requisite:** Knowledge on various physiological functions of plants.

**Learning Objectives:**

**1.**To extract biomolecule of diverse nature from different sources so that they will be able to assess the metabolic profile of their source material.

**2.**To recognize the role that water plays in several physiological processes in plants.

**Course Outcomes**

| On the successful completion of the course, students will be able to: | | |
|---|---|---|
| **1.** | perform quantitative tests for all major macro molecules and file a report of chemical profile of a plant cell. | **K1** |
| **2.** | understand the structure and properties of various enzymes. | **K2** |
| **3.** | apply the fundamentals of water and its relation to plants. | **K3** |
| **4.** | compare the role of pigment in photosynthetic mechanism and related events of plants. | **K4** |
| **5.** | evaluate the theory and practical skills gained during the course and create idea to seek for suitable job in relevant industries. | **K5 & K6** |

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

| Units | Contents | No. of Hours |
|---|---|---|
| I | **PLANT PHYSIOLOGY :**<br>1. Determination of osmotic potential by plasmolytic method.<br>2. Determination of water potential using gravimetric method.<br>3. Determination of water potential using dye method (Chardakov's method).<br>4. Effect of Monochromatic light on apparent photosynthesis.<br>5. Effect of $CO_2$ concentration on apparent photosynthesis. | **18** |
| **II** | **PLANT PHYSIOLOGY**<br>1. Effect of temperature on protoplasmic membrane.<br>2. Separation of chloroplast pigments using paper chromatographic technique.<br>3. Estimation of chlorophyll content using Arnon's method. | **18** |
| **III** | **BIOCHEMISTRY**<br>1. Rice coleoptile growth test for Indole Acetic Acid.<br>2. Effect of auxin on root initiation.<br>3. Experiments to show the heribicidal action of Auxin (2-4,D). | **18** |
| **IV** | **BIOCHEMISTRY**<br>1. Estimation of Proline content.<br>2. Estimation of Glycine betaine content.<br>3. Determination of Relative Water Content. | **18** |
| **V** | APPLIED BIOTECHNOLOGY<br>1. Isolation of genomic DNA.<br>2. Electrophoresis of nucleic acid.(Demo) | **18** |

| | | |
|---|---|---|
| | 3. Preparation of competent *E.coli* cells. (Demo)<br>4. Transformation and recovery of plasmid clones.(Demo) | |
| | **Total** | **90** |

| | |
|---|---|
| **Self-study** | Effect of temperature on protoplasmic membrane. |

**Textbooks:**


1. Gupta P.K. 2017. *Cell and Molecular Biology*, Rastogi Publications, Meerut.
2. Kumar, H.D. 2007. *Molecular Biology and Biotechnology*, Vikas Publishing House, New Delhi.


**Reference Books:**


1. Bala, M., Gupta, S., Gupta, N.K and Sangha, M.K. 2013. *Practical's in plant physiology and biochemistry*. Scientific Publishers, New Delhi.
2. Wilson, KandJ.Walker.2000. Principles and Techniques of Practical Biochemistry. Cambridge University Press.
3. Cambridge.Bendre,A.MandAshokKumar.2009.*AtextbookofpracticalBotany*.Vol.I&II.Rastogi Publication. Meerut.
4. ManjuBala, SunitaGupta,Gupta,N.K.2012.*Practical'sinPlantPhysiologyandBiochemistry*.ScientificPublisher Rajasthan.
5. Wilson,KandJ. Walker.2005.*PrinciplesandTechniquesofPracticalBiochemistry*,CambridgeUniversitypress,NewYork.


**Web Resources:**

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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 1 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 2 | 3 | 3 | 1 | 2 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| **Total** | **15** | **14** | **11** | **14** | **11** | **11** | **11** |
| **Average** | **3** | **2.8** | **2.2** | **2.8** | **2.2** | **2.2** | **2.2** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 3 | 1 | 2 | 2 | 3 | 3 | 3 | 1 |
| **CO2** | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 1 | 3 | 2 | 1 | 3 | 1 | 3 | 2 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| **Total** | **14** | **12** | **15** | **11** | **11** | **14** | **12** | **15** | **14** | **11** |
| **Average** | **2.8** | **2.4** | **3** | **2.2** | **2.2** | **2.8** | **2.4** | **3** | **2.8** | **2.2** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER IV**

**ELECTIVE COURSE VI a) FORESTRY AND WOOD TECHNOLOGY**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| **BP234EC1** | **4** | **-** | **-** | **-** | **3** | **4** | **60** | **25** | **75** | **100** |

**Pre-requisite:** Prior knowledge on trees, forests and their importance.

**Learning Objectives**

1. To study various aspects of Forest Botany.
2. To raise student awareness of the need to create a sustainable way of living and the current Global issues with forestry caused by human interference.

**Course outcomes**

| **On the successful completion of the course, the students will be able to:** | | |
|---|---|---|
| **1.** | gain knowledge on various aspects of forest botany | **K1** |
| **2.** | understand the importance and of different forests. | **K2** |
| **3.** | apply the ecological significance of forests in creating it | **K3** |
| **4.** | analyse the dynamics of the forest. | **K4** |
| **5.** | describe and concentrate on various Indian forests laws and acts. | **K5 & K6** |

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

| Unit | Contents | No. of hours |
|---|---|---|
| **I** | **Introduction and scope of Forest Botany** - Merits of combining traditional Botany and Forestry practices. Forest and gene conservation - Forest and ecosystem - Forest and civilization. Geographical history of the forest vegetation - natural vs. artificial. Special emphasizes on social forestry, Industrial forestry and multi-purpose forestry. Preservation of natural forestry - Pollution control. | **12** |
| **II** | Forest genetics, Forest physiology, forest ecology – strong interrelationships. Seedlings, leaves, bark branching pattern architectural models of trees. Major and minor forest products, use and misuse of forests by man, direct and indirect forest wealth, forest policies, forest protection through peoples committee. | 12 |
| **III** | **Silviculture:** concept and scope of study, forest in general form, composition, classification of world forests and Indian forests. Classification based on its quality density, tolerance, crown; water cycles of forest. Photosynthetic processes in forest: nitrogen and mineral nutrition in forests. | **12** |
| **1V** | **Seed dynamics in forest:** seed production, dissemination, germination, establishment and mortality, growth of trees in general terms – height, diameter, volume, growth of stands – gross increment, net increment, stand reaction to varies types of cuttings. | **12** |
| **V** | **Measurement:** definition, direct measurements, direct and indirect estimate. Measurement of volume – common units, different methods and procedures of volume measurements. Measurement of age: direct estimate. Progress to be achieved in social forestry, industrial forestry and multiple forestry. Forest Laws- Indian Forest Act, 1927; Forest conservation Act. Wild Life Protection Act, 1972. | **12** |
| | **Total** | **60** |

| | |
|---|---|
| **Self - study** | Forest and ecosystem, Major and minor forest products, Photosynthetic processes in forest: nitrogen and mineral nutrition in forests. |

**Textbooks:**


1. Manikandan, K and S. Prabhu. 2013. *Indian forestry, a breakthrough approach to forest service*. Jain Bros Publishers, New Delhi.
2. Roger Sands. 2013. *Forestry in a global context*, CAB international, USA.


**Reference books:**


1. Manikandan K, Prabhu S. 2018. *Indian Forestry*, Jain Brothers, New Delhi.
2. Pathak, P.S, Ram Newaj. 2012. *Agro forestry: Potentials and Opportunities*. India Agrobios, New Delhi.
3. Powell, Baden B.H. 2004. *Manual of Forest Law*. Biotech Books, New Delhi.
4. Uthappa, A.R. 2015. *Competitive Forestry*, New Vishal Publications, New Delhi.
5. Chaturvedi, A.N. and Khanna, L.S. 2015. *Hand Book of Forestry*. Repro Books, Mumbai.


**Web Resources:**

1. http://wwwwds.worldbank.org/external/default/WDServer/WDSP/IB/2006/10/19/000112742_2006 1019150049/Rendered/PDF/367890Loggerheads0Report.pdf.
2. https://www.britannica.com/science/forestry
3. https://en.wikipedia.org/wiki/Forestry.
4. https://www.biologydiscussion.com/forest/essay-forest-importance.major-products-and-its-conservation/25119
5. https://academic.oop.com

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 2 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| **Total** | 14 | 14 | 11 | 14 | 11 | 14 | 11 |
| **Average** | 2.8 | 2.8 | 2.2 | 2.8 | 2.2 | 2.8 | 2.2 |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 2 | 1 | 3 | 1 | 3 | 2 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO3** | 2 | 1 | 3 | 1 | 2 | 2 | 3 | 3 | 1 | 2 |
| **CO4** | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| **Total** | **11** | **11** | **14** | **11** | **11** | **14** | **11** | **14** | **11** | **14** |
| **Average** | **2.2** | **2.2** | **2.8** | **2.2** | **2.2** | **2.8** | **2.2** | **2.8** | **2.2** | **2.8** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER IV**

**ELECTIVE COURSE VI: b) ORGANIC FARMING**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP234EC2 | 4 | - | - | - | 3 | 4 | 60 | 25 | 75 | 100 |

**Pre-requisite:** Prior knowledge on organic farming.

**Learning Objectives:**

1. To study various aspects of organic farming.
2. To expose the students to about quality aspect and grading.

**Course outcomes**

| On the successful completion of this course, the students will be able to: | | |
|---|---|---|
| **1 .** | knowledge on various aspects of organic farming | **K1** |
| **2.** | understand the relevance of organic farming, its advantages. | **K2** |
| **3.** | explain the short comings against conventional high input agriculture and apply | **K3** |
| **4.** | compare the packaging methods of harvest. | **K4** |
| **5.** | discuss and develop skills for post harvest management. | **K5 & K6** |

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

| Unit | Contents | No. of Hours |
|---|---|---|
| I | **AGRONOMY:** Organic farming- concept, characteristics, significance, organic ecosystem, scope of organic farming in India - Principles and types of organic farming. Choice of crops & varieties in organic farming - Initiative by Govt/NGOs/Other organizations for promotion of organic farming Operational structure of NPOP (National Programme for Organic Production) - Concept of dryland agronomy Organic nutrient resources & their fortification, restriction to nutrient use in organic farming - Organic production methods for cereals, vegetables and fruit crops. | **12** |
| II | **SOIL SCIENCE:** Organic farming for sustainable agriculture; Manures- compost, methods of composting - Green manuring, vermicompost and biofertilizer<br>Harmful effect of non-judicious chemical fertilization - Organic farming practices for improving soil health.<br>Quality parameters of organic manures and specifications - Soil fertility in organic farming systems Manure preparation methodology - Soil improvement. | **12** |
| III | **FUNDAMENTAL OF ORGANIC FARM MANAGEMENT:** Land management in organic farming - Water management in organic farming. Organic insect disease management - Organic pest disease management. Preventive and cultural methods for insects and pest control - Identification of different fungal and bacterial biocontrol agents.<br>Indigenous technical knowledge for insects-pest, disease - Weed and nutrient management in organic farming. | **12** |
| IV | **POST HARVEST MANAGEMENT:** Processing, labelling of organic produce - Storage and transport of organic produce. | **12** |
| V | **ORGANIC QUALITY CONTROL STANDARDS:** Certification- types, process & procedure and agencies. Quality aspect and grading - Packaging and handling. Economic considerations and viability of organic products - Export of organic product and marketing | **12** |
| | **Total** | **60** |

| | |
|---|---|
| **Self-study** | Organic production methods for cereals, vegetables and fruit crops. Manure preparation methodology - Soil improvement, Weed and nutrient management in organic farming |

**Textbooks**

1. Singh, S M. 2018. *Organic Manure: Sources Preparation and Usage in Farming*. Lands,Siya Publishing House, New Delhi.
2. Subba Rao N.S. 2017. Biofertilizers in Agriculture and Forestry. Medtech, USA.

**Reference books**

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

**Web resources:**

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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 1 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| **CO3** | 2 | 2 | 3 | 1 | 1 | 2 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 3 | 2 |
| **Total** | **14** | **14** | **11** | **12** | **11** | **11** | **11** |
| **Average** | **2.8** | **2.8** | **2.2** | **2.4** | **2.2** | **2.2** | **2.2** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 3 | 1 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 |
| **CO3** | 2 | 1 | 3 | 2 | 1 | 2 | 1 | 2 | 3 | 1 |
| **CO4** | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 3 |
| **Total** | **11** | **11** | **13** | **11** | **9** | **11** | **11** | **14** | **11** | **12** |
| **Average** | **2.2** | **2.2** | **2.6** | **2.2** | **1.8** | **2.2** | **2.2** | **2.8** | **2.2** | **2.4** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER IV**

**ELECTIVE COURSE VI: c) GENE CLONING AND GENE THERAPY**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| **BP234EC3** | 4 | - | - | - | 3 | 4 | **60** | **25** | **75** | **100** |

**Pre-requisite:**

Prior knowledge in gene cloning and gene therapy.

**Learning Objectives**

1.To give a clear knowledge of genetic engineering, cloning vectors, enzymes involved in cloning.
2.To understand the procedure involved in recombinant DNA technology and restriction mapping

**Course Outcomes**

| **On the successful completion of the course, students will be able to:** | | |
|---|---|---|
| 1. | recollect the basic concepts of gene cloning. | **K1** |
| 2. | demonstrate and to identify the selection of clones. | **K2** |
| 3. | acquire knowledge on the gene therapy and use it in essential fields | **K3** |
| 4. | compare and understand the concept of gene therapy. | **K4** |
| 5. | discuss and develop skills for hybrid seed production and molecular farming. | **K5 & K6** |

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

| Units | Contents | No. of Hours |
|---|---|---|
| **I** | Definition of genetic engineering, gene cloning and recombinant DNA cloning vectors: plasmids, bacteriophages, plant and animal vectors. | **12** |
| **II** | Gene cloning in prokaryotes and eukaryotes, Isolation of DNA to be cloned, insertion of DNA fragment into vector. Use of Restriction Linkers: use of Homopolyer tails, Transfer of recombinant DNA into Bacteria cell. Selection of clones. | **12** |
| **III** | Gene Therapy: Definition, Germ cell and Somatic cell. Amniocentesis in human; patient therapy, embryo therapy. | **12** |
| **IV** | Restriction mapping –. Random amplified polymorphic DNA using PCR. DNA finger printing; Gene Tagging. Physical methods of gene delivery. Gene transfer techniques. Genetic counselling – Eugenics, Euthenics. | **12** |
| **V** | Transgenic plants with herbicide resistance, insect resistance, virus resistance and resistance against bacterial and fungal pathogens. Transgenic plants for hybrid seed production and molecular farming. | **12** |
| | **Total** | **60** |

| | |
|---|---|
| **Self-study** | Transgenic plants for hybrid seed production and molecular farming. |

**Textbooks:**

1. Halford, N. 2015. Plant Biotechnology: Current and Future Applications of Genetically Modified crops, John Wiley and Sons, USA.
2. Kumar, Pradeep. 2018. Advances in Microbial Biotechnology: Current Trends and Future Prospects. Apple Academic Press, London.

**Reference Books:**

1. .Harisha, S. 2007. *Biotechnology Procedures and Experiments Handbook*. Infinity Science Press, Hingham.

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

**Web Resources**:

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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 1 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 2 | 3 | 3 | 1 | 2 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| Total | 15 | 14 | 11 | 14 | 11 | 11 | 11 |
| Average | 3 | 2.8 | 2.2 | 2.8 | 2.2 | 2.2 | 2.2 |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 3 | 1 | 3 |
| **CO2** | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO3** | 3 | 2 | 1 | 2 | 1 | 3 | 2 | 2 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **Total** | **14** | **11** | **11** | **11** | **11** | **14** | **11** | **14** | **11** | **14** |
| **Average** | **2.8** | **2.2** | **2.2** | **2.2** | **2.2** | **2.8** | **2.2** | **2.8** | **2.2** | **2.8** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER IV**

**ELECTIVE COURSE VII: a) INDUSTRIAL BOTANY**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP234EC4 | 4 | - | - | - | 3 | 4 | 60 | 25 | 75 | 100 |

**Pre-requisite:**

Basic knowledge in algae, fungi, bacteria

**Learning Objectives:**

1. To learn the applied aspects of industrial application of algae, fungi, bacteria, plants, molecular biology and recombination technology.
2. To acquire knowledge on *in vitro* cultivation techniques to develop protocols targeted towards commercialization.

**Course outcomes**

| On the successful completion of this course, the students will be able to: | | |
|---|---|---|
| 1. | understand the basics of algae in industrial applications. | **K1** |
| 2. | demonstrate and to recollect the uses in fungi in industries. | **K2** |
| 3. | use bacterial role in industries. | **K3** |
| 4. | compare and contrast the use of plants in industries. | **K4** |
| 5. | discuss and develop skills for working in industries specializing in biomolecules. | **K5 & K6** |

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

| Unit | Contents | No. of hours |
|---|---|---|
| I | **ALGAE IN INDUSTRIES:** Fertilizer industry-Seaweeds, pharmaceutical industry – antibiotics, agar, carageenin, alginin, diatomate earth, mineral industry, fodder industry | **12** |
| II | **FUNGI IN INDUSTRIES:** Beneficial use of yeast, Fermentation of alcohol, preparations of enzyme, organic acid preparation, cheese production, protein manufacture, vitamins, fats. | **12** |
| III | **PLANT PRODUCTS:** Fibres and Fibre-Yielding Plants, wood and cork, tannins and dyes, rubber, fatty oils and Vegetable fats, sugars and starches, pulp and paper, gums and resins. | **12** |
| **IV** | **BACTERIA IN INDUSTRY:** Food industry, dairy products, bioleaching, biogas production**,** bioremediation | **12** |
| **V** | **RECOMBINANT PLANTS:** Tissue culture: Micropropagation, somatic seeds, cell culture. | **12** |
| | **Total** | **60** |

| **Self-study** | Seaweeds, Beneficial use of yeast**,** Micropropagation |
|---|---|

**Textbooks**

1. Dinabandhu, S and Kaushik. B.D. 2012. *Algal Biotechnology and Environment*. I.K. International, New Delhi.
2. Poonam Singh and Ashok Pandey. 2009. *Biotechnology for agro-Industrial residues utilization.* Springer, New York.

**Reference books**


1. Clemens Posten, Steven Feng Chen, 2016. *Microalgal Biotechnology*. Cambridge University Press, Cambridge.
2. Sahoo, D. 2000. Farming the ocean: seaweed cultivation and utilization. Aravali International, New Delhi.
3. Willie, J. and Sherwood, L. 2016. *Prescott's Microbiology* McGraw-Hill Education; 10th
4. Edition, ISBN: 978-1259281594
5. Pandey, B.P. 2005. College Botany I: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. S Chand & Company, New Delhi.


**Web Resources:**

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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 1 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 2 | 3 |
| **Total** | **14** | **14** | **11** | **14** | **11** | **11** | **14** |
| **Average** | **2.8** | **2.8** | **2.2** | **2.8** | **2.2** | **2.2** | **2.8** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 3 | 1 | 3 |
| **CO2** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 2 |
| **CO3** | 2 | 1 | 2 | 1 | 3 | 2 | 1 | 2 | 3 | 3 |
| **CO4** | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **Total** | **11** | **11** | **11** | **11** | **14** | **11** | **11** | **14** | **11** | **14** |
| **Average** | **2.2** | **2.2** | **2.2** | **2.2** | **2.2** | **2.2** | **2.2** | **2.8** | **2.2** | **2.8** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER IV**

**ELECTIVE COURSE VII: b) FARM SCIENCES: GREEN WEALTH**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP234EC5 | 4 | - | - | - | 3 | 4 | 60 | 25 | 75 | 100 |

**Pre-requisite:** To understand the concept of fertilizers in crop production.

**Learning Objectives:**

1. To understand the concept of agronomy and sustainable agriculture.
2. To develop the skills for cultivation of plants and their value-added processing/storage/quality control

**Course outcomes**

| On the successful completion of this course, the students will be able to: | | |
|---|---|---|
| 1. | recognise and identify the importance of agronomy and its scope. | **K1** |
| 2. | demonstrate both the theoretical and practical knowledge in weed management principles. | **K2** |
| 3. | apply the methods of herbicide and fertilizers . | **K3** |
| 4. | compare and contrast the yield estimation and water management. | **K4** |
| 5. | discuss and develop skills for effective conservation, harvesting and storage methods. | **K5 & K6** |

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

| Unit | Contents | No. of hours |
|---|---|---|
| **I** | Agronomy and its scope, seeds and sowing, tillage and tilth, crop density and geometry, Crop nutrition, manures and fertilizers, nutrient use efficiency, water resources, soil plant water relationship, crop water requirement, water use efficiency, irrigation- scheduling criteria and methods, quality of irrigation water, water logging. | **12** |
| **II** | Weeds- importance, classification, crop weed competition, concepts of weed management principles and methods, herbicides- classification, selectivity and resistance, allelopathy. Growth and development of crops, factors affecting growth and development, plant ideotypes, crop rotation and its principles, adaptation and distribution of crops, harvesting and threshing of crops. | 12 |
| **III** | Identification of crops, seeds, fertilizers, pesticides and tillage implements, Effect of sowing depth on germination and seedling vigour, Identification of weeds in crops, Methods of herbicide and fertilizer application. | **12** |
| **IV** | Study of yield contributing characters and yield estimation, Seed germination and viability test, use of tillage implements-reversible plough, one way plough, harrow, leveller, seed drill, Study of soil moisture measuring devices, Measurement of field capacity, particle density, bulk density and infiltration rate, Measurement of irrigation waer. | **12** |
| **V** | Harvesting, storage, physiological disorders of important vegetable crops like solanaceous fruit vegetables (brinjal, tomato &chilli), tuber crops (Potato), cucurbits (pumpkin, cucumber, watermelon & gourds), pod vegetables (pea & bean), cole crops (cabbage & cauliflower), bulb crops (onion, garlic), root crops (radish & carrot), common leafy vegetables, spices: turmeric and ginger, black pepper and cardamom. | **12** |
| | **Total** | **60** |

| | |
|---|---|
| **Self -study** | Management of crops in rain fed areas, Measurement of irrigation water, spices: turmeric and ginger, black pepper and cardamom. |

**Textbooks**


1. Reddy, T.Y and G.H. Sankar Reddi. 2015. *Principles of Agronom*y. Kalyani Publishers.
2. Reddy, S.R. 2016. *Principles of Agronomy*. Kalyani Publishers.


**Reference books**


1. Yawalkar, K.S. Agarwal, J. P and S. Bokde. 2012. *Manures and fertilizers* – Agri Horticultural Publication House.
2. Russell, J.E. 2002. *Soil Conditions and Plants Growth* - Daya Books.
3. Hansen, V. E. Israelsen, O.W and G. E. Stringham. 2000. *Irrigation Principles and Practices* -, New York Wiley.
4. Reddy, S.R. 2017. *Principles of Agronomy*. Kalyani Publishers, New Delhi
5. Sathe, T.V. 2004. *Vermiculture and Organic Farming*. Daya publishers, New Delhi


**Web Resources**

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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 1 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| **Total** | **14** | **14** | **11** | **13** | **12** | **11** | **14** |
| **Average** | **2.8** | **2.8** | **2.2** | **2.6** | **2.4** | **2.2** | **2.8** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 3 | 1 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 |
| **CO3** | 2 | 1 | 3 | 2 | 1 | 2 | 1 | 2 | 3 | 3 |
| **CO4** | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO5** | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2 |
| **Total** | **10** | **10** | **14** | **11** | **11** | **10** | **10** | **14** | **11** | **13** |
| **Average** | **2** | **2** | **2.8** | **2.2** | **2.2** | **2** | **2** | **2.8** | **2.2** | **2.6** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER IV**
**ELECTIVE COURSE VII: c) BIOPESTICIDE TECHNOLOGY**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| BP234EC6 | 4 | - | - | - | 3 | 4 | 60 | 25 | 75 | 100 |

**Pre-requisite**: Prior knowledge on impact of chemical pesticides on environment and biopesticides.

**Learning Objectives:**

2. 1.To understand the value and applications of biopesticides.
3. 2.To be aware of the application strategies and weeds, nematodes, and disease targets.

**Course outcomes**

| On the successful completion of this course, the students will be able to: | | |
|---|---|---|
| **1.** | recall and understand the issues in use of chemical pesticides and their harmful effects on life. | **K1& K2** |
| **2.** | recognise and analyse biopesticides and their beneficial role in controlling insect pests, diseases, nematodes and weeds. | **K1&K4** |
| **3.** | identify promising biopesticides and their mechanisms of action against insect pests, diseases, nematodes and weeds. | **K3& K4** |
| **4.** | apply the mass production and formulation technology of selected biopesticides and enhance them. | **K3& K6** |
| **5.** | derive knowledge on product development for commercialization of biopesticides. | **K5** |

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

| Unit | Contents | No.of hours |
|---|---|---|
| **I** | **INTRODUCTION:** Introduction of biopesticides. Biological control, History and concept of biopesticides. Importance, scope and potential of biopesticide. Advantages for the use of biopesticides. | 4. 12 |
| **II** | **TYPES OF BIOPESTICIDES:** Classification of biopesticides, botanical pesticides and biorationales. Mass production technology of bio-pesticides. Major classes-Properties and uses of Bioinsecticides, biofungicides, biobactericides, bionematicides and bioherbicides. Importance of neem in organic agriculture. | **12** |
| **III** | **IMPORTANT BIOINSECTICIDES:** Bacillus thuringiensis, NPV, entomopathogenic fungi (Beauveria, Metarhizium, Verticillium, Paecilomyces). Biofungicides: Trichoderma, Gliocladium, non-pathogenic Fusarium, Pseudomonas spp., Bacillus spp. Biobactericides: Agro bacterium radiobacter. Bionematicides: Paecilomyces, Trichoderma, Bioherbicides: Phytophthora, Colletotrichum. | **12** |
| **IV** | **STANDARDIZATION OF BIOPESTICIDES**: Target pests and crops of important biopesticides and their mechanisms of action. Testing of quality parameters and standardization of biopesticides. | **12** |
| **V** | **FORMULATION**: Mass multiplication and formulation technology of biopesticides. Prospects and problems in commercialization and efficiacy of biopesticides. Commercial products of biopesticides. | **12** |

| **Self -study** | Importance of neem in organic agriculture, Commercial products of biopesticides. |
|---|---|

**Textbooks**

1. Johri,J.2020.RecentAdvancesinBiopesticides:BiotechnologicalApplications.NewIndiaPublishing Agency (NIPA), NewDelhi.
2. Tebeest,D.O.2020.*Microbial Control of Weeds*.CBSPublishersandDistributors,New Delhi

**Reference books**

1. Carlile, M.J., Watkinson, S.C and Gooday, G.W. 2001. *The Fungi*. 2nd Edition. Academic Press, San Diego
2. Manoj Parihar, Anand Kumar. 2021. *Biopesticides*. Volume 2: Advances in Bio- inoculants. Elsevier.
3. Bailey, A., Chandler, D., Grant, W. P., Greaves, J., Prince, G., Tatchell, M. 2010. *Biopesticides: pest management and regulation*.Plumx press, New Delhi.
4. Manoharachary, C., Singh, H.B., Varma, A. 2020. *Trichoderma: Agricultural Applications and Beyond*. Springer International Publishing, New York, USA.
5. Nollet, L.M.L and Rathore, H.S. 2019. *Biopesticides Handbook*. 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

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 2 | 2 | 3 | 2 | 1 |
| **CO3** | 3 | 3 | 3 | 3 | 1 | 3 | 2 |
| **CO4** | 3 | 2 | 2 | 2 | 3 | 2 | 1 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| **Total** | **15** | **13** | **13** | **13** | **12** | **13** | **10** |
| **Average** | **3** | **2.6** | **2.6** | **2.6** | **2.2** | **2.6** | **2** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 3 |
| **CO2** | 2 | 3 | 1 | 3 | 3 | 2 | 2 | 3 | 2 | 2 |
| **CO3** | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 1 | 3 |
| **CO4** | 3 | 2 | 1 | 2 | 1 | 2 | 2 | 3 | 3 | 3 |
| **CO5** | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 10 | 2 |
| **Total** | **12** | **13** | **10** | **13** | **12** | **13** | **13** | **14** | **2** | **13** |
| **Average** | **2.2** | **2.6** | **2** | **2.6** | **2.4** | **2.6** | **2.6** | **2.8** | **1** | **2.6** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER IV**

**SKILL ENHANCEMENT COURSE III: PROFESSIONAL COMPETENCY IN BIOLOGY**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| **BP234SE1** | **4** | **-** | **-** | **-** | **2** | **4** | **60** | **25** | **75** | **100** |

**Pre-requisite:** Knowledge in the concept of skill enhancement.

**Learning Objectives:**

1. To understand the concept of agronomy and sustainable agriculture.
2. To learn the mechanism underlying the shift from vegetative to reproductive phase.

**Course Outcomes**

| **On the successful completion of the course, the students will be able to:** | | |
|---|---|---|
| **1.** | learn about the structure of atoms, molecules, and chemical bonds. | **K1** |
| **2.** | demonstrate both the theoretical and practical knowledge in cell biology and molecular biology. | **K2** |
| **3.** | explain and use the methods of recombinant technology. | **K3** |
| **4.** | compare and contrast the physiological functions and metabolism. | **K4** |
| **5.** | discuss and develop skills for effective comprehension and communication. | **K5 & K6** |

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

| Unit | Contents | No. of Hours |
|---|---|---|
| **I** | **MOLECULES AND THEIR INTERACTION RELEVANT TO BIOLOGY:** Structure of atoms, molecules, and chemical bonds. Composition, structure, and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids, and vitamins). Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes | **12** |
| **II** | **CELLULAR ORGANIZATION:** Membrane structure and function: structure of model membrane, lipid bilayer, and membrane protein diffusion, osmosis; ion channels; active transport; membrane pumps; mechanism of sorting and regulation of intracellular transport; electrical properties of membranes. Structural organization and function of intracellular organelles (cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, Organization of genes and chromosomes: Operon, unique and repetitive DNA. | **12** |
| **III** | **FUNDAMENTAL PROCESSES:** DNA replication, repair, and recombination: Unit of replication, enzymes involved, replication origin and replication fork, the fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination. **Protein synthesis and processing:** Ribosome, the formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, | **12** |
| | **CELL COMMUNICATION AND CELL SIGNALING:** **Host-parasite interaction**: Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by | **12** |

| | | |
|---|---|---|
| **IV** | pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.<br>**Cancer:** Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer, and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis. | |
| **V** | **DEVELOPMENTAL BIOLOGY**<br>Basic concepts of development: Potency, commitment, specification, induction, competence, determination, and differentiation; morphogenetic gradients; cell fate and cell lineages.Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum Programmed cell death, aging, and senescence. | **12** |
| | **Total** | **60** |

| | |
|---|---|
| **Self study** | Structure of atoms, molecules, and chemical bonds. Golgi bodies, lysosomes, endoplasmic reticulum |

**Textbooks**


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. Chawla, H.S. 2009. *Introduction to Biotechnology*. 2nd edn. Oxford IBH,London.


**Reference books**


1. Karp, G. 2010. Cell and *Molecular Biology: Concepts and Experiments*. 6thEdition. John Wiley & Sons. Inc, USA
2. Gupta. P.K. 2000. *Cell and Molecular Biology*, Rastogi Pub. Meerut.
3. Ignacimuthu, S. 2005. *Basic Bioinformatics*, Narosa publishing house. New Delhi.
4. Lesk, A.M. 2002. *Introduction to Bioinformatics*. Oxford University press. London.
5. Rastoji, S.C., Mendiratta,N., Rastogi, P. 2009. *Bioinformatics : Methods and Applications*, PHI, Third Edition.


**Web resources:**

1. https://www.nature.com/scitable/topic/cell-biology
2. https://plato.stanford.edu/entries/molecular-biology/
3. https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/bioinformatics
4. https://.britannica.com/technology/biotechnolog/
5. https://nptel.ac.in/courses/102/107/102107075/

## MAPPING WITH PROGRAMME OUTCOMES

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 2 | 1 | 1 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 2 | 3 |
| **Total** | **14** | **14** | **11** | **14** | **11** | **11** | **11** |
| **Average** | **2.8** | **2.8** | **2.2** | **2.8** | **2.2** | **2.2** | **2.2** |

## MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 3 | 2 |
| **CO2** | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 |
| **CO3** | 2 | 1 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 1 |
| **CO4** | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 |
| **Total** | **11** | **11** | **14** | **11** | **11** | **11** | **11** | **11** | **14** | **11** |
| **Average** | **2.2** | **2.2** | **2.8** | **2.2** | **2.2** | **2.2** | **2.2** | **2.2** | **2.8** | **2.2** |

**3 -Strong 2 - Medium 1 - Low**

**SEMESTER III & IV**
**LIFE SKILL TRAINING II - VALUES**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| PG23LST2 | 1 | - | - | - | 1 | 1 | 15 | 50 | 50 | 100 |

**Pre-requisites:** Value education-its purpose and significance in the present world

**Learning Objectives**

1. To guide students in making wise choices and decisions, and to help them discover the true purpose of their lives.
2. To ensure students not only grasp the concept of values but also incorporate them into their actions and attitudes.

**Course Outcomes**

| On the completion of this course the student will be able to | | |
|---|---|---|
| 1 | recognize the perception of life and lead a positive life | **K1** |
| 2 | understand relationship with family, friends and the society | **K2** |
| 3 | develop as socially responsible citizens. | **K3** |
| 4 | assess goals, fix targets and value life | **K4** |
| 5 | create a peaceful, communal community and embrace unity. | **K6** |

**K1**-Remember; **K2**-Understand; **K3**-Apply; **K4 – Analyse; K6**- Create

| Units | Contents | No. of Hours |
|---|---|---|
| I | **Positive Thinking -** Why you should change your thinking? – How to became a better thinker- Putting yourself in the right place to think- Portrait of the good thinker.<br>**Habits-** Habits vs. Addiction- Why are life styles changes so difficult to hold on to? - Habit Swapping. | 3 |
| II | **Art of Listening-** Many faces of speech- To be truly present- Valuing the other- Activating the subconscious.<br>**Leadership-** Introduction- Who is a better leader? - Qualities of a Leader- You too can be a leader. | 3 |
| III | **Interpersonal Relationship**- Introduction - Factors that build trust- Steps to build a positive personality.<br>**Managing Emotions**- 7 'Root' emotions- Importance of managing emotions- Why is it important to manage emotions? | 3 |
| IV | **Stress Management –** Highly effective tips for relieving stress- Fast-Acting Self Relief Strategies.<br>**Anger Management:** Effects of anger – Tips to reduce anger – Anger warning signs – Identify your triggers – Ways to cool down your anger. | 3 |
| V | **Forgiveness-** What is forgiveness- Value of forgiveness- Benefits of forgiving- Self-forgiveness.<br>**Gratitude –** What is gratitude? – How gratitude arises? –Features of gratitude – Gratitude is recognizing and acknowledging. | 3 |
| **TOTAL** | | **15** |
| **Self-Study** Salient values for life, Human Rights, Social Evils and how to tackle them, Holistic | | |

living, Duties and responsibilities.

**Textbooks**

Life Skill Training – II, Holy Cross College (Autonomous), Nagercoil

**Reference Books**

1. Holy Cross College (Autonomous), Nagercoil (2007). Foundation Course Life's Challenges. Sipca Computers.
2. Mathew, Sam (2010). Self Help Life Book. Opus Press Publisher.
3. Romuald Andrade. (2015). Habit Triggers: How To Create Better Routines And Success Rituals To Make Lasting Changes In Your Life. Kindle Edition.
4. William Fergus Martin. (2014). Four Steps to Forgiveness: A Powerful Way To Freedom, Happiness And Success. Findhorn Press.
5. Robert A. Emmons and Joanna Hill (2001). *Words Of Gratitude for Mind, Body, and Soul*. USA: Templeton Foundation Press.

**Web Resources**

1. https://www.mayoclinic.org/healthy-lifestyle/stress-management/in-depth/positive-thinking/art-20043950
2. https://jamesclear.com/habits
3. https://www.skillsyouneed.com/ps/managing-emotions.html
4. https://emeritus.org/in/learn/what-is-leadership/
5. https://www.verywellmind.com/how-to-maintain-interpersonal-relationships-5204856

**SEMESTER IV**

**SELF LEARNING COURSE: NET/SET FOR BOTANY STUDENTS**

| Course Code | L | T | P | S | Credits | Inst. Hours | Total Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CIA | External | Total |
| **BP234SL1** | - | - | - | - | 1 | - | - | 25 | 75 | 100 |

**Pre-requisite:** To understand the biological concepts of cell structure, evolutionary biology and basic genetics.

**Learning Objectives:**

1. Understand the fundamental principles of plant physiology, cell biology and biochemistry.
2. Understand the ethical considerations and controversies related to evolutionary biology and genetic modification.

**Course Outcomes**

| **On completion of this course, the students will be able to:** | | |
|---|---|---|
| **1.** | understand the principles of plant physiology, cell biology and biochemistry | **K1** |
| **2.** | demonstrate competency in the application of plant sciences including agronomic techniques and pest management | **K2** |
| **3.** | evaluate the various contributions of plant-based systems from local to global systems. | **K3** |
| **4.** | learn professional skills using experience based knowledge to develop a practical skill set | **K4** |
| **5.** | interpret and critically evaluate scientific information as it applies to the field of Plant Sciences | **K5 & K6** |

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

| UNIT | CONTENTS |
|---|---|
| **I** | **Cell Biology**: Structure and function of cells and intracellular organelles (of both prokaryotes and eukaryotes) mechanism of cell division including (mitosis and meisosis) and cell differentiation. Cellcell interaction: Malignant growth; Immune response Dosage compensation and mechanism of sex determination. |
| **II** | **Biochemistry:** Structure of atoms, molecules and chemical bonds; Principles of physical chemistry; Thermodynamics, Kinetics, dissociation and association constants; Nucleic acid structure, genetic code, replication, transcription and translation, Structure, function and metabolism of carbohydrates, lipids and proteins; Enzymes and coenzyme; Respiration and photosynthesis |
| **III** | **Physiology**: Response to stress: Active transport across membranes; Plant and animal hormones; Nutrition (including vitamins); Reproduction in plants, microbes and animals |
| **IV** | **Genetics**: Principles of Mendelian inheritance, chromosome structure and function; Gene Structure and regulation of gene expression; Linkage and genetic mappings; Extrachromosomal inheritance (episomes, mitochondria and chloraplasts); Mutation; DNA damage and repair, chromosome aberration; Transposons; Sexlinked inheritance and genetic disorders; Somatic cell genetic; Genome organisation (in both prokaryotes and eukaryotes). |
| **V** | **Evolutionary Biology:** Origin of life (including aspects of prebiotic environment and molecular evolution); Concepts of evolution; Theories of organic evolution; Mechanisms of speciation; Hardy weinberg genetic equilibrium, genetic polymorphism |

| | |
|---|---|
| | and selection; Origin and evolution of economically important microbes; plants and animals |

**Textbooks**


1. Geoffrey M, Cooper. I, 2019. *The Cell: A Molecular Approach*, Oxford University Press.
2. Satyanarayana, U and chakrapani, U. 2005. *Biochemistry*, Books and Allied (P) Ltd. Calcutta


**Reference books**


1. Neena Grover. 2022. *Fundamentals of RNA Structure and Function -Learning Materials in Biosciences*. Springer Nature, Switzerland.
2. Nelson, D.L. and Cox, M.M. 2017. Lehninger's Principles of Biochemistry, Prentice Hall, Publishers, USA.
3. Conn, E.J. and Stumpf, P.K. 2009. *Outlines of Biochemistry*. (5th ed.) Wiley Eastern Ltd., New Jersey.
4. Purohit, S.S. 2006. *Microbiology*. Agro Botanical Publishers, India.
5. Gupta P.K. 1997. *Cytology, Genetics and Evolution*. Rastogi Publications, Meerut.


**Web resources**:

1. https://www.nature.com/scitable/topic/cell-biology
2. https://plato.stanford.edu/entries/molecular-biology/
3. http://www.brainkart.com/subject/Plant-Biochemistry_257/
4. https://ifasonline.com/csir-net/life-science-study-material/6539046e640e05d28fe8ddaf
5. https://static.prepp.in/public/image/System_Physiology_plant_91420d983c251bf5bd5ed7f04e2c2305.pdf

**MAPPING WITH PROGRAMME OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 3 | 3 | 1 | 2 |
| **CO2** | 3 | 3 | 2 | 3 | 3 | 3 | 2 |
| **CO3** | 3 | 2 | 3 | 3 | 2 | 2 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | 3 | 3 |
| **Total** | **15** | **14** | **11** | **15** | **14** | **11** | **11** |
| **Average** | **3** | **2.8** | **2.2** | **3** | **2.8** | **2.2** | **2.2** |

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

| COs | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 3 | 3 | 2 | 3 | 2 | 3 | 1 | 3 |
| **CO2** | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 |
| **CO3** | 3 | 2 | 2 | 3 | 1 | 3 | 1 | 2 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **Total** | **15** | **11** | **14** | **15** | **11** | **15** | **11** | **14** | **11** | **15** |
| **Average** | **3** | **2.2** | **2.8** | **3** | **2.2** | **3** | **2.2** | **2.8** | **2.2** | **3** |

**3 -Strong 2 - Medium 1 - Low**