

**SACRED HEART COLLEGE (AUTONOMOUS), THEVARA  
KOCHI, KERALA, 682013**



**CURRICULUM AND SYLLABI  
CHOICE BASED COURSE CREDIT AND SEMESTER SYSTEM  
(CBCSS)**

**UNDERGRADUATE PROGRAMME IN BOTANY  
(B.Sc. BOTANY - MODEL I)  
(INTRODUCED FROM 2015 ADMISSION ONWARDS)**

**BOARD OF STUDIES IN BOTANY  
Sacred Heart College (Autonomous), Thevara, Kochi, Kerala**

## **FOREWORD**

In line with the changes in higher education, the state of Kerala had introduced the autonomy in its 13 selected colleges and, S H College, Thevara is proud to be one. Even while remaining affiliated to M G University, the academic autonomy was granted during 2014-2015 academic year onwards. In the undergraduate level the choice based course credit semester system was decided to be continued even after the attainment of autonomy to the institution. Exercising the opportune occasion of autonomy, the dept. of Botany had attempted to redraft the entire syllabus of U G in a different perspective and the rearrangement of the courses in a more systematic and learner friendly manner. The teachers who were dealing with the topics were given with the task for a thorough revisit of the syllabus and suggest changes thereof by addition, deletion, or substitution in the existing syllabus. After proper homework, several sittings were made to finalize the deliberations and compilations.

The following are the major changes envisaged in the new draft.

1. The general core course of semester one, entitled Methodology and perspectives of Science and an introduction to the world of plant sciences, and the core course second, entitled General informatics and methodology in plant sciences were edited and was shifted from first to 6th semester and compiled into a single core course, Perspectives of Science Methodology and General informatics. In that an introduction to plant diversity was deleted since it shall be reasonably placed in better suited courses. The rationale for the above modification shall be justified as follows. A student of first semester graduate studies coming directly from the school cannot be expected of that philosophically hard a topic to be received in the beginning as is experienced by teachers for the last few years. But after two year studies for the graduate programme, it shall be better received.
2. Under graduate programme in Botany has 13 courses designed as per a well thought out draft scheme where care is given to the scientific coherence of progression subjects. The dissertation of the sixth semester is modified in such a way that the candidates shall opt for either conventional dissertation or any of the hands on training projects of the following types. The hands on training shall be streamlined in such a way that an MoU shall be signed with the outside professional agency, if any, with that of the department.

The following are the projects considered for hands on training:

1. Mushroom cultivation
2. Landscaping and garden designing,
3. Nursery Management
4. Flower arrangement and Vegetable carving.
5. Topiary and Bonsai.
6. Polyhouse farming & Precision farming
7. Organic farming and Plantation management
8. Plant tissue culture
9. Cultivation of Medicinal plants
10. Traditional post harvest technology
11. Natural fibre extraction and Handicrafts
12. Natural dyes and Mural painting
13. Vermi composting and Organic manure
14. Biopesticides and Bioinsecticides

15. Biofertilizers and Biological control  
16. Floriculture and Cut flower marketing  
17. Traditional and Natural food processing

**Virtual Lab and Additional Credits**

In tune with the new trends, ICT enabled teaching methods and to spread the message of non-invasive methods, Green Chemistry and protection of environments, virtual labs are offered in the new syllabus. Out of the 13 courses in Botany programme, 8 courses are appended with a minimum of 3 virtual lab experiments. During the tenure of the programme, students can choose at least 18 experiments from these without sparing a course completely for which they can earn an additional credit.

Thevara  
March 15, 2015

**Dr. George Joseph**  
Chairman, BoS in Botany

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## **01. CURRICULUM**

### **1.1 SCOPE**

Applicable to regular Under Graduate Programme B.Sc. Botany, conducted by the Sacred Heart College (Autonomous) with effect from 2015-16 admissions.

### **1.2 STUDENT ATTRIBUTES**

#### **Rationale**

To our knowledge, the Earth is the only planet where life exists. Chlorophyll bearing organisms assimilate the atmospheric CO<sub>2</sub> and release O<sub>2</sub>, the vital component required for existence of life. Green plants are the only ultimate source of food for other living organisms. Plants and plant produce have been used as drug, cloth and shelter. Industrial revolution and its aftermath made a paradigm shift in the minds of the people around the world. The significance of ecosystem and natural environment with its natural products is accepted world over now. Botany programme envisages to unravel the significance of plants in the maintenance of life on planet earth.

#### **Attributes:**

1. Love and understanding of nature
2. Protection of natural habitats and biodiversity
3. Scientific character of observation and reasoning
4. Co-operation and team work
5. Practice of plant science knowledge in real life

### 1.3 DEFINITION

**1.3.1. 'Programme'** means a three year programme of study and examinations spread over six semesters, according to the regulations of the respective programme, the successful completion of which would lead to the award of a degree.

**1.3.2. 'Semester'** means a term consisting of a minimum of **450** contact hours distributed over 90 working days, inclusive of examination days, within **18** five-day academic weeks.

**1.3.3. 'Academic Week'** is a unit of five working days in which distribution of work is organized from day-one today-five, with five contact hours of one hour duration on each day. A sequence of 18 such academic weeks constitutes a semester.

**1.3.4. 'Common Course I'** means a course that comes under the category of courses for English and **'Common Course II'** means additional language, a selection of both is compulsory for all students undergoing undergraduate programmes.

**1.3.5. 'Core course'** means a course in the subject of specialization within a degree programme.

**1.3.6. 'Complementary Course'** means a course which would enrich the study of core courses.

**1.3.7. 'Open course'** means a course outside the field of his/her specialization, which can be opted by a student.

**1.3.8. 'Additional core course'** means a compulsory course for all under graduate students (as per the UGC directive) to enrich their general awareness.

**1.3.9. 'Additional Course'** is a course registered by a student over and above the minimum required courses.

**1.3.10. 'Credit'** is the numerical value assigned to a course according to the relative importance of the content of the syllabus of the programme.

**1.3.11. 'Additional credit'** is the numerical value assigned to Club activities, Social service, Internship etc. which is not added with the total academic credits of the students.

**1.3.12. 'Internship'** is job training for professional careers.

**1.3.13. 'College Co-ordinator'** is a teacher nominated by the College Principal to co-ordinate the continuous evaluation undertaken by various departments within the college.

**1.3.14. 'Department'** means any teaching department in a college.

**1.3.15. 'Parent Department'** means the department which offers core courses within a degree

programme.

**1.3.16. 'Department Council'** means the body of all teachers of a department in a college.

**1.3.17. 'Department Co-ordinator'** is a teacher nominated by a Department Council to co-ordinate the continuous evaluation undertaken in that department.

**1.3.18. 'Faculty Advisor'** means a teacher from the parent department nominated by the Department Council, who will advise the student in the choice of his/her courses and other academic matters.

**1.3.19. Grace Marks** shall be awarded to candidates as per the University Orders issued from time to time.

**1.3.20. 'Grade'** means a letter symbol (e.g., A, B, C, etc.), which indicates the broad level of performance of a student in a course/ semester/programme.

**1.3.21. 'Grade point'** (GP) is the numerical indicator of the percentage of marks awarded to a student in a course.

Words and expressions used and not defined in this regulation shall have the same meaning assigned to them in the Act and Statutes.

#### **1.4. DURATION**

The duration of U.G. programmes shall be **6 semesters**

The duration of odd semesters shall be from **June to October** and that of even semesters from **November to March**.

A student may be permitted to complete the Programme, on valid reasons, within a period of 12 continuous semesters from the date of commencement of the first semester of the programme.

#### **1.5. REGISTRATION**

The strength of students for each course shall remain as per existing regulations, except in case of open courses for which there shall be a minimum of 15 and maximum of 75 students per batch, subject to a marginal increase of 10. For non-core compulsory courses the student strength shall be decided by the Academic Council of the College from time to time.

Those students who possess the required minimum attendance and progress during a semester and could not register for the semester examination are permitted to apply for Notional Registration to the examinations concerned enabling them to get promoted to the next semester.

#### **1.6. SCHEME AND COURSES**

The U.G. programmes shall include (a) Common courses I & II, (b) Core courses, (c) Complementary Courses, (d) Open Course (e) Additional core course. (f) Study tour (g) Internship for English copy editor.

I. Additional credit components

(a) Talent & career club activity (optional)

(b) Social service (mandatory)



- (c) Internship for Commerce, Communication and Computer applications (mandatory).  
(d) Internship (desirable for other programmes).

**1.7. PROGRAMME STRUCTURE FOR MODEL - I**

|   |  |             |
|---|--|-------------|
| A | Programme Duration   | 6 Semesters |
| B | Minimum credits required from common courses   | 38          |
| C | Minimum credits required from Core + complementary + vocational* courses including Project | 79          |
| D | Minimum credits required from Open course  | 03          |
| E | Additional core course ( Environmental studies)  | 04          |
|   | <b>Total Credits required for successful completion of the programme</b>                   | <b>124</b>  |
| F | Club activity (desirable)  | 01          |
| G | Social service (mandatory)   | 01          |
| H | Hands on training/ Research Project (Mandatory)  | 01          |
| I | Minimum attendance required  | 75%         |

**1.8. EXAMINATIONS**

The evaluation of each course shall contain two parts:

(i) CONTINUOUS INTERNAL ASSESSMENT (CIA)

(ii) END-SEMESTER EXAMINATION (ESE)

The internal to external assessment ratio shall be 1:3, for both courses with or without practical. There shall be a maximum of 75 marks for external evaluation and maximum of 25 marks for internal evaluation.

**1.9. COMPUTATION of Grade and Grade points**

For all courses (theory & practical), grades are given on a 07-point scale based on the total percentage of marks. **(CIA+ESE)** as given below

| Percentage of Marks | Grade            | Grade Point |
|---------------------|------------------|-------------|
| 90 and above        | A+ - Outstanding | 10          |
| 80-89               | A - Excellent    | 9           |
| 70-79               | B - Very Good    | 8           |
| 60-69               | C - Good         | 7           |
| 50-59               | D - Satisfactory | 6           |
| 40-49               | E - Adequate     | 5           |
| Below 40            | F - Failure      | 0           |

**1.9.1 Computation of SGPA**

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses and the sum of the number of credits of all the courses undergone by a student in a semester.

$$\text{SGPA (Si)} = \frac{\sum(C_i \times G_i)}{\sum C_i}$$

Where  $C_i$  is the number of credits of the  $i^{\text{th}}$  course and  $G_i$  is the grade point scored by the student in the  $i^{\text{th}}$  course.

**1.9.2 Computation of CGPA**

i. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

$$\text{CGPA} = \frac{\sum(C_i \times S_i)}{\sum C_i}$$

Where  $S_i$  is the SGPA of the  $i^{\text{th}}$  semester and  $C_i$  is the total number of credits in that semester.

Note: The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

**Illustration of Computation of SGPA and CGPA and Format for Transcripts**

- i. Computation of SGPA and CGPA

**Illustration for SGPA**

| Course   | Credit | Grade letter   | Grade point | Credit Point (Credit x Grade) |
|----------|--------|----------------|-------------|-------------------------------|
| Course 1 | 3      | B              | 8           | 3 X 8 = 24                    |
| Course 2 | 4      | C              | 7           | 4 X 7 = 28                    |
| Course 3 | 3      | D              | 6           | 3 X 6 = 18                    |
| Course 4 | 3      | A <sup>+</sup> | 10          | 3 X 10 = 30                   |
| Course 5 | 3      | E              | 5           | 3 X 5 = 15                    |
| Course 6 | 4      | D              | 6           | 4 X 6 = 24                    |
|          | 20     |                |             | 139                           |

Thus, **SGPA = 139/20 = 6.95**

**Illustration for CGPA**

| Semester 1              | Semester 2               | Semester 3               | Semester 4              |
|-------------------------|--------------------------|--------------------------|-------------------------|
| Credit : 20<br>SGPA:6.9 | Credit : 22<br>SGPA:7.8  | Credit : 25<br>SGPA: 5.6 | Credit : 26<br>SGPA:6.0 |
| Semester 5              | Semester 6               |                          |                         |
| Credit : 26<br>SGPA:6.3 | Credit : 25<br>SGPA: 8.0 |                          |                         |

Thus, **CGPA =  $\frac{20 \times 6.9 + 22 \times 7.8 + 25 \times 5.6 + 26 \times 6.0 + 26 \times 6.3 + 25 \times 8.0}{144} = 6.73$**

144

**Grades for the different semesters and overall programme are given based on the corresponding SGPA/ CGPA as shown below:**

| <b>SGPA/CGPA</b>                               | <b>Grade</b>                   |
|--|--------------------------------|
| <b><i>Above 9</i></b>                          | <b><i>A+ - Outstanding</i></b> |
| <b><i>Above 8, but below or equal to 9</i></b> | <b><i>A - Excellent</i></b>    |
| <b><i>Above 7, but below or equal to 8</i></b> | <b><i>B -Very Good</i></b>     |
| <b><i>Above 6, but below or equal to 7</i></b> | <b><i>C – Good</i></b>         |
| <b><i>Above 5, but below or equal to 6</i></b> | <b><i>D – Satisfactory</i></b> |
| <b><i>Above 4, but below or equal to 5</i></b> | <b><i>E – Adequate</i></b>     |
| <b><i>4 or below</i></b>                       | <b><i>F – Failure</i></b>      |

Note: A separate minimum of 30% marks each for internal and external (for both theory and practical) and aggregate minimum of 40% are required for a pass for a course.

For a pass in a programme, a separate minimum of Grade E is required for all the individual courses. If a candidate secures F Grade for any one of the courses offered in a Semester/ Programme only F grade will be awarded for that Semester/ Programme until he/she improves this to E grade or above within the permitted period. Candidate secure E grade and above will be eligible for higher studies.

**1.10. Detailed Distribution of Courses**

**Choice-Based Credit and Semester System: B.Sc. (Botany) Programme – Model I**

The following table shows the structure of the programme which indicate Code of the courses, Title of the courses, instructional hours, Credits, end semester examination time and the components for internal and external evaluation

| Semester | CODE        | NAME OF CORE COURSE   | INST.HRS/<br>WEEK | CREDIT | Tot. CREDITS | Total Hours/<br>semester | University exam | Weightage |    |    |   |   |   |
|----------|-------------|---|-------------------|--------|--------------|--------------------------|-----------------|-----------|----|----|---|---|---|
|          |             |   |                   |        |              |                          |                 | IA        | EA |    |   |   |   |
| 1        | 15U1CRBOT01 | Microbiology and Phycology                                    | 2                 | 2      | 3            | 72                       | 3hrs            | 1         | 3  |    |   |   |   |
|          |             | *PRACTICAL A  | 2                 | 1      |              |                          |                 |           |    |    |   |   |   |
| 2        | 15U2CRBOT02 | Mycology, Lichenology and Plant Pathology                     | 2                 | 2      | 3            | 72                       | 3               | 1         | 3  |    |   |   |   |
|          |             | *PRACTICAL B  | 2                 | 1      |              |                          |                 |           |    |    |   |   |   |
|          | 15U2PRBOT1  | Practical A & B   |                   |        |              |                          |                 |           |    |    |   |   |   |
|          | 15U2ARENV1  | Additional Core Course – Environmental Studies                | 5                 | 4      | 4            | 50                       | 3               | 1         | 3  |    |   |   |   |
| 3        | 15U3CRBOT03 | Bryophytes, Pteridophytes, Gymnosperms and Paleobotany        | 3                 | 3      | 4            | 90                       | 3               | 1         | 3  |    |   |   |   |
|          |             | PRACTICAL C   | 2                 | 1      |              |                          |                 |           |    |    |   |   |   |
| 4        | 15U4CRBOT04 | Anatomy and Angiosperm Morphology                             | 3                 | 3      | 4            | 90                       | 3               | 1         | 3  |    |   |   |   |
|          |             | PRACTICAL D   | 2                 | 1      |              |                          |                 |           |    |    |   |   |   |
|          | 15U2PRBOT2  | Practical C & D   |                   |        |              |                          |                 |           |    |    |   |   |   |
| 5        | 15U5CRBOT05 | Angiosperm Systematics, Floral Morphology and Economic Botany | 2                 | 2      | 5            | 108                      | 3               | 1         | 3  |    |   |   |   |
|          |             | PRACTICAL E   | 4                 | 2      |              |                          |                 |           |    |    |   |   |   |
|          | 15U5CRBOT06 | Environmental Science and Ecotourism                          | 3                 | 3      | 4            |                          |                 |           |    | 90 | 3 | 1 | 3 |
|          |             | *PRACTICAL F  | 2                 | 1      |              |                          |                 |           |    |    |   |   |   |
|          | 15U5PRBOT3  | Practical E & F   |                   |        |              |                          |                 |           |    |    |   |   |   |
|          | 15U5CRBOT07 | Genetics and Plant Breeding                                   | 3                 | 3      | 4            | 90                       |                 |           |    |    |   |   |   |

|   |                     |  |        |        |   |     |   |   |   |
|---|---------------------|--|--------|--------|---|-----|---|---|---|
|   |                     | PRACTICAL G  | 2      | 1      |   |     | 3 | 1 | 3 |
|   | <b>15U5CRBO T08</b> | Cell and Molecular Biology and Evolution<br>*PRACTICAL H   | 3<br>2 | 3<br>1 | 4 | 90  | 3 | 1 | 3 |
|   | <b>15U5 PRBOT4</b>  | Practical G & H  |        |        |   |     |   |   |   |
|   | <b>15U5OCBO T01</b> | <b>OPEN COURSE:</b> Agribased Microenterprises/ Horticulture and Nursery Management/ Biotechnology Bioinformatics      | 4      | 4      | 4 | 72  | 3 | 1 | 3 |
| 6 | <b>15U6CRBO T09</b> | Plant Physiology and Biochemistry<br>*PRACTICAL I  | 3<br>4 | 2<br>2 | 4 | 126 | 3 | 1 | 3 |
|   | <b>15U6CRBO T10</b> | Perspectives of Science, Methodology and General Informatics<br>*PRACTICAL J   | 3<br>2 | 3<br>1 | 4 | 90  | 3 | 1 | 3 |
|   | <b>15U6 PRBOT5</b>  | Practical I & J  |        |        |   |     |   |   |   |
|   | <b>15U6CRBO T11</b> | Biotechnology and Bioinformatics<br>*PRACTICAL K   | 3<br>2 | 3<br>1 | 4 | 90  | 3 | 1 | 3 |
|   | <b>15U6CRBO T12</b> | Horticulture, Nursery Management, Embryology and Reproductive Biology<br>PRACTICAL L                                   | 3<br>2 | 3<br>1 | 4 | 90  | 3 |   | 3 |
|   | <b>15U6 PRBOT6</b>  | Practical K & L  |        |        |   |     |   |   |   |
|   | <b>15U6CRBO T13</b> | <b>*CORE- CHOICE BASED COURSE :-</b> Phytochemistry and Pharmacognosy/ Plant Genetic Resource Management/ Agribusiness | 3      | 3      | 3 | 54  | 3 | 1 | 3 |
|   | <b>15U6PJBO T13</b> | Hands on Training/ Research Project  |        | 1      | 1 |     |   | 1 | 3 |

\*Virtual Lab Experiments offered.

**RESTRUCTURED CURRICULUM FOR B. Sc. DEGREE IN  
BOTANY PROGRAMME  
COURSE STRUCTURE**

Total Credits 124

Total Instructional hours 150

**Semester I**

| No | Course Title  | Hrs/week  | Credit    |
|----|---|-----------|-----------|
| 1  | Common Course English -1  | 5         | 4         |
| 2  | Common Course English -2  | 4         | 3         |
| 3  | Common Course Sec. language -1                                      | 4         | 4         |
| 4  | Core Course -1 Microbiology and Phycology + practical               | 4         | 3         |
| 5  | 1 <sup>st</sup> Complementary – Chemistry/Biochemistry- I           | 2         | 2         |
| 6  | 1 <sup>st</sup> Complementary - Chemistry/Biochemistry- I practical | 2         | 1         |
| 7  | 2 <sup>nd</sup> Complementary- Zoology -1                           | 2         | 2         |
| 8  | 2 <sup>nd</sup> Complementary- Zoology - 1 Practical                | 2         | 1         |
|    | <b>Total</b>  | <b>25</b> | <b>20</b> |

**Semester 2**

| No | Course Title   | Hrs/week  | Credit    |
|----|--|-----------|-----------|
| 1  | Common Course -English -3  | 5         | 4         |
| 2  | Common Course -English -4  | 4         | 3         |
| 3  | Common Course - Sec. language -2                                     | 4         | 4         |
| 4  | Core Course -2 Mycology, Lichenology and Plant Pathology + practical | 4         | 3         |
| 5  | 1 <sup>st</sup> Complementary - Chemistry/Biochemistry- 2            | 2         | 2         |
| 6  | 1 <sup>st</sup> Complementary - Chemistry/Biochemistry- 2 practical  | 2         | 1         |
| 7  | 2 <sup>nd</sup> Complementary -Zoology -2 + Practical                | 4         | 3         |
| 8  | Additional Core Course – Environmental Science                       | 5         | 4         |
|    | <b>Total</b>   | <b>30</b> | <b>24</b> |

**Semester 3**

| No           | Course Title  | Hrs/week  | Credit    |
|--------------|---|-----------|-----------|
| 1            | Common Course English -5  | 5         | 4         |
| 2            | Common Course Sec. language -3  | 5         | 4         |
| 3            | Core Course -3 Bryology, Pteridology, Gymnosperms and PaleoBotany + practical | 5         | 4         |
| 4            | 1 <sup>st</sup> Complementary - Chemistry/Biochemistry- 3                     | 3         | 3         |
| 5            | 1 <sup>st</sup> Complementary - Chemistry/Biochemistry- 3 practical           | 2         | 1         |
| 6            | 2 <sup>nd</sup> Complementary -Zoology -3                                     | 3         | 3         |
| 7            | 2 <sup>nd</sup> Complementary Zoology – 3 practical                           | 2         | 1         |
| <b>Total</b> |   | <b>25</b> | <b>20</b> |

**Semester 4**

| No           | Course Title  | Hrs/Week  | Credit    |
|--------------|---|-----------|-----------|
| 1            | Common Course -English - 6  | 5         | 4         |
| 2            | Common Course Sec. language -4                                      | 5         | 4         |
| 3            | Core Course- 4 – Anatomy and Angiosperm Morphology + practical      | 5         | 4         |
| 4            | 1 <sup>st</sup> Complementary - Chemistry/Biochemistry- 4           | 3         | 3         |
| 5            | 1 <sup>st</sup> Complementary - Chemistry/Biochemistry- 4 practical | 2         | 1         |
| 6            | 2 <sup>nd</sup> Complementary -Zoology -4                           | 3         | 3         |
| 7            | 2 <sup>nd</sup> Complementary Zoology – 4 practical                 | 2         | 1         |
| <b>Total</b> |   | <b>25</b> | <b>20</b> |

**Semester 5**

| No           | Course Title  | Hrs/Week  | Credit    |
|--------------|---|-----------|-----------|
| 1            | Core Course - 5 Angiosperm Systematics, Floral Morphology and Economic Botany + Two Practical including practicals of project | 6         | 5         |
| 2            | Core Course-6 Environmental Science and Ecotourism + practical  | 5         | 4         |
| 3            | Core Course-7 Genetics and Plant Breeding + practical   | 5         | 4         |
| 4            | Core Course - 8 Cell and Molecular Biology and Evolution + practical  | 5         | 4         |
| 5            | Open Course : Horticulture and Nursery Management/Agri. Based Microenterprises/ Ecotourism/ Biotechnology/ Bioinformatics     | 4         | 3         |
| <b>Total</b> |   | <b>25</b> | <b>20</b> |



## Semester 6

| No | Course Title  | Hrs/Week  | Credit    |
|----|---|-----------|-----------|
| 1  | Core Course -9 Plant Physiology and Biochemistry +Two Practicals –including practicals of project         | 7         | 4         |
| 2  | Core Course -10 Perspectives of Science, Methodology and General Informatics + Practical                  | 5         | 4         |
| 3  | Core Course -11 Biotechnology and Bioinformatics + practical  | 5         | 4         |
| 4  | Core Course-12 Horticulture, Nursery Management, Embryology and Reproductive Biology +Practical           | 5         | 4         |
| 5  | Core Choice based – 13 Plant Genetic Resources Management/ Phytochemistry and Pharmacognosy/ Agribusiness | 3         | 3         |
| 6  | Hands on Training/ Research Project   | -         | 1         |
| 7  | <b>Total</b>  | <b>25</b> | <b>20</b> |

|   |           |            |
|---|-----------|------------|
| <b>Total credits for core and complementary</b>       | -         | <b>79</b>  |
| <b>Additional core course</b>                         |           | <b>4</b>   |
| <b>Open</b>   | -         | <b>3</b>   |
|   |           | -----      |
|   |           | <b>86</b>  |
| <b>Total credits for English and second language-</b> | <b>38</b> |            |
|   |           | -----      |
| <b>Total</b>  |           | <b>124</b> |

### 1.11. MARKS DISTRIBUTION FOR END SEMESTER EXAMINATION AND INTERNAL EVALUATION

Marks distribution for end semester and internal assessments and the components for internal evaluation with their marks are shown below.

Components of the internal evaluation and their marks are as below.

#### For all courses without practical

- a) Marks of end semester examination : 75
- b) Marks of internal evaluation : 25

All the three components of the internal assessment are mandatory. For common course English in I Semester, internal oral examination shall be conducted instead of test paper.

| <b>Components of Internal Evaluation</b>  | <b>MARKS</b>       |
|---|--------------------|
| Attendance  | <b>3</b>           |
| Assignments (Assignments shall be a field visit with report in a structured format, collection, preservation and presentation of botanical specimens, teacher monitored group discussions supported by report, museum enrichment, herbarium preparation, preparation of models, charts, posters, short report based on scientific papers or scripts on topics of respective semesters, small survey reports, written quiz, etc.) (Only in Semesters I – IV) | <b>7</b>           |
| Seminar (only in Vth Semester) / Viva (only in VIth Semester)   | <b>7</b>           |
| Test papers - 2   | <b>(5 + 5 =10)</b> |
| <b>Total</b>  | <b>20</b>          |

**Hands on Training/ Research Project Internal Evaluation:**

| <b>Components</b>        | <b>Marks</b> |
|--------------------------|--------------|
| Attendance & Punctuality | 10           |
| Commitment               | 10           |
| Skill                    | 10           |
| Conduct                  | 10           |
| Group Involvement        | 10           |
| <b>TOTAL</b>             | <b>50</b>    |

**Hands on Training/ Research Project External Evaluation:**

| Components     | Marks     |
|----------------|-----------|
| Project Report | 25        |
| Presentation   | 15        |
| Internal Viva  | 10        |
| <b>Total</b>   | <b>50</b> |

**Attendance Evaluation For all courses with / without practical**

| % of attendance | Marks |
|-----------------|-------|
| 90 and above    | 5     |
| 85 – 89         | 4     |
| 80-84           | 3     |
| 76-79           | 2     |
| 75              | 1     |

(Decimals are to be rounded to the next higher whole number)

**1.12. CONDONATION OF SHORTAGE OF ATTENDANCE**

Candidate can seek condonation of shortage of attendance only once in a 2 year course and twice in other courses of longer duration. Following are the rules regarding attendance requirement:-

1. Every candidate is to secure 75% attendance of the total duration of the course.
2. A candidate having a shortage of 10% can apply for condonation of shortage in prescribed form on genuine grounds. Condonation of shortage of attendance if any should be obtained at least 7 days before the commencement of the concerned semester examination.
3. It shall be the discretion of the Principal to consider such applications and condone the shortage on the merit of each case in consultation with the concerned course teacher and HoD.
4. Unless the shortage of attendance is condoned, a candidate is not eligible to appear for the examination.

## **02. Grievance Redressal Mechanism**

In order to address the grievance of students regarding Continuous internal assessment (CIA) a three-level Grievance Redressal mechanism is envisaged. A student can approach the upper level only if grievance is not addressed at the lower level.

### **Level 1:**

At the level of the concerned course teacher

### **Level 2:**

At the level of a department committee consisting of the Head of the Department, a coordinator of internal assessment for each programme nominated by the HoD and the course teacher concerned.

### **Level 3:**

A committee with the Principal as Chairman, Dean of concerned Faculty, HOD of concerned department and one member of the Academic council nominated by the principal every year as members.

## **03. Syllabi**

**MODEL I**  
**B.Sc. Programme in BOTANY**  
**Semester I**

**Course 1 15U1CRBOT01**  
**MICROBIOLOGY AND PHYCOLOGY**  
**(Theory: 48 hours; Practical: 24) (Theory Credit 2, Practical Credit 1)**

### **Course objectives**

Enable the student

1. to understand the world of microbes
2. to understand the identifying characters of the lower groups of plants
3. to understand the application of microbiology and Phycology in different fields.

**MICROBIOLOGY** (Theory: 16 hours; Practical: 6 hours)

**Module 1** **1 hour**

Introduction, Scope of Microbiology

**Module 2 - Bacteria** **8 hours**

Fine structure - cell wall - Peptidoglycan - cytoplasm - Nucleoid, Flagella

Reproduction - Binary fission

Genetic recombination - Conjugation, transformation & transduction

Archaeobacteria, Mycoplasma - general characters

**Module 3 - Virus** **4 hours**

Virus - General morphology and structure.

Plant viruses – architecture of TMV

RNA viruses, DNA viruses (Examples only)

Brief account of virus replication.

**Module 4 Applied Microbiology** **3 hours**

1. Biofertilizers & Bio pesticides.
2. Biogas production.
3. Reconversion of waste products.
4. Bioremediation.
5. Antibiotics.

6. Production of single cell protein and Probiotics.

**PRACTICAL**

**6 hours**

Students are expected to do the following practical

1. Preparation of bacterial smear.
2. Grams staining.
3. Isolation of microbes from soil (Streaking method).

**Additional Credit – Virtual Lab Experiments:**

1. Gram Staining
2. Streak plate method
3. Isolation and identification of two bacterial unknowns

**PHYCOLOGY** (Theory: 32 hours; Practical: 18 hours)

**Module 1**

**2 hours**

Introduction - General characters of algae. Classification (Fritsch F. E, 1935; 1945).

**Module 2**

**24 hours**

General characters of the following major groups with special reference to the structure, reproduction and life cycles of the following types.

- a. Cyanophyceae: *Nostoc*
- b. Chlorophyceae: *Chlamydomonas*, *Volvox*, *Spirogyra*, *Oedogonium*, *Chara*
- c. Xanthophyceae: *Vaucheria*
- d. Bacillariophyceae: *Pinnularia*
- e. Phaeophyceae : *Sargassum*
- f. Rhodophyceae : *Polysiphonia*

**Module 3**

**4 hours**

**Economic importance**

- a. Algae as pollution indicator and in waste water treatment
- b. Commercial products: Agar, Alginates, Carrageenin, Diatomaceous earth
- c. Algae in soil fertility, Fertilizer, Nitrogen fixation, minerals, soil algae and symbiosis
- d. Sources of food & medicine
- e. Diatoms and nanotechnology
- f. As a source of Hydrogen as fuel
- g. Toxic algae – Algal blooms, red tides & fish poisoning
- h. Algae as primary producers – Oxygen liberators
- i. Cyanobacteria as a source of restriction endonuclease
- j. Role of algae in aquaculture.

**Module 4**

**2 hours**

Algal culture: scope and methods (Brief account only)

**Practicals**

**18 hours**

1. Make micro preparation of vegetative and reproductive structures of the types mentioned in the syllabus.
2. Identify the algal specimens up to the generic level by noting their key characters.
3. Make labeled sketches of the specimens observed.

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17. Vasishta B R, Sinha A.K , Singh V.P 2004 *Botany For Degree Students . Algae*, S. chand & Co. Ltd. New Delhi.
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<http://www.phycology.net/>

<http://www.algaebase.org/>

<http://www.seaweed.ie/>

<http://www.brphycsoc.org/> (the british phycological society)

<http://www.intphycsoc.org/> (international phycological society)

<http://www.isaseaweed.org/> (the international seaweed association)

**Semester II**

**Course 2**

**15U2CRBOT02**

**MYCOLOGY, LICHENOLOGY AND PLANT PATHOLOGY**

**(Theory: 36 hours; Practical: 36 hours)**

**(Theory Credit 2, Practical Credit 1)**

**Course Objectives**

Enable the student to

1. Understand the diversity of fungal and lichen world and its significance.
2. Understand the various plant diseases and their impact on agriculture.
3. Familiarize with the various measures adopted to control plant diseases.

**I. MYCOLOGY** (Theory 26 hours; Practical: 26 hours)

**Module 1**

**18 hours**

1. Introduction, structure, reproduction, life cycle, evolutionary trends.  
Classification based on Ainsworth (1973)
2. Distinguishing characters of different classes of fungi with special reference to reproductive structures and life history of the genera mentioned in each group
  - a) Myxomycotina – General Characters
  - b) Mastigomycotina – *Albugo*
  - c) Zygomycotina - *Rhizopus*
  - d) Ascomycotina
    - Hemiascomycetes -- *Saccharomyces*
    - Plectomycetes -- *Pencillium*
    - Pyrenomycetes – *Xylaria*
    - Discomycetes -- *Peziza*
  - e) Basidiomycotina
    - Teliomycetes ---*Puccinia*
    - Hymenomycetes—*Agaricus*
  - f) Deuteromycotina – *Fusarium*

**Module 2**

**8 hours**



1. Economic importance of Fungi – useful and harmful aspects.
2. Fungi of Agricultural importance – mycoherbicides, myconematicides, mycoparasites, Mycorrhiza – diversity, function and significance.
3. Fungal biotechnology- Fundamental principles.  
Mushrooms- edible and poisonous types.  
cultivation technique-Spawn production .  
Cultivation of Oyster mushroom.

**PRACTICALS**

**24 hours**

1. Students are expected to identify the following types by making suitable micropreparations and make labeled sketches *Albugo*, *Rhizopus*, *Saccharomyces*, *Pencillium*, *Xylaria*, *Peziza*, *Puccinia*, *Fusarium* and *Parmelia*.
2. Isolation and culture of Oyster mushroom mycelium.
3. Preparation of bed for mushroom cultivation.
4. Staining of endomycorrhiza or fungus using Trypan Blue.

**Additional Credit: Virtual Lab Experiments**

1. Aseptic techniques and transfer of micro-organisms.
2. Selective and differential media for identifying micro-organisms.
3. Slide culture technique for fungi.

**II. LICHENOLOGY**

**2 hours**

**Module 1**

General account, economic and ecological importance of lichen  
Structure, reproduction and life cycle of *Parmelia*.

**III. PLANT PATHOLOGY** (Theory 10 hours; Practical: 10 hours)

**Module 1**

**2 hours**

History of plant pathology, Classification of plant diseases on the basis of causative organism and symptoms, Host parasite interaction, Defense mechanism in host, Mechanism of infection, transmission and dissemination of diseases.

**Module 2**

**1 hours**

Control of plant diseases –  
Prophylaxis-quarantine measures, seed certification  
Therapeutic – physical therapy, chemotherapy.  
Biological control.

**Module 3**

**6 hours**

Study of the following diseases with emphasis on symptoms, disease cycle and control

Bunchy top of Banana, Cassava Mosaic Disease

Citrus Canker

Root wilt of Coconut.

Abnormal leaf fall of Rubber.

Fungicides - Bordeaux mixture, Tobacco Neem decotion, preparation. (Brief account only)

**Module 4**

**1 hour**

Medical mycology- Mention about fungal infections of man – Fungal allergens Athlet's foot, aspergillosis, candidiosis, aflatoxin

**Practicals**

**10 hours**

Students are expected to:

1. Identify the diseases mentioned in the syllabus with respect to causal organisms and symptoms
2. Submit herbarium preparations of various stages (3stages) of any one of the diseases mentioned.
3. Students should be trained to prepare the fungicide – Bordeaux mixture, Tobacco decotion.

**Suggested Additional Topics**

Fungal ecology - details of fungal decomposition of organic matter, coprophilous fungi, cellulolytic fungi, lignin degrading fungi, details of wood decay, soil fungi, Plant diseases, Role of enzymes in pathogenesis.

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<http://www.fungibank.csiro.au/>  
<http://www.in2.dk/fungi/imageintroTxt.htm>  
<http://www.fungi4schools.org/>  
<http://www.fungiphoto.com/>  
<http://www.britmycolsoc.org.uk/> (British mycological society)  
<http://www.mycokey.com/>  
<http://www.bgbm.fu-berlin.de/sipman/keys/default.htm> (lichen)  
<http://www.bspp.org.uk/>  
<http://www.fs.fed.us/r6/nr/fid/coolpath.shtml>

<http://fruit.wsu.edu/>

<http://www.apsnet.org>

**SEMESTER I**

**Additional Core Course      15U2ACENV02  
ENVIRONMENTAL SCIENCE**

**(Theory: 50 hours)**

**(Theory Credit 4)**

The Core Module syllabus for environmental Studies includes class room teaching and field work. The syllabus is divided into eight units covering 50 lectures. The first seven units will cover 45 lectures which are class room based on field activities which will be covered in five lecture hours and would provide students first-hand knowledge on various local environmental aspects. Field experience is one of the most effective learning mode of teaching into the realm of real learning in the field, where the teacher merely acts as a catalyst to interpret what the student observes or discovers in his/her own environment. Field studies are as essential as class work and form an irreplaceable synergistic tool in the entire learning process.

**Unit 1: The multidisciplinary nature of environmental studies**

**2 hours**

Definition, scope and importance  
Need for public awareness

**Unit 2: Natural resources: Renewable and non-renewable resources**

**8 hours**

Forest resources: Use of over exploitation, deforestation, case studies. Timber, mining, dams and their effects on forests and tribal people.

- a. Water resources: Use and over utilization of surface and ground water, floods, drought, conflicts over water, dams- benefits and problems
- b. Mineral resources: Use of exploitation and environmental effects of extracting and using mineral resources, case studies.
- c. Food resources: World food problems, changes caused by agriculture and overgrazing, effect of modern agricultural fertilizers- pesticides, water logging, salinity, case studies.
- d. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources.

Case studies

- e. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Role of an individual in conservation of natural resources  
Equitable use of resources for sustainable lifestyles

**Unit 3: Ecosystems**

**6 hours**

Concept of an ecosystem

Structure and function of an ecosystem

Producers, consumers and decomposers

Energy flow in the ecosystem

Ecological succession

Food chains, food webs and ecological pyramids

Introduction, types, characteristic features, structure and function of the following ecosystem:-

- a. Forest ecosystem
- b. Grassland ecosystem
- c. Desert ecosystem
- d. Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries)

**Unit 4: Biodiversity and its conservation**

**8 hours**

Introduction- definition: genetic, species and ecosystem diversity

Biographical classification of India

Value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and option values

Biodiversity at global, national and local level

India as mega-diversity nation

Hot-spots of biodiversity

Threats of biodiversity: : habitat lose, poaching of wildlife, man- wildlife conflicts

Endangered and endemic species of India

Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

**Unit 5: Environmental Pollution**

**8 hours**

Definition

Causes, effects and control measures of:

- a. Air Pollution
- b. Water pollution
- c. Soil pollution
- d. Marine pollution
- e. Noise pollution
- f. Thermal pollution
- g. Nuclear pollution

Solid waste management: Causes, effects and control measures of urban and industrial wastes

Role of an individual in prevention of pollution

Pollution case studies

Disaster management: floods, earthquake, cyclone and landslides

**Unit 6: Social Issues and the Environment**

**6 hours**

From unsustainable to sustainable development

Urban problem relate to energy

Water conservation, rain water harvesting, water shed management

Resettlement and rehabilitation of people, its problem and concerns  
Case studies  
Environmental ethics: Issues and possible solutions  
Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.  
Case studies  
Wasteland reclamation  
Consumerism and waste products  
Environment Protection Act  
Air (Prevention and Control Pollution) Act  
Water (prevention and control of Pollution) Act  
Wildlife Protection Act  
Forest conservation Act  
Issues involved in enforcement of environmental legislation  
Public awareness

**Unit 7: Human Population and the Environment**

**6 hours**

Population growth, variation among nations  
Population exploitation- Family welfare programme  
Environment and Human health  
Human rights  
Value education  
HIV/AIDS  
Women and child welfare  
Role of information technology in environment and human health  
Case studies

**Unit 8: Field work**

**6 hours**

Visit to a local area to document environmental assets- river/forest/grassland/hill/ mountains.  
Visit to a local polluted site urban/rural/industrial/agricultural.  
Study of common plants, insects, birds.  
Study of simple ecosystem, pond, river, hill slopes etc.  
Each student has to submit a field report on any one of the above topics which forms the basis for evaluation of field work for 25 marks.

**Reference**

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2. Bharucha Erach, *The Biodiversity of India*. Mapin Publication Pvt. Ltd, Ahamadabad-380013, India , Email: [mapin@iccnel.net](mailto:mapin@iccnel.net) (R)
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(M) Magazine

(R) Reference

(TB) Textbook



**Semester III**

**Course 3 15U3CRBOT03**

**BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS & PALAEOBOTANY**  
**(Theory: 54 hours; Practical: 45 hours) (Theory Credit 3, Practical Credit1)**

**Course objectives**

1. Understand the diversity in habits, habitats and organization of various groups of plants.
2. Understand the evolutionary trends in plants.
3. Identify the anatomical variations in lower groups of plants.
4. Understand the significance of Paleobotany.

**BRYOLOGY** (Theory: 16 hours; Practical: 9 hours)

**Module 1** **2 hours**  
Introduction, general characters, classification, Evolution of Bryophytes.

**Module 2** **12 hours**  
Morphology, anatomy and reproduction in *Riccia*, *Marchantia*, *Anthoceros* and *Funaria*.  
Evolution of sporophyte and gametophyte (Development of sex organs not necessary).

**Module 3** **2 hours**  
Importance of Bryophytes, Prevention of soil erosion, pollution monitoring and control, Antibiotics, Horticultural importance.

**Practical** **15 hours**  
Make micro preparations of the types mentioned. Study vegetative and reproductive structures.

**PTERIDOLOGY** (Theory:16 hours; Practical :24 hours)

**Module 1** **2 hours**  
Introduction, general characters, classification, evolution of Pteridophytes.

**Module 2** **14 hours**  
Structural organization of sporophyte and gametophyte (devt. of sex organs not necessary) of the following types with special reference to stelar structure, heterospory and seed habit.

1. *Psilotum*
2. *Lycopodium*
3. *Selaginella*
4. *Equisetum*
5. *Pteris*
6. *Marsilea*

**PRACTICALS**

**18 hours**

Make micropreparations to study stelar structure and sporangia of the mentioned types.  
Identify at sight, noting the morphology.

**GYMNOSPERMS** (Theory: 14 hours ; Practical :12 hours)

**Module 1**

**2 hours**

Introduction, general characters, classification, origin and evolutionary significance

**Module 2**

**12 hours**

Study of morphology, anatomy and reproductive features of *Cycas*, *Pinus* and *Gnetum*.

**PRACTICAL**

**12 hours**

Study of the morphology, anatomy and reproductive structures of the types mentioned.

**PALAEOBOTANY** (Theory: 8 hours)

**Module 1**

**3 hours**

Introduction, Study of geological time scale, formation of fossil, fossil types & technique of study, fossil as a fuel.

**Module 2**

**4 hours**

Detailed study of

Fossil Pteridophyte : *Rhynia*

Fossil Gymnosperm: *Williamsonia*

Fossil Angiosperm : *Palmoxylon*

Indian contribution to Palaeobotany

**1 hour**

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<http://worldofmosses.com/>  
<http://www.unomaha.edu/~abls/>  
<http://www.anbg.gov.au/bryophyte/index.html>  
<http://www.bryoecol.mtu.edu/>  
<http://www.mobot.org/MOBOT/tropicos/most/Glossary/glosefr.html>  
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[http://botany.csdl.tamu.edu/FLORA/gallery/gallery\\_query.htm](http://botany.csdl.tamu.edu/FLORA/gallery/gallery_query.htm)  
<http://homepages.caverock.net.nz/~bj/fern/>  
<http://www.home.aone.net.au/~byzantium/ferns/>  
<http://www.northernontarioflora.ca/links.cfm?val=pteridophytes>  
[http://www.fiu.edu/~chusb001/giant\\_equisetum.html](http://www.fiu.edu/~chusb001/giant_equisetum.html)  
<http://www.mygarden.ws/fernlinks.htm>  
[http://www.nrm.se/en/menu/researchandcollections/departments/cryptogamicbotany/collections/pteridophytes.652\\_en.html](http://www.nrm.se/en/menu/researchandcollections/departments/cryptogamicbotany/collections/pteridophytes.652_en.html)  
<http://www.amerfernsoc.org/>  
<http://www.gymnosperms.org/>  
<http://www.plantapalm.com/vce/toc.htm>  
<http://www.cycad.org/conservation.htm>  
[http://allwebhunt.com/cgi.cfm/Top/Science/Biology/Flora\\_and\\_Fauna/Plantae/Cycadophyta/Cycadopsida/Cycadaceae/Cycas](http://allwebhunt.com/cgi.cfm/Top/Science/Biology/Flora_and_Fauna/Plantae/Cycadophyta/Cycadopsida/Cycadaceae/Cycas)  
<http://www.forestgiants.com/>  
<http://www.azpalmandcycad.org/>

**Semester IV**

**Course 4 15U4CRBOT04**

**ANATOMY AND ANGIOSPERM MORPHOLOGY**

**(Theory: 54 hours; Practical: 36 hours) (Theory Credit 3, Practical Credit 1)**

**Course Objectives**

1. This course aims to impart an insight into the internal structure and of the most evolved group of plants, the Angiosperm.
2. Identifies role of anatomy in solving taxonomic and phylogenetic problems.
3. Understand the morphology of Angiosperms.

**ANATOMY (Theory: 41 hours, Practical: 27 hours)**

**Module - 1 Scope and importance of Plant Anatomy**

**2 hours**

Interdisciplinary applications: - Histotaxonomy, Histochemistry, Histoenzymology, Pharmacognosy, Physiological Anatomy, Ecological Anatomy, Evolutionary trends in plant anatomy

**Module - 2 Study of Cell wall**

**6 hours**

Gross structure of primary and secondary cell walls, simple and bordered pits. Structure and function of plasmodesmata.

Submicroscopic structure of cell wall- Cellulose, micelle, micro fibril and macro fibril. Different types of Cell wall thickening in tracheary elements

Extra cell wall thickening materials: - Lignin, cutin, suberin and callose.

Origin of cell wall; Growth of Cell wall- Apposition and intussusceptions – cavities & ducts, schizogenous & lysigenous developments

Non living inclusions in plant cell: - Reserve food materials -carbohydrate (starch), protein (Aleurone grain) and lipids (fats and oil);

Secretory products- pigments, enzymes and nectar.

Metabolic byproducts: - tannin, gums, resins, essential oils, mucilage, latex, mineral crystals and alkaloids

**Module - 3 Tissues**

**7 hours**

Meristematic tissue- definition, structure, function and classification

Apical organization and theories; Shoot apex- Apical cell theory, Histogen theory and Tunica-Corpus theory.

Root apex - Histogen theory and Korper- Kappe theory.

Permanent Tissue: - Structure and function of simple and complex tissues.

Distribution and function of mechanical tissues in plants.

Plant fibres-economic importance.

Secretory tissues: - a). External secretory tissue- glands and nectaries, b). Internal secretory tissues- laticifers, epithelial cells.

**Module - 4 Tissue System**

**7 hours**

Structure and Function in root, stem and leaves.

- a) Epidermal Tissue System- Epidermis, Cuticle, Trichome, Stomata, Different types of stomata, Bulliform cells, Cork and Silica cells.
- b) Ground Tissue System- Cortex, Endodermis, Pericycle, Pith and Pith rays.
- c) Vascular Tissue System- Different types of vascular bundles and their arrangement in root and stem

**Module - 5 Vascular cambium**

**3 hours**

Development, structure and function, Activity of cambium, role of cambium in budding, grafting and wound healing.

**Module - 6 Normal secondary growth in dicot stem and root**

**8 hours**

Components of secondary xylem and phloem, Wood anatomy- basic structure, heart wood, sap wood, Histological difference between hard wood and soft wood, growth rings and dendrochronology, porous and non porous wood, ring porous and diffuse porous wood, tyloses, knots.

Wood rays: Structure and cell types, uniseriate and multiseriate rays; heterocellular and homocellular rays.

Reaction wood- Tension wood and compression wood.

Properties, defects and seasoning of wood.

Stem thickening in monocots.

Periderm: Structure and development- phellum, phellogen, phelloderm, bark, polyderm, rhytidome and lenticel.

**Module - 7 Anomalous secondary structure**

**3 hours**

*Bougainvillea* stem, *Bignonia* stem and *Dracaena* stem.

**PRACTICALS**

**27 hours**

1. Cell types and tissues.
2. Non living inclusions – starch grains, cystolith, raphides, aleurone grains.
3. Primary structure of stem root and leaf-Dicots and Monocots.
4. Stomatal types: - anomocytic, anisocytic, paracytic, diacytic and grass type.
5. Secondary structure of dicot stem and root.
6. Anomalous secondary structure of *Bougainvillea* stem, *Bignonia* stem and *Dracaena* stem.
7. Maceration of wood elements

**ANGIOSPERM MORPHOLOGY (Theory 15 hours; Practical: 9 hours)**

**Unit 1 Leaf Morphology (types, venation, phyllotaxy), Stem and Root**

**Unit 2 Morphology of flower - Parts of a flower- description of flower and it's parts in technical terms.**

**Unit 3 Inflorescence:**

(a) Racemose types-Simple Raceme, Corymb, Umbel, Spike, Spadix and Head.

(b) Cymose types-Simple Cyme, Monochasial- Scorpoid and Helicoid, Dichasial

(c) Special type- Cyathium, Hypanthodium

**Unit 4 Fruits:**

Simple-Fleshy, Dry- dehiscent, indehiscent, Aggregate, Multiple (Sorosis and Syconus)

**PRACTICALS**

1. Based on the theory topics

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**Semester V**

**Course 5 15U5CRBOT05**

**ANGIOSPERM SYSTEMATICS, FLORAL MORPHOLOGY**

**AND ECONOMIC BOTANY**

**(Theory 54 hours; Practical: 45 hours)**

**(Theory Credit 3, Practical Credit1)**

**Course objectives:-**

1. Acquaint with the aims, objectives and significance of taxonomy.
2. Identify the common species of plants growing in Kerala and their systematic position.
3. Develop inductive and deductive reasoning ability.
4. Acquaint with the basic technique in the preparation of herbarium.
5. Familiarizing with the plants having immense economic importance.

**Angiosperm Systematics and Floral Morphology (Theory 48 hours)**

**Module 1 Flower as modified shoot**

**4 hours**

Types of flower – Hypogyny, Perigyny and Epigyny, Symmetry of flowers.

Aestivation types; Placentation types; Floral Diagram and Floral Formula with examples for actinomorphic, zygomorphic, Monochlamydeae and Monocot flowers

**Module 2 Systematic Botany**

Unit 1. Aim, Scope and Significance, identification, field inventory, Monographs **1 hour**

Unit 2. Types of Classification- Artificial (Brief account), Natural – Bentham and Hooker (Detailed account) and Phylogenetic (Brief account) **3 hours**

Unit 3. Binomial Nomenclature, ICBN- Brief account **1 hour**

Unit 4. Interdisciplinary approach in Taxonomy- Cytotaxonomy and Chemotaxonomy, Palynology, Phylogeny and Molecular Systematic (brief study). **3 hour**

Unit 5. Herbarium technique- Preparation of herbarium, their preservation. Important herbaria, Botanical Gardens and BSI. Concept of eflora and other online groups that enumerate plant diversity, important flora works of India (Flora of British India and Flora of Presidency of Madras) **4 hours**

Unit 6. Family studies: - **32 hours**

Study the following families of Bentham and Hooker's System with special reference to their morphological and floral characters. Special attention should be given to common and economically important plants (Binomial, family and Morphology of useful parts) within the families, Annonaceae, Nymphaeaceae, Malvaceae, Sterculiaceae, Rutaceae, Meliaceae, Anacardiaceae, Leguminosae (Mimosaceae, Caesalpiniaceae and Fabaceae), Combretaceae, Myrtaceae, Cucurbitaceae, Apiaceae, Rubiaceae, Compositae (Asteraceae), Sapotaceae, Apocynaceae,

Asclepiadaceae, Solanaceae, Convolvulaceae, Scrophulariaceae, Acanthaceae, Verbenaceae, Lamiaceae (Labiatae), Amaranthaceae, Euphorbiaceae, Orchidaceae, Liliaceae, Arecaceae, Graminae (Poaceae)

**Practicals**

**45 hours**

1. Preparation of floral formula from floral description.
2. Identification of aestivation and placentation types.
3. Identify the families mentioned in the syllabus by noting their key, vegetative and floral characters.
4. Students must describe the floral parts, draw the L.S., floral diagram and write the floral formula of at least one flower from each family.
5. Study the finished products of plants mentioned in the syllabus of economic botany with special reference to the morphology, botanical name and family.
6. Prepare herbarium of 25 plants with field notes.
7. Conduct field work for a minimum of 5 days under the guidance of a teacher
8. Identify and describe the ethnobotanical uses of the items mentioned in the syllabus.

**Module – 3 Economic Botany**

**(Theory 4 hours)**

Unit 1. Study of the following groups of plants based on their uses with special reference to the botanical name, family and morphology of the useful part

**Cereals-** Rice, Wheat

**Millets-** Ragi

**Pulses-** Green gram, Bengal gram, Black gram

**Sugar yielding plants –** Sugarcane

**Fruits:-** Apple, Pineapple, Orange, Mango and Banana

**Vegetables:-** Bittergourd, Ladies finger, Carrot and Cabbage.

**Timber yielding plants:-** Teak wood and Jack wood

**Beverages-** Tea, Coffee

**Fibre yielding plants-** Coir, Jute, Cotton

**Oil yielding plants-** Ground nut, Gingelly

**Rubber yielding plants-** Para rubber

**Gums and Resins-** White damer, Gum Arabic, Asafoetida

**Spices –** Cardamom, Pepper, Cloves, Ginger

**Insecticide yielding Plants-** Tobacco and Neem



**Unit 2. Ethnobotany and its significance.**

**2 hours**

Study of the following plants used in daily life by tribals and village folks for Food, Shelter and Medicine

**Food** :- *Artocarpus, Corypha, Phoenix*

**Shelter** - *Bambusa, Ochlandra and Calamus*

**Medicine** - *Curcuma, Trichopus zeylanicus and Alpinia galanga*

**Suggested additional topics**

1. Interdisciplinary approach in Taxonomy, Molecular taxonomy, Numerical taxonomy, Barcoding for species identification and Taxonomy for biodiversity characterization.
2. Binomial nomenclature- Historical account, ICBN, Principles and major rules in – Type concept, priority, valid publication, author citation.

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6. Henry and Chandra Bose 2001 *An Aid to the International Code of Botanical Nomenclature.* Botanical Survey of India. Coimbatore.
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22. Jain S K. 2004, *A Manual Of Ethnobotany*, Scientific Publishers, India
23. Verma V. *Text book of Economic Botany*, Ane Book Pvt. Ltd.
24. Pandey & Misra 2008 *Taxonomy of Angiosperms*. Ane Book Pvt. Ltd.

**Semester V**

**Course 6 15U5CRBOT06**

**ENVIRONMENTAL SCIENCE AND ECOTOURISM**

**(Theory: 54 hours; Practical: 45 hours) (Theory Credit 3, Practical Credit1)**

**Course Objectives:**

1. Acquaint the student with the significance of Environmental Science.
2. Help the students to understand the extent, limitations and depletion of natural resources
3. Help the student to design novel mechanism for the sustainable utilization of natural resources.
4. Enable the students to understand the structure and function of the Ecosystems
5. Make the students to identify the nature and interactions of populations in the ecosystem
6. Enable the students to understand various kinds of pollution in the environment, their impacts on the ecosystem and their control measures
7. Make the students aware about the nature and structure of various environmental laws in India
8. Make the students aware about the role of various movements in the protection of nature and natural resources.
9. Make the students aware about the extent of the total biodiversity and their conservation.
10. Make the students to assess the positive and negative impacts of Ecotourism and its role in the sustainable utilization of resources for tourism.

**ENVIRONMENTAL SCIENCE**

**48 hours**

**Module 1 Environmental science and its multidisciplinary nature**

**1 hour**

Introduction, relevance and scope, public awareness

**Module 2 Natural Resources**

**6 hours**

Types of resources-renewable and non-renewable

Forest resources: Timber extraction, mining, dams, over exploitation, deforestation, MFP (minor Forest products), Joint Forest Management (JFM), Rights of Tribals to forests.

Water resources: surface and ground water, drinking water, dams-benefits and problems, conflict over water, Rain water harvesting, Water shed conservation, importance of hills and mountains in water conservation

Food resources: major food crops in India. Causes of food shortage. Food security, world food problems.

Energy resources: Energy plantation, - *Jatropha*, *Wind energy and Solar energy*

Land resources: Land use, land degradation, desertification, EFL( Ecologically Fragile Land), Ecological sensitive area

Conservation of Biodiversity, ecological footprints, umbrella species and keystone species conservation.

**Module 3 Ecosystems**

**10 hours**

Structure and function of ecosystem: Ecosystem components- abiotic and biotic, Productivity – primary and secondary-gross and net productivity. Decomposition in nature, homeostasis in ecosystem

Ecological energetics: energy flow, trophic levels, food chain and food web, ecological pyramids

Nutrient cycles: Biogeochemical cycles of C, N and S.

**Module 4 Community ecology**

**4 hours**

Population: size, density, natality, mortality.

Community characteristics: Species diversity and species richness, dominance, growth forms and structure, trophic structure.

Association of communities: plant association, ecotypes, ecotone, edge effect, ecological indicators.

Ecological succession: types of succession, process – migration, ecesis, colonization, stabilization and climax community; hydrosere, xerosere, lithosere.

**Module 5 Plants and environment**

**4 hours**

Ecological complexes and factors affecting plants growth and response:

Climatic factors: temperature and pressure; water - precipitation, humidity, soil water holding capacity; light - global radiation.

Topographic factors: altitude and aspects

Edaphic factors - profile and physical and chemical properties of soil

Biotic factors: interactions – positive and negative.

Species – ecosystem interaction: Habitat, ecological niche, microclimate

Adaptation of plants to environment: To Water- Xerophytes, Hydrophytes; Temperature – thermo periodicity, vernalization; light – photoperiodism, heliophytes, sciophytes; salinity – halophytes, mangroves.

**Module 6 Environmental pollution and Management**

**12 hours**

Definition and general introduction

Air pollution: Causes and sources, types of pollutants-particulates-aerosol, mist, dust, smoke, fume, plume, fog, smog. Effect of air pollution on plants and animals, Bhopal Gas Tragedy.

Water pollution: Sources and types of pollutants. Water quality standards, water quality assessment.

Ground water pollution-blue baby syndrome. Cycling of heavy metals, hydrocarbons. Eutrophication, BOD, Minamata disease.

Soil pollution: Causes and sources-waste dumps, municipal wastes, agrochemicals, mining, solid waste management-vermi composting.

Noise pollution: Sources, standards and measurements, effect on health, control techniques.

Thermal pollution: Sources and effects, management

Nuclear hazards: Sources and impacts, management, Chernobyl incident

EIA: Environmental Impact Assessment in polluted areas

**Module 7 Social issues and the environment**

**2 hours**

Climate change, global warming and greenhouse gases, IPCC, Acid rain, Ozone layer depletion, nuclear accidents and nuclear holocaust.

**Module 8 Environmental legislation and laws**

**1 hour**

Environment (protection) Act, 1986, (2) Air (Prevention and control of pollution) Act, 1981, (3) Water (Prevention and control of pollution) Act, 1974, (4) Wildlife (protection) Act, 1972, (5) Forest (Conservation) Act, 1980 (briefly).

**Module 9 Biodiversity and Conservation biology**

**6 hours**

Endemism: Definition-types-factors. Hotspot of endemism-hotspots in India. IUCN-threat categories. Red data book. Western Ghats as the hottest spot and its conservations.

Biodiversity loss: Causes and rate of biodiversity loss, extinction-causes. Alien species, negative and positive impacts

Conservation efforts: Rio Earth Summit, Agenda 21, Kyoto protocol, COP 15(15<sup>th</sup> Conference of the Parties under the U N Framework Convention on Climate Change), IPCC (Inter Governmental Panel for Climate Change) and its contribution. Conservation strategies and efforts in India and Kerala, In situ and ex situ conservation methods. Role of NGOs in biological conservation

**Module 10 Organizations, movements and contributors of Ecological studies** **2 hours**

*Organizations:* BNHS, WWF, CSE, NEERI, , MoEF, Green Peace, Chipko

*Famous contributors of Ecology in India:* Salim Ali, M.S. Swaminathan, Madhav Gadgil, M.C. Mehta, Anil Agarwal, Medha patkar, John C. Jacob, Sunderlal Bahuguna

**ECOTOURISM:**

**6 hours**

Definition, concept, introduction, history, relevance and scope. Components of ecotourism: Forms and types of ecotourism in India and Kerala, ecotourism resources- biological, historical, cultural, and geographical. Ecotourism centers in Kerala. Positive and negative impacts of ecotourism.

**PRACTICALS**

**45 hours**

1. Estimation of CO<sub>2</sub>, Cl, and salinity of water samples (Titremetry)
2. Determination of pH of soil and water
3. Assessment of diversity, abundance, and frequency of plant species by quadrat method (Grasslands, forests)
4. Study of the most probable number (MPN) of coliform bacteria in water samples
5. EIA studies in degraded areas (Sampling – line transect, Quadrant)
6. Visit to any forests types including grasslands and preparation of the list of Rare and threatened (R&T) plants (no collection of specimens)
7. Collection, identification and preparation of the list of exotic species in the locality.
8. Identification of pollutant to respective pollution types.
9. Study of anatomical, morphological, physiological adaptation of plants to the environment (Xerophytic, Hydrophytic, Epiphytic, Halophytic).
10. Collection and recording of rain data by using simple rain gauge.

**Additional Credits: Virtual Lab Experiments**

1. Biological Oxygen Demand
2. Chemical Oxygen Demand of waste water
3. Case studies on Ecology

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2. [www.envfor.nic.in](http://www.envfor.nic.in)
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10. <http://www.enviroliteracy.org/>
11. <http://www.webdirectory.com/>
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13. <http://www.envirolink.org/>
14. <http://www.epa.gov/>
15. <http://www.biodiversityhotspots.org>
16. <http://www.conservation.org>
17. <http://wgbis.ces.iisc.ernet.in/biodiversity>
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21. <http://www.iucnredlist.org>
22. <http://www.envfor.nic.in>
23. <http://www.greenpeace.org>
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25. <http://atree.org>
26. <http://www.frlht.org.in>
27. <http://www.worldwildlife.org>
28. <http://www.ipcc.ch/>

**Semester V**

**Course 7 15U5CRBOT07**

**GENETICS AND PLANT BREEDING**

**(Theory 54 hours; Practical 45 hours)**

**(Theory Credit 3, Practical Credit1)**

**Course Objectives**

1. Understand the basic principles of heredity and variations in life
2. Understand the inheritance pattern of nuclear and extra nuclear genes
3. Understand the objectives of plant breeding
4. Understand the methods of crop improvement

**GENETICS (Theory 25 hrs)**

**Module 1.**

**2 hours**

Origin of a new branch of Biology- Genetics- A short life sketch of Gregor Mendel; basic laws governing genetics, Mendelian ratios.

**Module 2.**

**8 hours**

Growth of Genetics- post Mendelian period- modified Mendelian ratios; incomplete dominance- flower color in *Mirabilis*: Interaction of genes- comb pattern in poultry (9:3:3:1): Epistasis- recessive-coat color in mice (9:3:4); dominant epistasis- fruit color in summer squash (12:3:1): complementary genes- flower color in *Lathyrus* (9:7).

**Module 3.**

**2 hours**

Multiple alleles- general account: ABO blood groups in man; co dominance; self-sterility in *Nicotiana*.

**Module 4**

**2 hours**

Quantitative characters- polygenic inheritance, continuous variation- skin colour inheritance in man; ear size in maize.

**Module 5**

**4 hours**

Linkage and crossing over- importance of linkage, linkage and independent assortment. Complete and incomplete linkage. Crossing over- general account, cytological basis of crossing over- two point test cross; determination of gene sequences; interference and coincidence; mapping of chromosomes.

**Module 6**

**4 hours**

Sex determination- sex chromosomes and autosomes- chromosomal basis of sex determination; XX-XY, XX-XO mechanism; genic balance theory of sex determination in *Drosophila*; hormonal theory of sex determination; sex chromosomal abnormalities in man- Down's syndrome, Klinefelter's syndrome, Turner's syndrome- Sex linked inheritance- eye color in *Drosophila*, Haemophilia in man; Y-linked inheritance.



**Module 7** **2 hours**  
Extra nuclear inheritance- general account- maternal influence- plastid inheritance in *Mirabilis*, kappa particle in *Paramecium*.

**Module 8** **1 hour**  
Population genetics-Hardy Weinberg law

**PLANT BREEDING (Theory: 15 hours)**

**Module 1** **1 hour**  
An Introduction to and objectives of plant breeding.

**Module 2** **1 hour**  
Plant introduction- procedure of plant introduction, quarantine regulations, acclimatization- agencies of plant introduction in India, major achievements.

**Module3** **2 hour**  
Selection- mass, pureline, clonal- genetic basis of selection- some achievements – semi dwarf wheat and Rice.

**Module 4** **5 hour**  
Hybridization- Introduction, history, objectives and procedure- choice of parents, evaluation of parents, emasculation procedures such as hand method, succession method, hot water method, alcohol method and cold treatment methods- intergeneric, interspecific and intervarietal hybridization with examples- composite and synthetic varieties- heterosis in plant breeding, inbreeding depression; genetics of heterosis and inbreeding depression; single cross, pedigree method, bulk population method, multiple cross, back cross, polyploidy breeding, male sterility in plant breeding. Use of apomixis in plant breeding.

**Module 5** **2 hours**  
Mutation breeding- methods- achievements in India; breeding for pest, disease and stress resistance

**Module 6** **2 hours**  
Modern tools for plant breeding; Genetic Engineering and products of genetically modified crops

**Module 7** **2 hours**  
Modern tools for plant breeding; Genetic engineering and products of genetically modified crops

**PRACTICAL (45 hours)**

**A. Genetics** **36 hours**

- a. Students are expected to work out and record the problems in:
1. Monohybrid, dihybrid cross and back crosses.
  2. All types of modified Mendelian ratios mentioned in the syllabus.

- b. Study of human karyotype and study of characteristic karyotypes and symptoms of the syndromes mentioned in the syllabus and record it.

**B. Plant breeding**

**9 hours**

1. Emasculation and bagging
2. Comparison of percentage of seed germination and the effect of any one chemical on the rate of elongation of radicle in any three crop seeds

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**Semester V**

**Course 8 15U5CRBOT08**

**CELL MOLECULAR BIOLOGY AND EVOLUTION**

**(Theory: 54 hours; Practical: 45 hours) (Theory Credit 3, Practical Credit1)**

**Objectives**

1. Understand the Ultra structure and functioning of cell in the submicroscopic and molecular level.
2. Get an idea of origin, concept of continuity and complexity of life activities.
3. Familiarization of life process.
4. Understand the basic and scientific aspect of diversity.
5. Understand the cytological aspects of growth and development.
6. Understand DNA as the basis of heredity and variation.
7. Understand the concept of evolution as the basis of biodiversity.

**Module I CELL BIOLOGY**

**28 hrs**

Unit 1. Historical account of cell Biology, Cell theory, Protoplasm theory

**1 hr**

Unit 2. Cell

**8 hrs**

The physio-chemical nature of plasma membrane and cytoplasm Eukaryotic, Prokaryotic cell. The ultra-structure of plant cell with brief description and function of the following organelles- Endoplasmic reticulum, Plastids, Mitochondria, Ribosomes, Dictyosome, Microbodies, lysosomes. Vacuole and cell sap, Nucleus - ultra structure, nucleolus structure and function.

Unit 3. Chromosomes

**15 hrs**

Morphology - fine structure Dupraw model - Nucleosome model – chemical organization of nucleosome – nucleoproteins, karyotype and idiogram; Special type of chromosomes - salivary gland, Lampbrush and B chromosome. Cell cycle, mitosis, meiosis: significance of mitosis and meiosis. Change in number of chromosomes -Aneuploidy and Euploidy  
Change in the structure of chromosomes - Chromosomal aberrations deletion, duplication, inversions and translocations. Meiotic behaviour of chromosomes. Lagging of chromosomes and Chromosome Bridge

Unit 4. Mutations

**2 hrs**

Spontaneous and induced. Mutagens- Physical and Chemical mutagens. Chromosomal and point mutations. Molecular mechanism of mutation - Transition, Transversion and Substitution.

Unit 5. Stem cells; definition, sources and applications.

**2 hrs**

**Module II MOLECULAR BIOLOGY****17 hrs**

Unit1. Nucleic acids - structure of DNA and RNA - basic features, alternate forms of DNA - types and structure of RNA **3 hrs**

Unit2. Replication of DNA - Meselson-Stahl experiment - details of semiconservative replication of DNA **3 hrs**

Unit3. Gene expression - concept of gene, definitions - the central dogma - details of transcription in procaryotes and eucaryotes - RNA processing.details of translation - genetic cod features **6 hrs**

Unit4. Control of gene expression - positive and negative control - operon model - lac operon, trp operon -attenuation **3 hrs**

Unit5. Genetic basis of cancer - oncogenes - tumor suppressor genes - metastasis **2 hrs**

**PRACTICALS:** Problems based on DNA, RNA and Proteins **9 hrs**

**Module III EVOLUTION****9 hrs**

Unit 1. Introduction, Origin of life – biochemical origina of life, Progressive, Retrogressive, Parallel and Convergent evolution. Theories of evolution - Lamark’s, Darwin’s, Weisman’s and De Vries.

**4 hrs**

Unit 2 Neo Darwinism

**5 hrs**

Reproductive isolation, Mutation, Genetic drift, Speciation. Variation and evolution, hybridization and evolution, Polyploidy and evolution. Mutation and evolution.

**PRACTICALS****36 hrs**

1. Make acetocarmine squash preparation of onion root tip to identify mitotic stages.
2. Study the Mitotic Index of onion root tip cells
3. Study of meioses in any flower bud by smear preparation of PMC’s
4. Identification of Barr body
5. Identification of salivary gland chromosome.
6. Identify and study photographs and diagrams of cell division anomalies like lagging chromosomes, chr. Bridge, aneuploidy, polyploidy. Study the chromosomal patterns/ Karyotype in auto-, allo-, and aneuploids

**Additional Credits: Virtual Lab Experiments**

1. Lignin staining
2. Preparation of Buffer Stocks
3. Plasmid isolation

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**Semester V**

**Semester V**

**Open Course**

**15U50CBOT1**

**AGRIBASED MICROENTERPRISES  
(72 Hours) Theory Credits 3**

**Course objectives**

1. Get basic information about the business opportunities in plant sciences.
2. Inform the students about sustainable agriculture and organic farming.
3. Inculcate an enthusiasm and awareness about ornamental gardening, nursery management, floriculture and mushroom cultivation.

**Module 1 Organic Farming and Composting Techniques**

**9 hours**

Organic manures and fertilizers. Composition of fertilizers – 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 of both; vermicompost – preparation, vermish. Biofertilizers – definition, types – *Trichoderma*, *Rhizobium*, PGPR. Biopesticides – Tobacco and Neem decoction. Biological control. Sustainable agriculture.

**Module 2 Horticulture and Nursery management**

**20 hours**

Soil components. Preparation of potting mixture. Common Garden tools and implements. Methods of plant propagation – by seeds – advantages and disadvantages. Vegetative propagation – advantages and disadvantages. Natural methods of vegetative propagation. Artificial methods – cutting, grafting, budding and layering. Use of growth regulators for rooting. Micropropagation by tissue culture. Gardening – Types of garden – ornamental, indoor garden, kitchen garden, vegetable garden for marketing. Rockery and artificial ponds. Ornamental garden designing – garden components – flower beds, borders, hedges, edges, drives and paths, garden adornments. Lawn - preparation by seeds, by transplanting seedling and by turfing. Bonsai preparation. Pruning of plants. Types of Nurseries – Management aspects and Maintenance. Irrigation Methods: surface, drip and mist chamber. Plant growth structures – advantages of green house, polyshed, fernery and orchidarium. Packaging of fruits, vegetables, nursery products and flowers.

**Module 3 Floriculture and Flower Arrangement**

**7 hours**

Prospects and problems of floriculture in Kerala, Scope of floriculture, especially anthurium, orchids and jasmine in Kerala, Common cut flowers- Rose, Gerbera, Gladiolus, Aster, Chrysanthemum, Carnation, Anthurium, Liliium, Orchids; Common leaves in flower arrangement – Cyprus, Podocarpus, Asparagus, palms, cycads, ferns; Flower arrangement types – western, eastern (Japanese), modern, wases, flower holders, floral foam, dry flower arrangement.

**Module 4 Mushroom Cultivation and Spawn Production**

**9 hours**

Significance of Mushrooms, General outline of life cycle. Types of mushrooms - button mushroom, oyster mushroom and milky mushroom, poisonous mushroom – methods of

identification. Spawn – isolation and preparation. Cultivation of oyster and milky mushrooms – using paddy straw and saw dust by polybag. Farm design and control of pests and diseases. Value added products from mushroom – pickles, candies, dried mushrooms.

**Module 5 Plant Tissue Culture and Micropropagation****9 hours**

Protoplasm- basic structure and function of plant cell concept of totipotency- differentiation and dedifferentiation. Infra-structure of a tissue culture laboratory. Solid and liquid media- composition and preparation. Sterilization- dry, wet and filter sterilization. Explant- inoculation and incubation techniques. Callus induction- organogenesis and embryogenesis. Transplanting, hardening, package and transportation of tissue cultured plantlets.

**Module 6 Self Employment Opportunities****3 hours**

Funding Agencies and self-employment schemes, Procedure to get financial support, special scheme for women empowerment.

**Hands on Training****15 hours**

1. Prepare a chart showing the NPK composition of minimum 6 manures and fertilizers.
2. Identification and familiarization of the following organic manures- cow dung (Dry), Coconut cake, Vermicompost, neem cake, Organic mixture, Bone meal.
3. Preparation of potting mixture.
4. Make a Vermicompost pit /pot in the campus/ house of the student.
5. Familiarization of common garden tools and implements.
6. Estimation of germination percentage of seeds
7. Demonstrate the effect of a rooting hormone on stem cutting.
8. Demonstration of T budding, epicotyle grafting and air layering on live plants
9. Familiarization of garden components from photographs
10. Familiarization of different mushrooms and preparation of a polybag of *Pleurotus* using straw/sawdust
11. Visit to a well-established tissue culture lab, nursery and mushroom cultivation unit.
12. Familiarization of common cut flowers in Kerala
13. Fresh cut flower arrangement
14. Preparation and arrangement of dry flowers
15. Interaction with funding agencies

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**Semester VI**

**Course 9 15U6CRBOT09**

**PLANT PHYSIOLOGY AND BIOCHEMISTRY**

**(Theory 54: hours; Practical: 45 hours) (Theory Credit 2, Practical Credit 2)**

**Course objectives**

1. Understand the basic principles related to various physiological functions in plant life.
2. Familiarize with the basic skills and techniques related to plant physiology.
3. Understand the role, structure and importance of the bio molecules associated with plant life.
4. Familiarize with the recent trends in the field of plant physiology.
5. Familiarize with applied aspects of plant physiology in other fields like agriculture.

**PLANT PHYSIOLOGY (Theory 36: hours; Practical: 33 hours)**

**MODULE I Water relations**

**6 hours**

- A. Physical aspects of absorption-Diffusion, imbibition, osmosis, OP, DPD, TP, WP, Concept of Water potential, matrix potential, pressure potential.
- B. Absorption of water-active & passive, Ascent of sap-cohesion adhesion theory, Transpiration-types-mechanism-theories-(starch-sugar, proton-K<sup>+</sup>ion exchange)-significance – antitranspirants, Guttation.

**MODULE II Mineral Nutrition and mechanism of absorption**

**3 hours**

Essential and non-essential elements- macro& micro- role- deficiency symptoms. Absorption of minerals– active & passive-ion exchange, carrier concept.

**MODULE III Photosynthesis**

**10 hours**

History - Photosynthetic pigments, photo excitation- Fluorescence, Phosphorescence - Absorption and action spectra, Red drop and Emerson enhancement effect, Concept of photo systems, Cyclic & Non Cyclic photophosphorylation, Carbon assimilation pathways-C<sub>3</sub>, C<sub>4</sub>, CAM- Photorespiration – factors affecting photosynthesis.

**MODULE IV Translocation of solutes**

**2 hours**

Pathway-phloem transport-mechanism-pressure flow-phloem loading and unloading.

**MODULE V Respiration 8 hours**

Aerobic and Anaerobic, Glycolysis, Krebs cycle, Electron transport system & Oxidative phosphorylations, ATPases - chemi osmotic hypothesis-RQ –significance-factors affecting respiration.

**MODULE VI Plant responses to environment 1 hour**

Allelochemicals- herbivory

**MODULE VII Physiology of growth and development 4 hours**

- A. Physiological effects and practical application of hormones-Auxins, Giberillins, Cytokinins, ABA, ethylene.
- B. Physiology of flowering–phytochrome–photoperiodism–vernalisation

**MODULE IX Stress physiology 2 hours**

Abiotic - concept of plant responses to water, salt and temperature stresses; Biotic- pathogens

**BIO-CHEMISTRY (Theory 18: hours; Practical: 12 hours)**

**MODULE I Water, Solutions & pH 2 hours**

Physical and chemical properties of water, Acid and bases, pH definition, significance, measurement, pH indicators, buffer action, pH and life.

**MODULE II Chemistry of biological molecules 10 hours**

Carbohydrates- structure and role of mono-di & poly-saccharides-common sugars seen in plants  
Proteins-peptide bond-essential and non-essential amino acids-primary structure-physiologically important proteins. Lipids - general features and their roles - fatty acid types and structure - fatty acid derivatives- fats and oils, structure and functions - compound lipids

**MODULE III Enzymes 6 hours**

Nomenclature, characteristics mechanism and regulation of enzyme action, enzyme kinetics, factors affecting enzyme action.

**PLANT PHYSIOLOGY PRACTICAL (33 hours)**

**Core Experiments**

1. Determination of osmotic pressure of plant cell sap by plasmolytic method.
2. Compare the stomatal indices of hydrophytes, xerophytes and mesophytes.
3. Separation of plant pigments by thin layer chromatography (TLC) and paper chromatography.
4. Measurement of photosynthesis by Willmott's bubbler/any suitable method.
5. Estimation of plant pigments by colorimeter.

**Demonstration only- experiments.**

1. Papaya petiole osmoscope.
2. Demonstration of tissue tension.
3. Relation between transpiration and absorption.
4. Necessity of chlorophyll, light and CO<sub>2</sub> in photosynthesis.
5. Simple respiroscope
6. Respirometer and measurement of R.Q.
7. Fermentation.
8. Measurement of transpiration rate using Ganong's photometer/ Farmer's Potometer.

**BIOCHEMISTRY PRACTICAL (12 hours)**

1. General test for carbohydrates- Molisch's test, Benedict's tests, Fehling's test.
2. Colour test for starch – Iodine test.
3. Colour tests for proteins in solution. Biuret test, Million's test, Ninhydrin test.
4. Detect the presence of any three major organic compounds in the given food stuff/material viz. reducing /non-reducing sugar/fat proteins/starch.sucrose.
5. Action of various enzymes in plant tissues: peroxidases, dehydrogenase.
6. Estimation of protein using colorimeter.

**Additional Credits: Virtual Lab Experiments**

1. Isolation of plant pigments by column chromatography
2. Construction of protein standard curve using Folin's Lowry method
3. Effect of substrate concentration on enzyme kinetics

**Suggested additional topics**

1. Mycorrhizae
2. Chelating agents
3. Photosynthetic rates, efficiencies and crop production.
4. Pentose phosphate pathway.
5. Nitrogen fixation.
6. Plant protective coats –cutins, waxes and suberin.
7. Senescence and abscission.

8. Circadian rhythms.

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**Semester VI**

**Course 10 15U6CRBOT10**

**Perspectives of Science, Methodology and General Informatics**

**(Theory 54 hours, Practical 36 hours)**

**(Theory Credit 3, Practical credit 1)**

**A. Perspectives of Science (Theory 12 hours; Practical 4 hours)**

**Module 1 Introduction to science and scientific methods**

**4 hours**

-Introduction to science

-Steps in scientific methods

- Observation and thoughts
- Formulation of a hypothesis
- Designing of experiments
- Testing of hypothesis
- Formulation of theories

**Module 2 Experimentation in science**

**8 hours**

- Selection of a problem

- Searching the literature

- Selection of variables, study area, and a suitable design

- Necessity of units and dimensions

Units of length, volume, area, concentration, temperature, pressure

- Setting of hypothesis, Null- hypothesis and alternative hypothesis

- Need of control, treatments and replication

- Analysis, presentation and interpretation of data

- Testing of hypothesis, need of statistical tools

- Examples of great experiments in life sciences

-An example of moving from a question to hypothesis and then to an experimental design

-Contributions and the great experiments of Louis Pasteur, and Robert Koch

-Ethics in science

**PRACTICAL**

**4 hours**

1. Prepare  $\text{CuSO}_4 \cdot \text{H}_2\text{O}$  solution of different molarity using a stock solution
2. Determination of the area of different types of leaves using graph paper.

**B. Methodologies of Plant Science (Theory 24 hours, Practical 18 hours)**

**Module 1 Micro technique**

**6 hours**

- Introduction

- Microscopy:- simple, compound, phase contrast, fluorescent, confocal and electron microscopes (working principle and application only)

- Microtome:- rotary, sledge, cryotome (application only)

- Sectioning:- Hand sections, microtomy

- Staining technique:- Principle of staining

Stains:- Safranin, Hematoxylin, Acetocarmine

Vital stains: Purpose, Examples: Neutral red and Evan's blue

Mordents: Purpose and examples

Single staining and double staining

- Mounting and Mounting Media, Purpose of mounting media , Glycerin, DPX, Canada balsam
- Use of permanent whole mounts, permanent sections
- Maceration
- Smear and squash preparation

**PRACTICALS**

**2 hours**

1. Maceration and identification of tracheary elements

**Module 2 Biophysics**

**8 hours**

- Principles and applications of colorimeter, spectrophotometer and centrifuge, Beer-Lambert's Law,
- Separation methods :- chromatography; thin layer, paper, column (principle and applications only), electrophoresis; PAGE, Agarose gel electrophoresis(Principle and applications only)
- pH:- concept of pH, methods to measure pH ; pH paper and pH meter,
- Buffers:- definition, functions of buffers in biological systems, use of buffers in biological research, examples of commonly used buffers

**PRACTICALS**

**6 hours**

1. Preparation of 0.1M sodium phosphate buffer (pH 6 and 7)
2. Measurement of pH using pH meter
3. Paper chromatography of plant pigments (demonstration)
4. Electrophoresis of nucleic acids (demonstration)
5. Column chromatography of plant pigments (demonstration)
6. Determination of the concentration of a given solution of  $\text{CuSO}_4$  using colorimetry

**Additonal Credits: Vitual Lab**

1. Western Blotting
2. Haemocytometer
3. PAGE

**Module 3 Biostatistics**

**8 hours**

- Introduction, statistical terms and symbols
- Sample:- concept of sample, sampling methods,
- Collection and representation of data, graphic representation of data( Line graph, bar diagram, Pie diagram & Histogram)
- Measures of central tendency:- mean, mode, median
- Measures of dispersion:- standard deviation, standard error
- Distribution patterns:- normal distribution, binomial distribution
- t-test :- introduction, uses, procedure
- chi-square test:- introduction, uses, procedure

**PRACTICALS**

**4 hours**

1. Collect numerical data and find out the central tendencies and prepare different types of graph mentioned in the syllabus
2. Familiarize with situations requiring t-test, chi-square test

**Module 4 Research Methodology**

**2 Hour**

- Need for research
- Types of research
- Scientific literature, Books, Research Journals, Reputed National and International journals in life sciences, Research paper
- INSDOC services
- Laboratory Etiquette
- Laboratory Hygiene

**C. General Informatics (Theory 18 hours, Practical 12 hours)**

**Module 1 Overview of the information technology**

**3 hours**

- Features of the modern personal computers and peripherals.
- Internet as a knowledge repository, e-mail, search engines (Google, ), study of educational sites related to life sciences (DNAi, Scitable) , academic search techniques, (Science direct and INFLIBNET)
- Introduction to the use of information technology in teaching and learning.

**Module 2. Use of computers**

**15 hours**

- DOS – The basic concept of operating systems (Study of commands not required)
- MS-WINDOWS:- logging to windows, organizing files and folders, copying, moving, deleting and saving documents, installing software, installing hardware
- MS-WORD:- word processing using WORD, editing tools ( cut , copy, paste, ) formatting tools font, paragraph) use of spell check, inserting tables (draw), inserting graphs and pictures
- MS-EXCEL:- Creating a worksheet, data entry, sorting (ascending and descending), use of statistical tools in EXCEL (SUM, MEAN, MODE, MEDIAN), preparation of graphs (bar diagram, pie chart and line graph)
- MS-POWERPOINT:- Creating a presentation, Inserting tables, charts and pictures into slides, Use of animation tools

**PRACTICALS**

**12 hours**

1. Gather information and pictures on a given topic using the internet. Make a list of the sites visited for the purpose
2. Prepare a project report using MS-WORD based on the information and pictures gathered from the internet.
3. Prepare a worksheet using a set of data collected and find out the SUM, MEAN, MEDIAN and MODE using EXCEL
4. Prepare suitable tables/ charts/graphs based on the data using EXCEL
5. Prepare a powerpoint presentation based on the 1 & 2 exercises

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**Semester VI**

**Course 11 15U6CRBOT11**

**BIOTECHNOLOGY AND BIOINFORMATICS**

**(Theory 54 hours; Practical: 45hours) (Theory Credit 3, Practical Credit1)**

**COURSE OBJECTIVES**

1. Familiarize with the fundamental principles of biotechnology, various developments in biotechnology and potential applications.
2. Make aware that the life forms and activities can be exploited for human advancement.
3. Impart an introductory knowledge about bio informatics to the students.
4. Use of computers to handle biological data base.

**BIOTECHNOLOGY (Theory 36 hours; Practical 32 hours)**

**Module 1**

**20 hours**

1. Introduction – The concept of biotechnology, landmarks in biotechnology.
2. Plant tissue culture – Principles and techniques.  
Cellular totipotency, *in vitro* differentiation –de differentiation and re-differentiation , callus induction, organogenesis and somatic embryogenesis.
3. Tissue culture medium – Basic components in tissue culture medium – Solid and liquid medium – suspension culture. Murashige and Skoog medium – composition and preparation. Aseptic techniques in tissue culture – sterilization – different methods – sterilization of instruments and glass wares, medium, explants; working principle of laminar air flow and autoclave; preparation of explants – surface sterilization. Inoculation, incubation, subculturing.
4. Micropropagation - Different methods – axillary bud proliferation, direct and indirect organogenesis and somatic embryogenesis. Different phases of micropropagation – hardening, transplantation and field evaluation Advantages and disadvantages of micropropagation. Somaclonal variation.
5. Methods and Applications of tissue culture - Shoot tip and meristem culture Synthetic seed production, embryo culture, *In vitro* mutagenesis, Protoplast isolation culture and regeneration – transformation and transgenics, Somatic cell hybridization- cybrids. *In vitro* secondary metabolite production — cell immobilization, bioreactors *In vitro* production of haploids – anther and pollen culture, *In vitro* preservation of germplasm.

**Module 2**

**8 hours**

**Recombinant DNA Technology**

Gene cloning strategies – recombinant DNA construction – cloning vectors – plasmids pBR322, bacteriophage based vectors, Ti plasmids. Restriction endonucleases and ligases – Ligation techniques, transformation and selection of transformants – using antibiotic resistances markers, southern blotting; PCR.

Different methods of gene transfer – chemically stimulated DNA uptake by protoplast, transduction, electroporation, microinjection, microprojectiles, *Agrobacterium* mediated gene transfer gene library, gene banks.

**Module 3**

**6 hours**

Important achievements in Biotechnology:

Production of human insulin, Bt Brinjal and Bt cotton, Golden rice, Flavr Savr tomato, Shikonin pigments

Current trends in Biotechnology:

Tissue Engineering, Stem cell culture, Nanobiotechnology

Strategic Applications of Biotechnology:

Production of disease/ stress resistant plants, Gene therapy, DNA fingerprinting

**Module 4**

**2 hours**

Social and ethical issues, biosafety, biowar, patenting and IPR issues.

**PRACTICALS (32 hours)**

1. Preparation of nutrient medium – Murashige and Skoog medium, sterilization, preparation of explants, inoculation.
2. Extraction of DNA from plant tissue.
3. Immobilization of whole cells or tissues in sodium alginate.
4. Determination of appropriate flower bud containing uninucleate pollen for anther culture using cytological techniques
5. Study of genetic engineering tools and techniques using photographs/diagram (Southern blotting, DNA finger printing, PCR)
6. Visit a well-equipped biotechnology lab and submit a report along with the practical record.

**Additional Credits: Virtual Lab Experiments**

1. PCR
2. Transformation of host cells
3. 16s RNA Sequencing

**BIOINFORMATICS (Theory: 18 hours; Practical: 10 hours)**

**Module 1**

**7 hours**

1. Introduction to Bioinformatics, scope and relevance, genome, transcriptome, proteome.
2. Biological data bases –

Nucleotide sequence database – EMBL, Gen Bank, DDBJ.

Protein sequence database – PDB, SWISS PROT

Organismal database – *Saccharomyces* genome database

Biodiversity database – Species 2000

3. Information retrieval from Biological database, sequence alignment types and tools: pair wise sequence alignment multiple sequence alignment, use of BLAST, FASTA.

**Module 2**

**6 hours**

1. Genomics: DNA sequencing Sangers procedure-automation of DNA sequencing, genome sequence assembly, Genome projects – Major findings of the following genome projects – Human, *Arabidopsis thaliana*, Rice, *Haemophilus influenza*, Application of genome projects.

2. Proteomics : Protein sequencing- Edman degradation method, automation of sequencing, protein structure prediction and modelling (Brief account only)

**Module 3**

**5 hours**

A brief account on

1. Molecular phylogeny and phylogenetic trees.
2. Molecular visualization – use of Rasmol.
3. Molecular docking and computer aided drug design.

**PRACTICALS (13 hours)**

1. Familiarizing with the different data bank mentioned in the syllabus.
2. Molecular visualization using Rasmol.
3. Blast search.

**Additional Credits: Virtual Lab Experiments**

1. Retrieving sequence data from Entrez
2. Pair wise alignment of data using FASTA
3. Visualizing secondary structure of a protein
4. Designing a primer

**Suggested additional topics**

Tissue culture and crop improvement, Genetic transformation and transgenics, Advances in crop biotechnology molecular markers-molecular biology tools in plant breeding, Gene and genome library, Terminator technology, Advances in microbial biotechnology, enzyme technology, Advances in animal biotechnology-stem cell research. Micro array Bioinformatics.

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**Semester VI**

**Course 112 15U6CRBOT12**

**HORTICULTURE, NURSERY MANAGEMENT, EMBRYOLOGY AND REPRODUCTIVE BIOLOGY**

**(Theory 54 hours; Practical: 45hours) (Theory Credit 3, Practical Credit 1)**

**COURSE OBJECTIVES**

1. To understand the basics of Horticulture and Nursery Management
2. To make students interested in Agriculture
3. To understand the importance of horticulture in human welfare
4. To understand the life cycle pattern of Angiosperms
5. To understand the morphology and development of reproductive parts in flowering plants.
6. To get an insight in to the fruit and seed development.

**HORTICULTURE (Theory 14 hours; Practical 18 hours)**

**Module 1**

**2 hours**

Introduction to horticulture - definition, history, classification of horticultural plants, disciplines of horticulture; Garden tools and implements. Irrigation methods- surface, sub, drip and spray irrigations, mist chambers - advantages and disadvantages

**Module 2**

**6 hours**

Propagation of horticultural plants- by seeds- Seed viability, seed dormancy, seed testing and certification, seed bed preparation, seedling transplanting, hardening of seedling; advantages and disadvantages of seed propagation. Vegetative propagation- organs used in propagation- natural and artificial vegetative propagation; methods- cutting, layering, grafting and budding; advantages and disadvantages of vegetative propagation.

**Module 3**

**6 hours**

Gardening- ornamental gardens, indoor gardens, home gardens- terrestrial and aquatic gardens- garden adornments; garden designing- garden components- lawns, preparation of lawns by seeds, seedling, turfing. Shrubs and trees, borders, hedges, edges, walks, drives- famous gardens of India; Landscape architecture- home landscape design, parks. Physical control of plant growth- training and pruning; repotting; disease and pest control selection of plant for bonsai, bonsai containers and method of bonsai formation

**PRACTICALS**

**Horticulture**

**18 hours**

1. Tongue grafting, budding ('T' and patch), air layering
2. Identification of different garden tools and their uses

3. List out the garden components in the photograph of the garden given
4. Preparation of potting mixture in the given proportion.



**REPRODUCTIVE BOTANY (Theory 20 hrs; Practical 12 hrs)**

**Module 1 Introduction 2 hours**

General account and interdisciplinary relevance of embryology, embryology in relation to taxonomy; experimental embryology.

**Module 2 4 hours**

Structure and development of anther, microsporogenesis, development of male gametophyte, anthesis and anther dehiscence, structure of pollen, pollen germination, pollen tube growth and pollen viability.

**Module 3 4 hours**

Structure and development of ovule, megasporogenesis, embryosacs-monosporic (polygonum type), bisporic (*Allium* type) and tetrasporic (*Peperomia* type). Structure of mature embryo sac.

**Module 4 4 hours**

Breeding/Reproductive systems and pollination syndromes (with examples for each syndrome) in angiosperms; pollen stigma interaction; self-compatibility and incompatibility; syngamy and fusion; apomixis.

**Module 5 3 hours**

Development of endosperm and embryo in Dicots and Monocots; Poly-embryony; Development and general structure of fruits (dry and fleshy) and seed.

**Module 6 3 hours**

Any Indian example from a reputed journal to study the pollination mechanisms and methods (eg. *Adathoda vasica*, *Strobilanthes kunthianus*)

**PRACTICALS 12 hours**

1. Identification of C.S. of anther, embryo sac and embryo.
2. Identification of various anther types-monothealous, dithealous
3. Identification of placentation types.
4. Observation of pollen and locating pollen pore
5. Pollen germination study

**NURSERY MANAGEMENT (Theory 20 hours; Practical 15 hrs)**

**Introduction**

**4 hours**

Preparation of potting mixtures, polybags. Plant Growth structures – green houses, shaded houses, polyshed, mist chamber, sprinkling system, drip irrigation. Modern strategies in propagation by root initiation of cutting, layering technique, budding and grafting technique – Micropropagation; Planting, Transplanting and Hardening of seedlings, After care of seedlings. Packing and transporting of seedlings.

**Organic farming and Composting Techniques**

**6 hours**

Organic manures and fertilizers, Composition of fertilizers. NPK content of various fertilizers and preparation of fertilizer mixtures. Common organic manures – bone meal, cow dung, poultry waste, oil cakes, organic mixtures and compost. Preparation of compost – aerobic and anaerobic- advantages and limitations. Vermicompost – preparation - Vermiwash. – preparation. Biofertilizers – Definition and preparation of different types – Trichoderma, Rhizobium, PGPR, PSB, mycorrhiza. Application of Biofertilizers. Biopesticides – Tobacco and Neem decoction. Biological control of disease and pests. Organic traps – Natural dyes.

**Cultivation of Vegetables, Fruits and Medicinal Plants**

**3 hours**

Types–Home gardening, Market gardening and Truck gardening. Packing and Transporting of Vegetables.

Organic farming of fruit crops – Packing and Transporting of fruits.

Induction of flowering and weed control.

Cultivation of Medicinal and Aromatic plants of common use and great demand.

Traditional production techniques and Post-harvest techniques

**Floriculture and Flower arrangement**

**4 hours**

Problems and prospects of Floriculture in Kerala.

Scope of growing Anthurium, Orchids and Jasmine in Kerala.

Common cut flowers – Rose, Gerbera, Gladiolus, Aster, *Chrysanthemum*, Daisys, Carnation, Golden rod, Anthurium, Orchids, Liliium and Limolium.

Common leaves used in flower arrangement – *Cyprus*, *Podocarpus*, *Asparagus*, Palms, Cycads, Ferns and *Eucalyptus*.

Floral arrangement: Types - Western, Eastern (Japanese/ Ikebana) and Modern.

Wases, Flower Holders and Floral Foam.

Wase life of flowers and leaves.

After care of flower arrangements – Bouquets.

Packing and Maintenance of flowers and leaves.

**Self-Employment Opportunities****3 hours**

Funding Agencies and self-employment schemes, Procedure to get financial support, special scheme for women empowerment.

**PRACTICAL****15 hrs**

1. Preparation of potting mixture
2. Preparation of Tobacco/ Neem decoction
3. Familiarization of common fertilizers and manures
4. Familiarization of common cut flowers and leaves used in flower arrangements
5. Different flower arrangement types (demonstration)

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**Websites**

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**Semester VI**

**Core Course Choice Based 15U6CRBOT13  
PHYTOCHEMISTRY AND PHARMACOGNOSY  
(54 Hours) Theory Credits 3**

**Course objectives**

1. Understand the structure and function of basic secondary metabolites in medicinal and aromatic plants.
2. Familiarize with the common separation and characterization techniques used in phytochemistry
3. Understand the basic officinal part present in the common medical plants and their use in ayurvedic formulations

**Module 1 Introduction**

**2 hours**

Introduction to phytochemical approaches –morphological-organoleptic-microscopic- to study drug and aromatic plants

**Module 2 Extraction and characterisation techniques**

**4 hours**

Cold extraction- hot extraction—soxhlet-clevenger apparatus; Solvents - petroleum ether, chloroform, ethanol, water. Separation technique-TLC, Column, HPLC. Characterization technique-GC/MS, HPTLC, UV Spectra, IR Spectra.

**Module 3 Study of the drug plants and their active principles**

**10 hours**

- A. Alkaloids – introduction, properties, occurrence, structure, classification, functions, and pharmacological uses.
- B. Triterpenoids. Introduction, properties, occurrence, classification, functions and pharmacological uses.
- C. Phenolics. Quinines- benzoquinones, naphthoquinones, anthraquinone, and coumarins.

**Module 4 Study of the following plants with special reference to**

**20 hours**

- (1) Habit, habitat and systematic position and morphology of the useful part.
- (2) Organoleptic, anatomical and chemical evaluation of the officinal part.
- (3) Phytochemistry and major pharmacological action of plant drugs.
- (4) Ayurvedic formulations using the plant,

*Tinospora cordifolia, Papaver somniferum, Aegle marmelos, Punica granatum, Plumbago rosea, Adhatoda vasica, Withania somnifera, Achyranthes aspera, Asparagus racemosus, Kaempheria galanga, Sida acuta, Carica papaya, Azadirachta indica, Glycyrrhiza glabra, Phyllanthus neruri, Datura stramonium, Hemidesmus indicus, Aloe veera, Tylophora indica, Acorus calamus.*

**Module 5 Study of the following aromatic plants - volatile oils and methods of extraction 10 hrs**  
*Vetiveria zizanioides, Cinnamomum zeylanica, Syzygium aromaticum, Santalum album, Eucalyptus, Ocimum bacilicum, Rosa, Mentha piperita, Cymopogon, Cananga, Pelargonium.*

**Module 6 Pharmacognosy**

**4 hours**

Introduction, tools for identifying adulteration; methods in pharmacognosy- microscopy, phytochemical methods- study of starch grains of maize, wheat, rice, potato, curcuma

**Ethnomedicine**

**4 hours**

Traditonal plant medicines as a source of new drugs – The process of modern drug discovery using ethnopharmacology – Taxol, Artemisinin, Galathamine and Flavopyridole as examples of drug discovery based on ethanopharmacological approach.

**Suggested additional topics**

1. Basic principles in spectroscopy - UV, NMR, IR etc
2. Use of secondary metabolites for protection against pathogens, herbivores

**Additional Credits: Virtual Lab Experiments**

1. Estimation of saponification value of fats/ oils
2. Estimation of Iodine value of fats and oils
3. Extraction of caffeine from Tea

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## **04. PATTERN OF QUESTIONS**

Questions shall be set to assess knowledge acquired, standard application of knowledge, application of knowledge in new situations, critical evaluation of knowledge and the ability to synthesize knowledge. The question setter shall ensure that questions covering all skills are set. He/ She shall also submit a detailed scheme of evaluation along with the question paper.

A question paper shall be a judicious mix of objective type, short answer type, short essay type/ problem solving type and long essay type questions.

### **Pattern of questions for external examination for theory paper with practical**

|              | Total no. of questions | Number of questions to be answered | Marks of each question | Total marks |
|--------------|------------------------|------------------------------------|------------------------|-------------|
|              | 8                      | 8                                  | 1                      | 8           |
|              | 10                     | 6                                  | 2                      | 12          |
|              | 6                      | 4                                  | 4                      | 16          |
|              | 4                      | 2                                  | 12                     | 24          |
| <b>TOTAL</b> | <b>28</b>              | <b>22</b>                          | x                      | <b>60</b>   |

### **Pattern of questions for external examination for theory paper without practical**

|              | Total no. of questions | Number of questions to be answered | Marks of each question | Total marks |
|--------------|------------------------|------------------------------------|------------------------|-------------|
|              | 10                     | 10                                 | 1                      | 10          |
|              | 10                     | 8                                  | 2                      | 16          |
|              | 7                      | 5                                  | 5                      | 25          |
|              | 3                      | 2                                  | 12                     | 24          |
| <b>TOTAL</b> | <b>30</b>              | <b>25</b>                          | x                      | <b>75</b>   |

## **05. MODEL QUESTION PAPERS**

Semester I Course I 15U1CRBOT01

### **MICROBIOLOGY AND PHYCOLOGY**

Time 3 hours

Maximum 60 Marks

#### Part A

I. Answer ALL questions; each question carries ONE mark. 8 x 1 = 8 marks

1. Who is Father of Indian Algology?
2. What is Pamella stage?
3. What is coenobium?
4. Give an example for RNA virus
5. What is single cell protein?
5. What is nucule?
7. Name a toxic alga
8. Name a commercial product from algae

#### Part B

II. Answer ANY SIX questions; each question carries TWO marks. 6 x 2 = 12 marks

9. What are the general characteristics of bacteria?
10. Write a short note on root nodules
11. What is cap cell?
12. Write notes on bacterial flagella
13. Explain binary fission in bacteria
14. What is bioremediation?
15. What are mycoplasma?
16. Explain the thallus structure of Vaucheria
17. What are the economic importance of diatoms?
18. Explain the role of algae in soil fertility

#### Part C

III. Answer ANY FOUR questions; each question carries FOUR marks. 4 x 4 = 16 marks

19. With suitable diagram, explain cell wall structure in bacteria
20. Comment on algae as primary producers.
21. What are conceptacle and receptacle?
22. Explain sexual reproduction in Oedogonium
23. Explain briefly various mechanisms for movement in algae.
24. Enumerate the scope of microbiology

#### Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks. 12 x 2 = 24 marks



25. Explain the morphology of TMV. Add a note on virus replication.

**OR**

26. With suitable diagrams, explain genetic recombination in bacteria.

27. With the help of a schematic sketch describe the alternation of generations in the life cycle of Polysiphonia.

**OR**

28. Write an essay on thallus organization in algae with suitable examples.

Semester II Course 2 15U2CRBOT02  
**MYCOLOGY, LICHENOLOGY AND PLANT PATHOLOGY**

Time 3 hours

Maximum 60 Marks

Part A

I. Answer ALL questions; each question carries ONE mark.

8 x 1 = 8 marks

1. Name the cell wall material of fungi
2. What is the characteristic fruiting body of ascomycetes?
3. What are basidia?
4. Why deutromycetes are called so?
5. What are the important characters of myxomycotina?
5. Name the causative organism of Bunchy top disease of banana
7. What is aspergillosis?
8. Name any two economically important lichen

Part B

II. Answer ANY SIX questions; each question carries TWO marks.

6 x 2 = 12 marks

9. Describe the fruiting body of Xylaria
10. Draw a labeled sketch of peziza fruiting body
11. What are the salient features of ascomycotina
12. Describe the fruiting body of agaricus
13. What is a macro cyclic fungus?
14. Name two harmful fungi
15. What is mycorrhiza?
16. Write down the steps for the spawn production of mushrooms
17. What is prophylaxis?
18. What is biological control?

Part C

III. Answer ANY FOUR questions; each question carries FOUR marks.

4 x 4 = 16 marks

19. Explain the role of fungi in biotechnology
20. With help of suitable sketches, explain the life cycle of saccharomyces cereviseae
21. Explain the asexual reproduction in pencillium
22. Explain the crozier formation in peziza
23. Explain the methods of reproduction in parmelia
24. Explain the preparation of Bordeaux mixture.

Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks. 12 x 2 = 24 marks

25. Explain the life cycle of puccinia with suitable illustrations

**OR**

26. With suitable diagrams, illustrate the life cycle of agaricus

27. Describe the agricultural importance of fungi

**OR**

28. Briefly explain the symptoms, causative organism, disease cycle and control measure of abnormal leaf fall of rubber

**BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS AND PALEOBOTANY**

Time 3 hours

Maximum 60 Marks

Part A

I. Answer ALL questions; each question carries ONE mark. 8 x 1 = 8 marks

1. Name an aquatic Bryophyte?
2. Name a Bryophyte with branched photosynthetic filament ?
3. Name a Bryophyte with pseudoelater ?
4. Name a pteridophyte with Elater ?
5. Name a pteridophyte with eustele ?
5. Name a Gymnosperm with winged seed ?
7. Name a Gymnosperm with circinate ptyxis ?
8. Name the pale botanical centre in India ?

Part B

II. Answer ANY SIX questions; each question carries TWO marks. 6 x 2 = 12 marks

9. Describe the Photosynthetic region of Marchantia ?
10. Draw a labeled sketch of Pegged & Smooth rhizoids ?
11. What are the salient features of Bryophytes ?
12. Describe the strobilus of Selaginella ?
13. What is a Sporocarp, Give an example ?
14. What is Eusporangiate & Leptosporangiate condition ?
15. What is Endoscopic & Exoscopic Embryo development ?
16. What is Palisade tissue, what is its function ?
17. What are the different types of Fossil formations ?
18. What is Bars of sanio ?

Part C

III. Answer ANY FOUR questions; each question carries FOUR marks. 4 x 4 = 16 marks

19. Explain the Sporophyte of Riccia ?
20. With help of suitable sketches, explain the life cycle of Anthoceros ?
21. Explain the stem anatomy of Marsilea rhizome ?
22. Explain the xerophytic adaptations of equisetum stem ?
23. Explain the xerophytic adaptations of Pinus needle ?
24. What are the Angiosperm characters of Gnetum ?

Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks. 12 x 2 = 24 marks

25. What are the economic importance of Bryophytes ?

**OR**

26. With suitable diagrams, illustrate the life cycle of Pogonatum ?

27. Describe the the Stelar structure in Pteridophytes ?

**OR**

28. Write an essay on the anatomy of Gnetum stem with diagrams ?

Semester II Course 4 15U4CRBOT04  
**ANATOMY AND MORPHOLOGY OF ANGIOSPERMS**

Time 3 hours

Maximum 60 Marks

Part A

I. Answer ALL questions; each question carries ONE mark.

8 x 1 = 8 marks

1. What is Casparian Thichkening?
2. What is Plasmodesmata?
3. What is included phloem?
4. What is Duramen?
5. What are Bulliform cells?
6. What is a carpel
7. What is a regma?
8. What is pinnately compound leaf ?

Part B

II. Answer ANY SIX questions; each question carries TWO marks.

6 x 2 = 12 marks

9. Distinguish between Sapwood and Heartwood
10. Distinguish between Diffuse porous wood and Ring porous wood ?
11. Explain apical cell theory
12. Write brief notes on Laticifers
13. Distinguish between storied and non-storied cambium?
14. Draw alabelled diagram of a Bordered pit ?
15. What are the major anatomical differences between dicot and monocot leaf?
16. What is Apposition and Intssuception ?
17. What is Periderm ?
18. What is a cymose inflorescence

Part C

III. Answer ANY FOUR questions; each question carries FOURmarks.

4 x 4 = 16 marks

19. What are the importance of fibres?
20. With the help of labelled diagram explain the tissue system in Dicot stem
21. What are the different types of cell wall thickening of tracheid?
22. Explain schizogenous and lysigenous developments
23. Distinguish between monochasial cyme and Dichasial cyme ?
24. Write a brief note on different dry dehiscent fruits .

Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks. 12 x 2 = 24 marks

25. With the help of suitable labelled diagrams, describe the anomalous secondary structures in Bignonia and Bougainvillia

**OR**

26. With the help of suitable diagrams explain secondary growth in Dicot root

27. Write an essay on different cell types in Xylem and Phloem

**OR**

28. Give an account of microscopic and sub microscopic growth of cell wall

Semester VI Course 05 **15U5CRBOT05**  
**FLORAL MORPHOLOGY AND ANGIOSPERM SYSTEMATICS**

Time 3 hours

Maximum 60 Marks

Part A

I. Answer ALL questions; each question carries ONE mark.

8 x 1 = 8 marks

1. What is obdiplostemonous condition?
2. What is syngenesious anthers?
3. What is a pollinium?
4. What is corolline corona?
5. Write the binomial of any two medicinal plants of the family Rubiaceae
5. Define polyadelphous condition
7. Write common name and binomial of any pulse plant
8. What is the characteristic feature of stigma of Apocynaceae family

Part B

II. Answer ANY SIX questions; each question carries TWO marks.

6 x 2 = 12 marks

9. Differentiate between interpetiolar and intrapetiolar stipule
10. What is a perigynous flower?
11. Draw floral diagram of vexillary aestivation
12. What is a dichasial cyme
13. With the help of a diagram explain ray floret
14. Explain cyathium
15. Describe the gynostegium in Orchidaceae
16. Describe the essential whorls of Poaceae family
17. Give the binomial of 2 economically important plants of Arecaceae
18. Write a short note on the economic importance of the family Asteraceae

Part C

III. Answer ANY FOUR questions; each question carries FOUR marks.

4 x 4 = 16 marks

19. Write economic importance of the family Verbenaceae and Lamiaceae
20. Write binomial, useful part and uses of 2 economically important plants each from the -families Apiaceae, Myrtaceae, Lamiaceae and Rutaceae
21. Describe the floral features of Solanaceae
22. Differentiate between Scrophulariaceae and Acanthaceae
23. Describe the flower of Sapotaceae
24. Differentiate between Verbenaceae and Lamiaceae



Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks. 12 x 2 = 24 marks

25. Write an essay on the family cucurbitaceae

**OR**

26. With the help of suitable diagrams explain the characteristic features of the family Euphorbiaceae

27. Compare the floral characters of the families Fabaceae, Caesalpiniaceae and Mimosaceae

**OR**

28. Compare and contrast Apocynaceae and Asclepiadaceae families

Semester V Course 6 **15U5CRBOT06**  
**ENVIRONMENTAL SCIENCE AND ECOTOURISM**

Time 3 hours

Maximum 60 Marks

Part A

I. Answer ALL questions; each question carries ONE mark. 8 x 1 = 8 marks

Write short notes on the following

1. Key stone species
2. Energy plantations
3. Renewable energy sources
4. Food security problem
5. Itai Itai disease
6. Land degradation
7. Noise pollution
8. Eutrophication

Part B

II. Answer ANY SIX questions; each question carries TWO marks. 6 x 2 = 12 marks

9. Give an account on ecological pyramids.
10. What is the importance of Forest (conservation) Act, 1980
11. What is meant by blue baby syndrome?
12. Explain briefly on Bhopal tragedy.
13. What is meant by environmental Impact assessment?
14. What are the famous ecotourism centres in Kerala?
15. Write a note on BNHS
16. What is the contribution of Salim Ali in the field of ecology?
17. What are the components of ecotourism?
18. Briefly give an account of mangrove ecosystems.

Part C

III. Answer ANY FOUR questions; each question carries FOUR marks. 4 x 4 = 16 marks

19. Write a note on the environmental laws in India.
20. Explain the sources of sound pollution and its control
21. What are the problems due to climate change?
22. What are the forms and types of ecotourism in India?
23. Briefly explain the biogeochemical cycles of Carbon and Nitrogen.
24. Write a note on the positive and negative impacts of ecotourism

Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks. 12 x 2 = 24 marks

25. Write an essay on ecological succession. Distinguish between ecotone and edge effect

**OR**

26. Give a detailed account of environmental pollution and its management.

27. Describe the components of ecotourism and explain different types of ecotourism

**OR**

28. What are the reasons for biodiversity loss? Explain the different types of conservation of biodiversity

Semester V Course 7 **15U5CRBOT07**  
**GENETICS AND PLANT BREEDING**

Time 3 hours

Maximum 60 Marks

Part A

I. Answer ALL questions; each question carries ONE mark.

1. Define genetics
2. What is meant by an 'allele'?
3. What is dominance?
4. What is a test cross?
5. How do you differentiate phenotype and genotype?
6. What is back cross?
7. Define reciprocal cross
8. Name a Y- linked gene.

Part B

II. Answer ANY SIX questions; each question carries TWO marks.

9. Briefly describe complementary gene interaction.
10. Distinguish between epistasis and dominance
11. What is meant by interference?
12. What is coincidence?
13. Describe briefly Turner's syndrome
14. Distinguish between Klinefelter's syndrome and Down's syndrome
15. Describe haemophilia in man
16. Write notes on cytoplasmic inheritance
17. What do mean by Hardy-Weinberg law?
18. What are quarantine regulations?

Part C

III. Answer ANY FOUR questions; each question carries FOUR marks.

19. What is recessive epistasis? Explain with suitable example.
20. Distinguish between Inter-genic interaction and Intra-genic interaction
21. Describe XX-X0 method of sex determination.
22. What is reversion or Atavism?
23. Examine the role of linkage in Mendel's experiments
24. What is sex linked inheritance? Explain with an example.

Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks.

25. With suitable example, explain multiple allelism.

**OR**

26. Explain chromosome theory of heredity.

27. Write an essay on genetic engineering and products of genetically modified crops

**OR**

28. Explain the procedures for plant introduction in the Indian context.

Semester V Course 8 **15U5CRBOT08**  
**CELL, MOLECULAR BIOLOGY AND EVOLUTION**

Time 3 hours

Maximum 60 Marks

Part A

I. Answer ALL questions; each question carries ONE mark.

8 x 1 = 8 marks

1. What is the function of lysosome?
2. What is meant by endomitosis?
3. What is meant by chromosomal bridge?
4. What is fluid mosaic model of cell membrane?
5. What is genetic drift?
6. Name any two properties of genetic code
7. Write down the central dogma in Molecular Genetics
8. Define speciation.

Part B

II. Answer ANY SIX questions; each question carries TWO marks

6 x 2 = 12 marks

9. Draw a labeled diagram of mitochondria
10. Write note on ribosomes.
11. Distinguish between karyotype and Idiogram
12. Briefly explain on B chromosome
13. What is meant by cell cycle?
14. What are the differences between DNA and RNA?
15. Describe the structure of tRNA
16. What is a gene?
17. What are oncogenes?
18. Explain Lamarck's theory of evolution.

Part C

III. Answer ANY FOUR questions; each question carries FOUR marks.

4 x 4 = 16 marks

19. Explain different types of chromosomal aberrations.
20. What is the significance of mitosis?
21. What are the types of mutations and their importance?
22. Write note on Polyploidy.
23. Explain RNA processing
24. Explain biochemical origin of life.

Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks. 12 x 2 = 24 marks

25. Explain the sources and applications of stem cells

**OR**

26. Describe the various phases of first meiotic division with diagrams

27. Explain the operon model of gene expression

**OR**

28. Write an essay on the structure of DNA. Add a note on different types.

Semester V Open Course 01 15U5OCBOT1  
**AGRIBASED MICROENTERPRISES**

Time 3 hours

Maximum 75 Marks

Part A

I. Answer ALL questions; each question carries ONE mark.

10 x 1 = 10 marks

1. Give any two commonly used organic manures
2. What is spawn?
3. What is topiary?
4. What is turfing?
5. Name a biopesticide
5. What do you mean by explants?
7. Name any two common leaves used in flower arrangement
8. Give one growth regulator for rooting
9. What is the merit of drip irrigation?
10. What is arboriculture?

Part B

II. Answer ANY EIGHT questions; each question carries TWO marks.

8 x 2 = 16 marks

11. Differentiate between edges and hedges
12. What is vermiwash?
13. What is surface irrigation?
14. Write a note on value added products from mushroom
15. List different types of mushrooms
16. What is grafting?
17. Explain advantages of green house
18. What is pruning?
19. Comment on Trichoderma
20. What is PGPR?

Part C

III. Answer ANY FIVE questions; each question carries FIVE marks. 5 x 5 = 25 marks

21. How will you prepare tobacco decoction?
22. What are the steps involved in a lawn preparation?
23. How do you make bonsai?
24. List the steps in plant tissue culture
25. How will you prepare a kitchen garden in your home?
26. Explain various flower arrangement types.
27. Explain various artificial methods of vegetative propagation



Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks. 12 x 2 = 24 marks

28. Write an essay on organic manures. What are the advantages of organic manures?  
Add a note on the preparation of vermi-compost at your home.
29. Explain various components of an ornamental garden.
30. Explain the cultivation of oyster mushroom using paddy straw.

Semester VI Course 9 15U6CRBOT09  
PLANT PHYSIOLOGY AND BIOCHEMISTRY

Time 3 hours

Maximum 60 Marks

Part A

I. Answer ALL questions; each question carries ONE mark.

8 x 1 = 8 marks

1. What is Guttation?
2. Define water potential
3. Name the end products of alcoholic fermentation.
4. Name a pentose sugar.
5. Name the polysaccharide found commonly in the wood of conifers.
6. An example of a simple protein enzyme
7. Name the first stable product of C<sub>4</sub> cycle
8. What is phloem loading?

Part B

II. Answer ANY SIX questions; each question carries TWO marks.

6 x 2 = 12 marks

9. What is cellobiose?
10. Explain the structure of chlorophyll
11. Explain vernalization
12. What is RUBISCO?
13. Write the importance of transpiration in plants.
14. What is pH? What is the significance of buffers?
15. What are anti-transpirants?
16. Explain red drop phenomenon
17. What are the factors affecting photosynthesis?
18. What is glycolysis?

Part C

III. Answer ANY FOUR questions; each question carries FOUR marks.

4 x 4 = 16 marks

19. Explain the pressure flow hypothesis by Munch.
20. What are the significance of carbohydrates?
21. Draw the schematic representation of photorespiration.
22. Describe the cyclic electron transport in chloroplast.
23. What are the major characteristics of enzymes?
24. What are cytokinins?

Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks. 12 x 2 = 24 marks

25. Explain the path of carbon assimilation in Calvin cycle.

**OR**

26. Explain the role of plant hormones in growth and development

27. Explain the mechanism of enzyme action

**OR**

28. Make a comparison of C<sub>3</sub>, C<sub>4</sub> and CAM plants.

Semester V Course 10 **15U6CRBOT10**  
**METHODOLOGY, PERSPECTIVES OF SCIENCE AND GENERAL INFORMATICS**

Time 3 hours

Maximum 60 Marks

Part A

I. Answer ALL questions; each question carries ONE mark.

8 x 1 = 8 marks

1. Define hypothesis
2. What is a variable?
3. What is a null hypothesis?
4. What is the need of a control?
5. Expand DOS
5. Name a substance used for staining chromosomes
7. What is PAGE?
8. What is SD?

Part B

II. Answer ANY SIX questions; each question carries TWO marks.

6 x 2 = 12 marks

9. What is plagiarism?
10. What is mean?
11. What are vital stains? Give one example.
12. Differentiate between smear and squash
13. What is the use of EXCEL?
14. List the editing tools used in MS-WORD
15. What is the significance of buffer in Biology?
16. What is the principle of Chromatography?
17. Explain Beer-Lambert's law
18. What is the use of INFLIBNET?

Part C

III. Answer ANY FOUR questions; each question carries FOUR marks.

4 x 4 = 16 marks

19. What are the components of a good experiment?
20. With suitable examples, explain research engines
21. What are the applications of powerpoint?
22. What is the difference between standard deviation and standard error?
23. Comment on different mounting media
24. What is a microtome? List the application of various microtomes.

Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks. 12 x 2 = 24 marks

25. Explain various steps involved in preparing a project report and presenting it using computer

**OR**

26. Compare and contrast the principle and applications of Compound Light Microscope and Electron Microscope

27. Write an essay on presentation of data

**OR**

28. Write an essay on separation techniques in biological science.

Semester VI Course11 **15U6CRBOT11**  
**BIOTECHNOLOGY AND BIOINFORMATICS**

Time 3 hours

Maximum 60 Marks

Part A

I. Answer ALL questions; each question carries ONE mark. 8 x 1 = 8 marks

1. Name a popular tissue culture medium
2. Name a transgenic plant
3. Name a surface sterilant
4. What is Rasmol?
5. Name a tissue culture technique used for producing haploid plants
6. Name a tissue culture technique to produce virus free plants
7. Name an Auxin.
8. What is EMBL?

Part B

II. Answer ANY SIX questions; each question carries TWO marks. 6 x 2 = 12 marks

9. Name the enzyme used for joining DNA fragments
10. What is the enzyme used for degrading cellulose in cell wall during protoplast isolation
11. What is an autoclave?
12. What is Flavr Savr
13. Define micropropagation.
14. What is the pH of M S medium/
15. What is the respiratory substrate added in tissue culture medium
16. What is FASTA?
17. Explain molecular docking?
18. What is DDBJ?

Part C

III. Answer ANY FOUR questions; each question carries FOUR marks. 4 x 4 = 16 marks

19. What is PCR? Name the heat resistant polymerase enzyme used in PCR
20. What are databases? Give an account of different databases you have studied.
21. Name the various cloning vectors and explain how a plasmid can be used for genetic engineering experiments.
22. What is the use of laminar air flow bench in tissue culture? Comment on its working principle?
23. What are the potential uses of artificial seeds?
24. Write a note on pBR322.

Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks. 12 x 2 = 24 marks

25. Explain Sangers dideoxy method of DNA sequencing? Write a note on autosequencing

**OR**

26. Explain Edman's degradation method for protein sequencing.

27. Write a comprehensive account of application of tissue culture.

**OR**

28. Explain different methods of gene transfer.

Semester VI Course12 **15U6CRBOT12**  
**HORTICULTURE, NURSERY MANAGEMENT, EMBRYOLOGY AND REPRODUCTIVE BOTANY**

Time 3 hours

Maximum 60 Marks

Part A

I. Answer ALL questions; each question carries ONE mark.

8 x 1 = 8 marks

1. What is Parthanocarpy?
2. What is double fertilization?
3. What is tapetum?
4. What is topiary?
5. Give any two advantages of vegetative propagation?
6. What are hedges?
7. Comment on Trichoderma
8. List any two common biofertilizers

Part B

II. Answer ANY SIX questions; each question carries TWO marks.

6 x 2 = 12 marks

9. Differentiate monocot and dicot embryo
10. Define self incompatibility
11. What is anemochory? Write any two advantages of anemochorous seeds?
12. Define anthesis and anther dehiscence
13. Define micropropagation.
14. Differentiate between walks and paths
15. What is turfing?
16. Give the names of any two garden implements and their uses
17. How will you prepare vermiwash?
18. Explain the scope of floriculture in Kerala

Part C

III. Answer ANY FOUR questions; each question carries FOUR marks.

4 x 4 = 16 marks

19. Microsporogenesis
20. Illustrate the structure of mature embryosac
21. Briefly explain the modern strategies in plant propagation
22. What are the advantages of organic farming?
23. Why repotting is essential in bonsai formation?
24. Compare drip irrigation with mist chambers



Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks. 12 x 2 = 24 marks

25. Explain different pollination syndromes with examples for each syndrome

**OR**

26. Write an essay on the structure and development of ovule in Angiosperms

27. Write an essay on artificial vegetative propagation methods with suitable illustrations

**OR**

28. Design an ornamental garden of your choice giving suitable examples of plants and other garden components.

Semester VI Course 13 **15U6CRBOT13**  
**PHYTOCHEMISTRY AND PHARMACOGNOSY**

Time 3 hours

Maximum 60 Marks

Part A

I. Answer ALL questions; each question carries ONE mark.

8 x 1 = 8 marks

1. What are alkaloids?
2. What is Pharmacognosy?
3. What is meant by organoleptic identification?
4. What are volatile oils?
5. What is the characteristic feature of the starch of potato?
6. Why methanol is called a super solvent?
7. Name the ayurvedic formulation in which *Adhathoda vasika* is used
8. What is the ayurvedic use of *Acorus calamus*?

Part B

II. Answer ANY SIX questions; each question carries TWO marks.

6 x 2 = 12 marks

9. What is the phytochemistry and pharmacological action of *Tinospora caudifolia*?
10. Name four chemical constituents present in the oil of Vetiveria
11. Name the phytochemical constituent and pharmacological action of *Glycyrrhiza glabara*
12. Compare the starch grains of Maize and Wheat
13. Explain hot extraction
14. What is the use of Clevenger apparatus?
15. Give an example for the use of traditional plant medicine as a source of new drug
16. Explain the use of chloroform as solvent
17. What is R<sub>f</sub> value?
18. What is the use of Gas Chromatography?

Part C

III. Answer ANY FOUR questions; each question carries FOUR marks.

4 x 4 = 16 marks

19. Explain how microscopy is useful in pharmacognosy
20. Describe Thin Layer Chromatography
21. What is the principle of IR Spectroscopy?
22. What are phenolics?
23. Name any four alkaloids useful in medicine
24. What are the ayurvedic formulations developed from *Aegle marmelos*?

Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks. 12 x 2 = 24 marks

25. Describe the principle and applications of HPLC

**OR**

26. Describe the properties, occurrence, classification and functions of Triterpenoids.

27. Describe the organoleptic, anatomical, chemical evaluation and pharmacological action of *Phyllanthus niruri* and *Aloe vera*.

**OR**

28. Describe the method of volatile oil extraction from *Eucalyptus sp.* and *Santalum album*.

## **B.Sc. BOTANY PROGRAMME**

### **SEMESTER I COMPLEMENTARY COURSE –I 15U1CPBOT1**

#### **CRYPTOGAMS, GYMNOSPERMS AND PLANT PATHOLOGY**

**(Theory: 36 hrs; Practical: 36 hrs)**

**(Theory credit 2 Practical Credit 1)**

#### **Course objectives**

1. Acquire fundamental knowledge in plant science and to make the student to understand that Botany is an integral part of the human life and developments.
2. Foster and encourage an attitude of curiosity, appreciation and enquiry of various life forms of plants
3. Understand the identifying characters of the different types included in the syllabus
4. Understand the diversity of microbes and plants with respect to Viruses, Bacteria, Algae, Fungi, Lichens, Bryophytes, Pteridophytes and Gymnosperms

#### **Module - 1 Cryptogams**

**28 hours**

1. Viruses : General account, structure of Tobacco Mosaic Viruses (TMV), mode of infection- T phages  
2 hrs
2. Bacteria: Classification, structure, nutrition chemosynthesis, respiration, reproduction (binary fission). Economic importance – agriculture, industry and medicine. Archaeobacteria.  
2 hrs
3. Algae (Phycology) Classification, main features of structure, and life history of the following groups  
Cyanophyceae : *Nostoc*  
Chlorophyceae : *Volvox, Oedogonium, Cladophora*  
Phaeophyceae : *Ectocarpus*  
Rhodophyceae : *Polysiphonia*  
Economic importance of Algae (general account) **8 hrs**
4. Fungi (Mycology) :Classification, main features of structure, and life history of the following groups.  
Phycomycetes : *Phytophthora*  
Ascomycetes : *Peziza*  
Basidiomycetes : *Puccinia*  
Economic importance of Fungi (general account) **7 hrs**
5. Lichens (Lichenology): Classification and general account.  
Type *Usnea* : **2 hrs**
6. Bryophytes (Bryology): General account of Bryophytes  
Type: *Riccia* **3 hrs**
7. Pteridophytes (Pteridology): General account of Pteridophytes  
Type: *Selaginella* **4 Hrs**

**Module-2 Gymnosperms**

General account of Gymnosperms

Type: *Cycas*

**4 hrs**

**Module-3 Plant Pathology**

**4 Hrs**

1. Classification of plant diseases on the basis of causative organism and symptoms
2. Study of the following diseases with name of disease, causative organism, symptoms and control measures:
  - a. Nut fall of Arecanut
  - b. Bacterial blight of Rice
  - c. Leaf mosaic of Tapioca

**PRACTICAL**

**36 Hrs**

Student should be able to

1. Identify Cryptogamic and Gymnosperm specimens and their parts prescribed in the syllabus; make micro-preparations wherever necessary
2. Identify plant diseases mentioned in the syllabus.

**Suggested additional topics**

1. The five kingdom classification – proposed by Whittaker (1969)
2. Advanced anatomical and reproductive characters of *Gnetum*

**References:**

1. Ahamdijan, Vernon and Mason H. E (1973) *The Lichens*. New York: Academic press.
2. Alexopoulos C. J. and Mims C. W. (1983) *Introductory Micology*, New York: Wiley Eastern
3. Bhatia K. N (1975) *A treatise on Algae*. New Delhi. S. Chand and co. Publishing, New Delhi, Vikas publishing House Pvt.Ltd.
4. Bilgrami K. S and Dube H. C (1976). *Text Book of Modern Plant Pathology*. New Delhi. Vikas Publishing House Pvt.Ltd
5. Bishwas S.B and Biswas A. (1973). *An Introduction to Viruses*. New Delhi. Vikas Publishing House Pvt. Ltd.
6. Chaube H. S. and Ramji S. (2000) *Introductory Plant Pathology*, International Book Distributing Co. Lucknow.
7. Chopra R.N and Kumra P. K (1988) *Biology of Bryophytes*. New Delhi, Wiley Eastern Ltd.
8. Fritsch F. B (1945), *Structure and Reproduction of Algae Vol. I & II*. Cambridge University Press.
9. Gangulee H. C and Kar A. K(1993) *College Botany Vol. II Calcutta*, New Central Book Agency.
10. Kanika Sharma (2009), *Manual of Microbiology*, Ane Books Pvt. Ltd.
11. Mamatha Rao(2009) *Microbes and Non- flowering plants, Impact and applications*, Ane Books Pvt.Ltd..
12. Pandey S. N and Trivedi P. S(1994) . *A Textbook of College Botany Vol I*
13. Pandey S. N. and Trivedi P. S(1998). *A text Book of College Botany Vol.II*
14. Pandey B.P (2007), *College Botany Vol. I*, S. Chand and Company
15. Pandey B. P(2007), *College Botany Vol II*, S. Chand and Company
16. Sharma P. D(2003) *Microbiology and Plant Pathology and Biochemistry*, Rasthogy Publications
17. Vasishta B. R. *Bryophyta – S. Chand and Co. New Delhi*

**B.Sc. BOTANY PROGRAMME  
SEMESTER II COMPLEMENTARY COURSE II 15U2CPBOT2  
PLANT PHYSIOLOGY**

**(Theory: 36 hrs; Practical: 36hrs)**

**(Theory credit 2 Practical Credit 1)**

**Course objectives**

Understand the mechanism of various physiological processes related to plant life.

**Module 1**

**10 hrs**

1. Water relations of plants: (a) Physical aspects of water absorption –imbibition, diffusion and osmosis. Plant cell as an osmotic system. Diffusion pressure deficit, water potential, plasmolysis (b) Mechanism of absorption of water. Active and passive absorption. (4 hrs)
2. Transpiration – types, structure and mechanism of stomatal transpiration, (theories) significance and factors affecting transpiration, antitranspirants, Guttation. (4 hrs)
3. Stress Physiology – Water and salt stress, adaptations (2 hrs)

**Module 2**

**14 hrs**

Photosynthesis: Structure of chloroplast, Pigments, Red drop and Emerson's enhancement effect: Two pigments systems, light and dark reaction  $C_3 - C_4$  and CAM mechanisms. Factors affecting Photosynthesis: External and Internal, photo respiration.

**Module 3**

**12 hrs**

1. Translocation of organic solutes: Path and mechanism of Translocation, Munch mass flow hypothesis. (3 hrs)
2. Nitrogen fixation, Nitrogen Cycles. (2 hrs)
3. Dormancy of seeds, factors causing dormancy, photoblastisms, techniques to break dormancy, germination – mobilization of food reserves, physiology of fruit ripening. (2 hrs)
4. Growth and Movements: Sigmoid curve, measurement of growth, regions of growth, general account of natural growth hormones, synthetic auxins (brief account) effect of ABA. Senescence and Abscission. Tropic and nastic movements with reference to geotropism, phototropism, Seismonastic and nyctinastic movements. Photoperiodism and Vernalization. (5 hrs)

**PRACTICAL**

**36 hours**

Student should be trained to carry out or demonstrate the following experiments

**Core Experiments:**

- 1) Determination of osmotic pressure by plasmolytic method
- 2) Separation of Chlorophyll pigments by paper chromatography.
- 3) Determination of transpiration under different environmental conditions using Ganong's / Farmer's Potometer
- 4) Demonstration of osmosis using plant membrane

**Demonstration Experiments:**

1. Effect of carbon dioxide concentration on the rate of photosynthesis by *Hydrilla* plants
2. Relation between transpiration and absorption
3. Evolution of O<sub>2</sub> during photosynthesis
4. Light screen expt.
5. Mohl's experiment
6. Experiment with variegated leaf
7. Measurement of growth using Arc Auxanometer
8. Experiment with Kleinostat.
9. Effect of hormones on growth

**References**

1. Devlin and Witham - Plant Physiology, C B S Publishers
2. Jain V. K., 2008. Fundamentals of Plant Physiology, S. Chand and Co.
3. Kochhar P. L. & Krishnamoorthy H. N. Plant Physiology, Atmaram and Sons, Delhi, Lucknow.
4. Kumar & Purohit Plant Physiology – Fundamentals & Applications, Agrobotanical Publishers
5. Malik C. P. 2002. Plant Physiology, Kalyani Publishers
6. Malik C. P. and Srivastava A. K- Text Book of Plant Physiology – Kalyani Publishers, New Delhi.
7. Mukherjii. S. & Ghosh A.K, 2005. Plant Physiology, Calcutta New Central Book Agency.
8. Noggle G. R. & Fritz G.J- Introductory Plant Physiology- Prentice Hall of India.
9. Pandey S. N & Sinha B.K – Plant Physiology- Vikas Publishing House, New Delhi.
10. Salisbury F.B & Ross C.W –Plant Physiology- Wadsworth Publishing Co.
11. Sinha A.K 2004. Modern Plant Physiology, Narosa Publishing House, New Delhi.
12. Srivastava H. S.,2004. Plant Physiology & Biochemistry, Rasthogi Publications.
13. Verma V. 2007. Text Book of Plant Physiology, Ane Books Pvt Ltd.
14. Verma S. K.& Mohit Verma,2006. A Text book of Plant Physiology, Biochemistry & Biotechnology, S. Chand and Co.
15. William G. Hopkins- Introduction to Plant Physiology –John Wiley & Sons, New York.

**B.Sc. BOTANY PROGRAMME  
SEMESTER III COMPLEMENTARY COURSE III 15U3CPBOT3**

**ANGIOSPERM TAXONOMY AND ECONOMIC BOTANY  
(Theory 54 hours; Practical 36 hours) Theory credit 3 Practical Credit 1**

**Course objectives**

1. Acquaint the student with the objectives and components of Taxonomy.
2. Help the student to understand the systems of classification of angiosperms.
3. Help the student to identify the common angiosperm species of Kerala.
4. Familiarize the student with plants of immense economic importance.

**Module 1. Angiosperm Taxonomy (Theory 36 hours; Practical 24 hours)**

1. Importance of plant classification, types of classification, binomial nomenclature; ICBN, cytotaxonomy, chemotaxonomy. 4 Hrs
2. Herbarium techniques : Field study, field note, vasculum, plant press, disinfecting and mounting, labeling, importance of herbarium. 3 Hrs
3. Bentham and Hooker's system of classification. 3 Hrs
4. Morphology of Angiosperms – flowers, inflorescence, fruits 4 Hrs
5. Study of the following families of Bentham and Hookers system of classification with special reference to major identifying characters and economic importance : Annonaceae, Malvaceae, Rutaceae, Leguminosae, Apiaceae (Umbelliferae), Rubiaceae, Asteraceae, Apocynaceae, Lamiaceae (Labiatae), Euphorbiaceae, Arecaceae (Palmae), Poaceae (Gramineae). 22 Hrs

**Module 2. Economic Botany (Theory 18 hours, Practical 12 hours)**

1. Classification of economic plants based on their uses. (Cereals, legumes and pulses. tuber crops, spices, beverages etc.) 3 Hrs
2. Study of the following economic plants with special reference to their botanical name, family, morphology of useful part, economic products and uses. 10 Hrs

|                        |                             |
|------------------------|-----------------------------|
| Cereals                | : Paddy, Wheat.             |
| Pulses                 | : Green gram, Bengal gram.  |
| Tuber crops            | : Tapioca.                  |
| Spices                 | : Pepper, Cardamom.         |
| Beverages              | : Tea, Coffee.              |
| Oil yielding plants    | : Coconut, Groundnut        |
| Fibre yielding plants  | : Cotton, Coir.             |
| Timber yielding plants | : Teak, Rose wood.          |
| Latex yielding plants  | : Para rubber.              |
| Bio pesticides         | : Neem, Tobacco.            |
| Ornamental plants      | : Rose, Orchids, Anthurium. |



3. Study of the following medicinal plants with special reference to their binomial, family, morphology of useful parts and uses. 5 Hrs

1. *Adhatoda*, 2. *Aloe*, 3. Brahmi (*Bacopa*), 4. *Catharanthus*, 5. *Eclipta*, 6. Neem, 7. *Ocimum*, 9. *Phyllanthus amarus*, 9. *Rauwolfia*, 10. *Sida*.

**Practicals**

**36 hours**

1. Students should be able to identify typical plants belonging to the families prescribed in the syllabus. They should be able to describe the floral parts in technical terms.
2. Students should study the botanical name, family, morphology of the useful part and the uses of the plants listed in the syllabus.

**Suggested additional topics**

1. Classification of Angiosperms proposed by Adolf Engler, John Hutchinson and Arthur Cronquist.
2. Origin of agriculture and crop plants; centers of origin of crop plants proposed by N.I Vavilov.
3. Ethnobotany – significance and methods of ethnobotanical research.

**Reference**

1. Eames, A. J. 1969. *Morphology of Angiosperms*. Mc Graw – Hill, New York.
2. Hill, A.F. 1952. *Economic Botany: A Text book of Useful Plants and Plant Products*. Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. Kochhar, S.L. 1981. *Economic Botany in the Tropics*. Macmillan India Limited, Delhi.
4. Lawrence, G.H.M. 1951. *Taxonomy of Vascular Plants*. Oxford & IBH, New Delhi.
5. Naik, V.N. 1984. *Taxonomy of Angiosperms*. Tata McGraw – Hill Publishing Co; New Delhi.
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7. Simpson, B.S and M. Conner – Ogorzaly. 1986. *Economic Botany: Plants in Our World*. McGraw – Hill Book Company, New York.
8. Singh, G. 1999. *Plant Systematics – Theory and Practice*. Oxford & IBH, New Delhi.

**B.Sc. BOTANY PROGRAMME  
SEMESTER IV COMPLEMENTARY COURSE IV 15U4CPBOT4**

**ANATOMY AND APPLIED BOTANY**

**(Theory 54 hours; Practical 36 hours)**

**Theory credit 3 Practical Credit 1**

**Course objectives**

To help the student

1. Understand different types of plant tissues.
2. Understand the internal structure of different plant organs with reference to their functions.
3. Understand the process of normal and anomalous secondary thickening in plants.
4. Know the morphological and anatomical adaptations of plants growing in different habitats.
5. Understand the applications of botanical knowledge in the field of crop improvement for human prosperity.

**Module 1: Anatomy (Theory 30 hours; Practical 24 hours)**

1. Cell types, electron microscopic studies on plant cell – living and non-living inclusions, cell wall – ultra structure of cell wall (brief account only) 4 Hrs
2. Tissues: simple and complex; meristems, secretory tissues. 4 Hrs
3. Cambium: origin, structure, function, role in budding and grafting. 2 Hrs
4. Primary structure of stem and root in dicots and monocots. 3 Hrs
5. Secondary thickening in dicot stem and dicot root; growth rings, heart wood and sap wood; hard wood and soft wood; ring porous wood and diffuse porous wood, Anomalous secondary thickening in *Bignonia*. 5 Hrs
6. Anatomy of monocot and dicot leaf. 3 Hrs
7. Ecological anatomy: Study of the morphological and anatomical adaptations of the following groups; Hydrophytes (*Nymphaea*), Xerophytes (*Nerium*), Epiphytes (*Vanda*) and Halophytes (*Avicinia/Rhizophora*). 9 Hrs

**Module 2: Applied Botany**

**(Theory 24 hours)**

1. Plant breeding: Objectives, sexual and asexual reproduction; apomixis, apogamy, apospory, amphimixis, parthenogenesis, parthenocarpy, polyembryony. 5 Hrs
2. Methods of plant improvement
  - a. Plant introduction, acclimatization plant quarantine.
  - b. Selection: Mass selection; pureline selection and clonal selection.
  - b. Hybridization; intervarietal, interspecific and intergeneric; procedure of hybridization. 5 Hrs
3. Special methods of plant breeding.
  - a. Mutation breeding.
  - b. Polyploidy breeding. 3 Hrs

- 4 Horticultural practices  
Propagation through cutting, layering, budding and grafting 5Hrs
- 5 Tissue culture  
Principles, techniques and applications; culture media, asepsis, callus, organogenesis, somatic embryogenesis, anther culture, artificial seeds.

6 Hrs      **Practicals**

- a. Types of tissue – simple and complex.
- b. Primary structure of stem and root of dicots and monocots.
- c.                                Structure of dicot stem and dicot root after secondary thickening.
- d.                                Anomalous secondary thickening in *Bignonia*.
- e.                                Anatomy of monocot and dicot leaf.
- f.                                Morphological and anatomical adaptations of Hydrophytes (*Nymphaea* petiole), Xerophytes (*Nerium* leaf), Epiphytes (Velamen root of *Vanda*), Halophyte (Pneumatophore and vivipary of *Avicinia* or *Rhizophora*).
- g.                                Emasculation of pea or *Caesalpinia* flower.
- h.                                ‘T’budding, approach grafting, air layering.
- i.                                Demonstration of tissue culture techniques: culture media, callus induction and organogenesis.

**Suggested additional topics**

- 1. Anomalous secondary thickening in monocots.
- 2. Wood – seasoning, properties and uses.
- 3. Industrial uses of cellulose.
- 4. Contributions of Dr. Norman S. Borlaug and Dr. M.S. Swaminathan in the field of green revolution.

**Reference.**

- 1. Christopher, E.P. 1958. *Introductory Horticulture*. McGraw – Hill, New York.
- 2. Esau, K. 1965. *Plant Anatomy*. Wiley, New York.
- 3. Fahn. 1985. *Plant Anatomy*. Pergamon Press, Oxford.
- 4. Hartman, H.T. and D.E. Kester. 1991. *Plant Propagation – Principles and Practices*. Prentice – Hall of India, New Delhi.
- 5. Kumar, N. 1994. *Introduction to Horticulture*. Rajalakshmi Publications, Nagercoil.
- 6. Pandey, B.P. 1984. *Plant Anatomy*. S. Chand and Company, New Delhi.
- 7. Vasishta, V.C. 1978. *Plant Anatomy*. S. Nagin and Company, Jallundhur.

Semester I Complementary Course 1 15U1CPBOT1  
**CRYPTOGAMS, GYMNOSPERMS AND PLANT PATHOLOGY**

Time 2 hours

Maximum 60 Marks

Part A

I. Answer ALL questions; each question carries ONE mark.

8 x 1 = 8 marks

1. What is the nature of food in Rhodophyceae?
2. Name an alga where we find prokaryotic cell organization.
3. Name the type of nucleic acid present in TMV.
4. Name a viral disease in plants and the causal organism.
5. What is sporophyll?
6. What is coralloid root?
7. Name the two types of rhizoids seen in *Riccia*.
8. Name the two types of xylem in *Cycas*

Part B

II. Answer ANY SIX questions; each question carries TWO marks.

6 x 2 = 12 marks

8. What is coenobium? Give an example.
9. Describe carposporophyte in *Polysiphonia*.
10. Write a note on the asexual mode of reproduction in *Phytophthora*.
11. Write any two industrial uses of bacteria.
12. Explain the terms phycobiont and mycobiont.
13. Explain the nature of stele in *Selaginella*.
14. What is transfusion tissue? What is its function?
15. Explain the structure of mature sporophyte in *Riccia*.
16. What is plasmid? What is its role?
17. Write a note on the beneficial roles of fungi.
18. Explain the structure of apothecium in *Peziza*.

Part C

III. Answer ANY FOUR questions; each question carries FOUR marks.

4 x 4 = 16 marks

19. Describe the different methods of vegetative reproduction in *Riccia*
20. What are the distinguishing features of Cyanophyceae?
21. Describe asexual reproduction in *Volvox*
22. Explain the structure of a bacteriophage
23. Describe the form and structure of lichens
24. Explain the internal structure of leaflet in *Cycas*

Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks. 12 x 2 = 24 marks

25. Give an illustrated account of sporophyte of *Selaginella*

OR

26. Describe the process of sexual reproduction in nannandrous species of *Oedogonium*.

27. Describe the life cycle of *Puccinia* in wheat plant

OR

28. Explain the disease cycle in nut fall of arecanut. Add a note on the control measures.

Semester II Complementary Course 2 **15U2CPBOT2**  
**PLANT PHYSIOLOGY**

Time 3 hours

Maximum 60 Marks

Part A

I. Answer ALL questions; each question carries ONE mark.

8 x 1 = 8 marks

1. What is Red drop?
2. Define Translocation.
3. What are the major factors affecting photosynthesis?
4. Expand CAM.
5. What is meant by water potential?
6. What is a nastic movement?
7. Name a volatile hormone.
8. What is vernalization?

Part B

II. Answer ANY SIX questions; each question carries TWO marks.

6 x 2 = 12 marks

9. What is photolysis of water?
10. Comment on Kranz anatomy?
11. Differentiate between PS I and PSII.
12. What are primary and accessory pigments?
13. Write a short note on RUBISCO.
14. What is the significance of photoperiodism?
15. What is meant by senescence?
16. What are antitranspirants?
17. Explain the mechanism of water absorption in plants.
18. What is meant by DPD?

Part C

III. Answer ANY FOUR questions; each question carries FOUR marks.

4 x 4 = 16 marks

19. What are the theories related to the closing and opening of stomata?
20. Write a brief note on nitrogen cycle.
21. Explain Munch mass flow hypothesis.
22. Point out the differences between C<sub>3</sub> and C<sub>4</sub> cycle.
23. What are the factors affecting transpiration?
24. Distinguish between transpiration and guttation

Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks. 12 x 2 = 24 marks

25. With the help of schematic diagram, describe the mechanism of photophosphorylation.

**OR**

26. Explain the process of nitrogen fixation in plants.

27. Write an essay on plant movements

**OR**

28. Write an essay on Stress physiology in plants

Semester III Complementary Course 03 15U3CPBOT3  
**ANGIOSPERM TAXONOMY AND ECONOMIC BOTANY**

Time 3 hours

Maximum 60 Marks

Part A

I. Answer ALL questions; each question carries ONE mark. 8 x 1 = 8 marks

1. What are the essential parts of a flower?
2. What is meant by a complete flower?
3. What is a zygomorphic flower? Give one example.
4. Explain the functions of calyx and corolla.
5. What do you mean by petaloid and sepaloid condition?
6. Who is considered as the Father of Taxonomy?
7. Write down the binomial and family of cotton.
8. What is chemotaxonomy?

Part B

II. Answer ANY SIX questions; each question carries TWO marks. 6 x 2 = 12 marks

9. How will you distinguish artificial classification from natural classification? Give examples.
10. Comment on any two spices you have studied.
11. What is binomial nomenclature? How is it different from polynomial nomenclature?
12. Describe the androecium and gynoecium in Rubiaceae.
13. What is aestivation? Name the different types of aestivation you have studied.
14. Differentiate between polypetalous and gamopetalous condition.
15. Write down the binomial of any two oil yielding plants giving their uses.
16. With the help of a neat diagram, explain different parts of stamen.
17. What is placentation? Explain different types of placentation.  
What is meant by floral formula. Give example.

Part C

III. Answer ANY FOUR questions; each question carries FOUR marks. 4 x 4 = 16 marks

18. Draw the floral diagram of a flower belonging to the family Rubiaceae.
19. What is phylogenetic or evolutionary classification?
20. Briefly explain ICBN.
21. Give the binomial, useful part and uses of any two cereals and pulses?
22. What are the major criteria for biological classification?



Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks. 2 x 12 = 24 marks

24. Give an account of various steps involved in Herbarium preparation.

OR

25. Explain Bentham and Hooker's system of classification. Add a note on its merits and demerits.

26. Describe the salient features of the family Apocynaceae with a suitable example.

OR

28. Evaluate the plants *Adhatoda*, *Catharanthus*, and *Rauvolfia* with special reference to their binomial, family, morphology of useful parts and uses.

Semester IV Course IV 15U4CPBOT4  
**ANATOMY AND APPLIED BOTANY**

Time 3 hours

Maximum 60 Marks

Part A

I. Answer All questions; each question carries ONE mark.

8 x 1 = 8 marks

1. What is Heterosis?
2. What is Asepsis ?
3. What is Multiple cross ?
4. What is plasmodesmata ?
5. What is dendrochronology ?
6. What is inter fascicular cambium?
7. What are bulliform cells ?
8. What is vivipary ?

Part B

II. Answer ANY SIX questions; each question carries TWO marks.

6 x 2 = 12 marks

9. What is layering, what are the different types of Layering ?
10. What is Mutation breeding, Give an example?
11. What is Hybridization, mention different types?
12. What is plant introduction, mention the types of introduction?
13. Distinguish between Sap wood and Heart wood
14. Distinguish between storied cambium and non storied cambium?
15. Distinguish between Schizogenous and lysigenous type of inter cellular formation ?
16. What are the distinguishing features of monocot root?
17. Write two anatomical adaptations of Hydrophytes.
18. What are velamen roots?

Part C

III. Answer ANY FOUR questions; each question carries FOUR marks.

4 x 4 = 16 marks

19. What is Emasculation?
20. What is quarantine?
21. What is the anomaly in the secondary growth of Bignonia ?
22. Explain the components of secondary Xylem.
23. What are bordered pits? Draw a labeled diagram.
24. What are the important extra cell wall materials? Name the tissues where each one is present?

Part D

IV. Answer ANY TWO questions; each question carries TWELVE marks. 12 x 2 = 24 marks

25. Give an account of microscopic and submicroscopic structure of cell wall. Explain how the cell wall grows in thickness

**OR**

26. Explain Structure, function and seasonal activity of cambium? What is the role of cambium in budding and grafting

27. Write an essay on Tissue culture, mention the principles & requirements?

**OR**

28. Write an essay on the Methods of Plant improvement?

## Model Practical Question Papers

**B.Sc. BOTANY Programme  
Core Course 15U1CRBOT1 & 15U2CRBOT2 - PRBOT1  
(Practical A & B Combined)**

### **MICROBIOLOGY, PHYCOLOGY, MYCOLOGY, LICHENOLOGY AND PLANT PATHOLOGY**

**Time 3 hrs**

**Marks - 30**

- Q .1. Conduct Gram Staining / Serial Dilution / Streaking method of sample A      3 marks
- |                        |        |
|------------------------|--------|
| Conduct of experiment  | 1 mark |
| Procedure / flow chart | 1 mark |
| Diagram                | 1 mark |
- Q. 2. Make suitable micro preparation of sample B, C & D      6 marks
- |                |        |
|----------------|--------|
| Preparation    | 1 mark |
| Identification | ½ mark |
| Diagram        | ½ mark |
- Q. 3. Make suitable micro preparation of sample E, F & G to reveal the reproductive structure.  
Identify the material and draw labeled diagram of the part displayed      6 marks
- |                            |        |
|----------------------------|--------|
| Preparation                | 1 mark |
| Diagram                    | ½ mark |
| Identification with reason | ½ mark |
- Q. 4. Spot at sight H,I, J, K & L      5 marks
- |                |        |
|----------------|--------|
| Generic name   | ½ mark |
| Part displayed | ½ mark |
- Q. 5. Name the disease, causative organism, symptoms and control measures of plant disease M.
- |                    |        |
|--------------------|--------|
| Name of Disease    | ½ mark |
| Causative Organism | ½ mark |
| Symptoms           | ½ mark |
| Control Measures   | ½ mark |
- 2 marks
- Q.6. Prepare a bed for Oyster mushroom cultivation N. Comment on the role of ..... in it.
- |             |          |
|-------------|----------|
| Preparation | 1½ marks |
| Comments    | ½ mark   |
- 2 marks
- Viva voce (based on practicals)      2 marks
- Record      4 marks

**Instructions to the Examiners**

1. A - Gram staining / Serial dilution of soil sample to isolate microbes / streak plate method.
2. B, C, D - Algae / Fungi / Lichen thallus
3. E, F, G - Algae / Fungi / Lichen with reproductive structures
4. H, I, J, K, L - Spotters Algae / Fungi / Lichen
5. M - Any one pathology specimen from the syllabus
6. N – Materials for bed preparation has to be provided.  
Role of any material used (polybag, paddy straw, spawn, calcium carbonate, water)

**B.Sc. (BOTANY) Programme  
Course 15U3CRBOT3 & 15U4CRBOT4 – PRBOT2  
(Practical C & D Combined)**

**BRYOLOGY, PTRIDODOLOGY, GYMNOSPERM, ANATOMY &  
MORPHOLOGY OF ANGIOSPERMS**

**Time 3 hrs.**

**Marks – 30**

Q .1. Make micro preparation of A/B

|                 |          |         |
|-----------------|----------|---------|
| Preparation     | 1 marks  |         |
| Labeled diagram | 0.5 mark |         |
| Key characters  | 1 mark   |         |
| Identification  | 0.5 mark | 3 marks |

Q. 2. Make Micro preparation and compare stelar type of C & D

|                                |          |                   |
|--------------------------------|----------|-------------------|
| Identification of stelar types | 0.5 mark |                   |
| Labeled diagram                | 1 mark   |                   |
| Comparison                     | 1 mark   | 2.5 x 2 = 5 marks |

Q. 3. Take a T.S of given material E&F, stain and mount in Glycerine

|                            |         |                 |
|----------------------------|---------|-----------------|
| Preparation                | 1 mark  |                 |
| Diagram                    | 1 mark  |                 |
| Identification with reason | 2 marks | 4 x 2 = 8 marks |

Q. 4. Identify the stomata type of the material G

|                             |         |  |
|-----------------------------|---------|--|
| Identification with diagram | 2 marks |  |
| Preparation                 | 1 mark  |  |

**OR**

Q.4. Macerate the given wood piece G and identify whether it is an angiosperm or Gymnosperm

|                |        |         |
|----------------|--------|---------|
| Preparation    | 1 mark |         |
| Identification | 1 mark | 2 marks |

Q. 5. Spot at sight H, I & J

|                 |          |                 |
|-----------------|----------|-----------------|
| Generic name    | 0.5 mark |                 |
| Parts displayed | 0.5 mark | 3 x 1 = 3 marks |

Q.6.. Identify and comment on K, L & M

|                                 |  |                 |
|---------------------------------|--|-----------------|
| 1 mark each                     |  | 3 x 1 = 3 marks |
| Viva voce (based on practicals) |  | 2 marks         |
| Record                          |  | 4 marks         |



**Instructions to the Examiners**

- A. Thallus of Bryophyte
- B. Stem/leaf/ of Gymnosperm
- C. & D stem / petiole /rhizome of pteridophyte
- E & F Anatomy of primary/secondary/Anomalous material
- G Stomata on leaf / any angiosperm wood or Gymnosperm wood
- H Spot at sight of reproductive part of Bryophytes
- I. Spot at sight of reproductive part of Pteridophytes
- J Spot at sight of reproductive part of Gymnosperm
- K. Morphology of leaf
- L. Morphology of inflorescence
- M. Morphology of fruit



**B.Sc. BOTANY Programme  
Core Course 15U5CRBOT05 & 15U5CRBOT06 – PRBOT3  
(Practical E & F Combined)**

**ANGIOSPERM SYSTEMATICS, FLORAL MORPHOLOGY, ECONOMIC BOTANY, ENVIRONMENTAL SCIENCE & ECOTOURISM**

**Time 3 hrs**

**Marks - 30**

- Q.1. Identify specimen **A** up to respective families giving systematic keys and characters **4 marks**
- |   |        |
|---|--------|
| Identification                                | 1 mark |
| Family characters                             | 1mark  |
| Characters up to series and plant description | 2 mark |
- Q. 2. Estimate the CO<sub>2</sub>/ Cl/ Salinity in the given water sample **B** **4 marks**
- |                        |         |
|------------------------|---------|
| Procedure              | 1 mark  |
| Conduct                | 2 marks |
| Calculation and Result | 1 mark  |
- Q. 3. Describe the given flower **C** in technical terms (floral formula, floral diagram), draw an LS of the flower **3 marks**
- |                            |         |
|----------------------------|---------|
| Floral formula             | ½ mark  |
| Floral Diagram             | ½ mark  |
| Identification with reason | 2 marks |
- Q. 4. Take TS of the given material **D**, identify the ecological importance, giving reasons and draw a labeled diagram **3 marks**
- |                             |        |
|-----------------------------|--------|
| Preparation                 | 1 mark |
| Identifying characters      | 1 mark |
| Identification with diagram | 1 mark |
- Q.5. Find out the Density/abundance/frequency from the given data **E** obtained through a quadrat study **2 marks**
- |             |        |
|-------------|--------|
| Formula     | 1 mark |
| Calculation | 1 mark |
- Q.6. Identification of 2 herbarium specimens **F & G** (1 mark each) **2 marks**
- Q.7. Write down the binomial, family and morphology of useful part of the given materials **J** and **K** (1 mark each) **2 marks**
- Q.8. Identify and write environmental impact based on the given photograph **L**  
**Or**
- Q.9. Identify ecotourism methods adopted in the given photograph **L** **1 mark**
- Q.10. Herbarium of 25 specimens including field book **3 marks**
- Q.11. Viva voce (based on practicals) **2 marks**
- Q.12. Record **4 marks**



**Instructions to the Examiners**

- A. Flowering specimen from any angiosperm family included in the syllabus
- B. Water sample from the estuary
- C. Flower from Sub class Polypetalae or Gamopetale
- D. Hydrophyte/ Xerophyte/ Halophyte/ Epiphyte (Stem/ leaf/ roots)
- E. Data from the quadrat study (Maximum 5 Quadrats)
- F. Any herbarium from the students collection
- G. Any herbarium from the students collection
- H. Inflorescence/ Fruit
- I. Inflorescence/ Fruit
- J. Specimen with economic importance included in the syllabus
- K. Specimen with economic importance included in the syllabus
- L. Photograph of any environmental impact of any Anthropogenic activity/ Photograph of an Ecotourism spot

B.Sc. BOTANY Programme  
Core Course 15U5CRBOT07 & 15U5CRBOT08 – PRBOT4  
(Practical G & H Combined)

**GENETICS, PLANT BREEDING, CELL AND MOLECULAR BIOLOGY AND EVOLUTION**

**Time 3 hrs**

**Max.Marks - 30**

- I. Work out the problems A, B and C 10 marks
- |                        |         |
|------------------------|---------|
| Monohybrid/ Dihybrid   | 2 marks |
| Intergenic Interaction | 4 marks |
| Molecular Genetics     | 4 marks |
- II. Make acetocarmine squash preparations of the root tips supplied as D and Submit any two stages of Mitosis. 6 marks
- |                   |                                      |
|-------------------|--------------------------------------|
| Preparation       | 2 marks                              |
| Identification    | $\frac{1}{2} + \frac{1}{2} = 1$ mark |
| Labelled Diagrams | $\frac{1}{2} + \frac{1}{2} = 1$ mark |
- Calculation of Mitotic Index*
- |             |        |
|-------------|--------|
| Tabulation  | 1 mark |
| Calculation | 1 mark |
- III. Identify the given stage of Meiosis in E 1 mark
- IV. Match the Karyotype with the phenotype F and identify the genetic disorder. Make comments on karyotype and phenotype 3 marks
- |                  |        |
|------------------|--------|
| Correct matching | 1 mark |
| Comments         | 2 mark |
- V. Conduct emasculation/ budding/ grafting/ layering in G and draw labeled diagram
- |                           |         |
|---------------------------|---------|
| Conduct of the experiment | 2 marks |
| Labelled diagram          | 1 mark  |
- 3 marks**
- VI. Identify the chromosomal anomaly in the given photograph/ diagram 1 mark
- Viva voce (based on practicals) 2 marks
- Record 4 marks

**Instructions to the Examiners**

1. Problem A – Monohybrid / Dihybrid  
Problem B – Intergenic Interaction  
Problem C – Molecular Genetics
2. Onion Root tip (fresh material) shall be supplied.
3. Meiosis photograph/ diagram/ permanent slide shall be used.
4. Photographs of Turner's / Klinefelter's / Down's syndrome (any one) and the respective ideogram shall be displayed.
5. Materials for emasculation / budding / grafting / layering shall be supplied.  
Photographs of any of the Chromosomal anomalies studied in the syllabus.

B.Sc. BOTANY Programme  
Core Course 15U6CRBOT09 & 15U6CRBOT10 – PRBOT5  
(Practical I & J Combined)

**PLANT PHYSIOLOGY, BIOCHEMISTRY, PERSPECTIVES OF SCIENCE AND METHODOLOGY****Time 3 hrs****Marks - 30**

- Q .1. Conduct the experiment A and bring out the result. 10 marks
- |                           |         |
|---------------------------|---------|
| Requirement               | 1 mark  |
| Procedure                 | 2 marks |
| Setting up the experiment | 4 marks |
| Labeled diagram           | 1 mark  |
| Result and Inference      | 2 marks |
- Q. 2. Examine the compound leaf supplied and measure the lengths of the leaflets
- Group them into frequency classes according to their length
  - Calculate the mean and standard deviation of the data manually
  - Prepare a histogram using EXCEL to represent the data.
  - Make a print out and submit. 6 marks
- |  |        |
|--|--------|
| Construction of the classes and scoring of frequency | 2 mark |
| Mean   | 1 mark |
| Standard deviation                                   | 1 mark |
| Histogram  | 2 mark |
- Q. 3. Determine the concentration of the given solution of CuSO<sub>4</sub> using colorimetry.  
Use the values supplied for the preparation of a standard graph. 4 marks
- |  |         |
|--|---------|
| Standard Graph                                     | 2 marks |
| Determination of Concentration from standard graph | 2 marks |
- Q. 4. Comment on the defect in the experiment set up 2 marks
- |                |             |
|----------------|-------------|
| Defects        | ½ + ½ marks |
| Correct set up | ½ + ½ marks |
- Q. 5. Detect any two organic compounds in the given sample 2 marks
- |                       |             |
|-----------------------|-------------|
| Conduct of experiment | ½ + ½ marks |
| Identification        | ½ + ½ marks |
- Viva voce (based on practicals) 2 marks
- Record 4 marks

**Instructions to the Examiners**

A – Physiology experiments – Determination of OP by plasmolytic method/ Comparison of stomatal indices/ Paper Chromatographic separation of plant pigments/ TLC / measurement of rate of photosynthesis / estimation of pigments by colorimetry. Students must prepare the plant extract.

Compound leaves (at least 20-30 leaflets) should be provided. Students should take the print out of the graph / histogram.

Values of standard graph should be provided.

Any experimental set up with at least two defects.

Students should be supplied with samples containing non-reducing sugar/ reducing sugar/ protein.

SACRED HEART COLLEGE, THEVARA, (Autonomous )  
B.Sc. (BOTANY) Programme  
Core Course: 15U6CRBOT11 & 15U6CRBOT12  
(Practical K & L Combined)

**BIOTECHNOLOGY, BIOINFORMATICS, HORTICULTURE, NURSERY MANAGEMENT, EMBRYOLOGY & REPRODUCTIVE BOTANY**

**Time 3 hrs.**

**Marks - 30**

- Q.1. Extract DNA from the given plant material **A** **5 marks**
- |                            |         |
|----------------------------|---------|
| Requirements and Procedure | 2 marks |
| Working                    | 4 marks |
| Result                     | 2 marks |
- Q. 2. Immobilize whole cells/plant tissue **B** in Alginate beads **5 marks**
- |                            |         |
|----------------------------|---------|
| Requirements and Procedure | 2 marks |
| Working                    | 4 marks |
| Result                     | 2 marks |
- Q. 3. Sterilize the plant material **C** and inoculate into the medium supplied **2 marks**
- |                |        |
|----------------|--------|
| Steps followed | 1 mark |
| Working        | 1 mark |
- Q. 4. Using Molecular visualization tool RASMOL, show required information of given protein **D** /BLAST **4 marks**
- Q.5. Comment on the given specimens **E & F** (½ mark each) **1 mark**
- Q.6. Identify and Comment on the given tools **G & H** (½ mark each) **1 mark**
- Q.7. Conduct germination experiments on the given pollen **I** **2 marks**
- |                      |        |
|----------------------|--------|
| Working              | 1 mark |
| Procedure and Result | 1 mark |
- Q. 8. Conduct grafting/layering/budding experiments on the given plant material **4 marks**
- |                            |         |
|----------------------------|---------|
| Requirements and Procedure | 1 mark  |
| Working                    | 3 marks |
- Q.8. Viva voce (based on practicals) **2 marks**
- Q.9. Record **4 marks**



**Instructions to Examiners**

- A. Suitable plant material (onion, Coconut endosperm etc.) can be provided
- B. Yeast cell or any plant tissue (meristem) can be provided
- C. Shoot tip/stem/leaf/Nodal segment can be provided
- D. Tools for RASMOL has to be installed and provide a computer with internet for BLAST - experiment
- E. & F. Any specimens/photographs from Biotechnology/ Bioinformatics
- G. & H. Tools used in Nursery management or Horticulture
- I. Provide pollen and medium for the experiment

B.Sc Botany Programme  
Practical 01 Complementary (15U1CPBOT1 & 15U2CPBOT2)  
**Cryptogams, Gymnosperms, Plant Pathology & Plant Physiology**

Time: 3 Hours

Max. Marks:30

1. Make suitable micropreparations of **A** and **B**, stain and mount in glycerine, draw, label the parts and identify giving reasons.

|                  |        |                 |
|------------------|--------|-----------------|
| Preparation      | 1 Mark |                 |
| Labelled diagram | 1 Mark |                 |
| Identification   | ½ Mark |                 |
| Reasons          | 1 Mark | (3½ x2=7 Marks) |

2. Identify **C** with reasons and draw diagram.

|                  |        |                |
|------------------|--------|----------------|
| Identification   | ½ Mark |                |
| Reason           | ½ Mark |                |
| Labelled diagram | 1 Mark | (2 x1=2 Marks) |

3. Identify at sight **D & E**.

|                |        |               |
|----------------|--------|---------------|
| Part displayed | ½ Mark |               |
| Genus          | ½ Mark | (2x1=2 Marks) |

4. Write note on pathological interest of **F**.

|                     |        |               |
|---------------------|--------|---------------|
| Name of the disease | ½ Mark |               |
| Causative organism  | ½ Mark |               |
| Symptoms            | 1 Mark | (2x1=2 Marks) |

5. Conduct the experiment **G**. Write the requirements,aim and procedure.

|                          |         |               |
|--------------------------|---------|---------------|
| Requirements             | 1 Mark  |               |
| Aim                      | 1 Mark  |               |
| Conduction of experiment | 2 Marks |               |
| Procedure                | 2 Marks | (6x1=6 Marks) |

6. With suitable diagram, write the aim and 2 defects of the experiment **H**.

|         |        |               |
|---------|--------|---------------|
| Aim     | 1 Mark |               |
| Defects | 1 Mark | (2x1=2 Marks) |

7. Viva 3 Marks

8. Record 6 Marks

**Instructions to the Examiners**

- A & B : Fresh or well preserved specimens from fungi, Bryophyte, Pteridophyte and Gymnosperms.
- C : Specimens from algae.
- D & E : Fresh or well preserved specimens from Fungi, Lichen, Bryophyte, Pteridophyte and Gymnosperms.
- F : Any one pathological material mentioned in the syllabus.
- G : From the list of core experiments.
- H : From demonstration experiments.

**Practical Complementary 02 (15U3CPBOT3 & 15U4CPBOT4)  
ANGIOSPERM TAXONOMY, ECONOMIC BOTANY  
ANATOMY AND APPLIED BOTANY**

**Time 3 hours**

**Marks-30**

|     |   | <b>Questions</b> |   |
|-----|---|------------------|---|
| 1.  | Assign <b>A</b> to its family giving diagnostic characters.   |                  |   |
|     | Name of the family  | 1                |   |
|     | Diagnostic characters   | 2                | 3x1= 3marks                               |
| 2.  | Draw L.S. Construct floral diagram and write the floral formula of <b>B</b>   |                  |   |
|     | L.S of the flower   | 2                |   |
|     | Floral diagram  | 1                |   |
|     | Floral formula  | 1                | 4x1= 4marks                               |
| 3.  | Identify <b>C</b> and <b>D</b> Write notes  |                  |   |
|     | Identification  | $\frac{1}{2}$    |   |
|     | Reason  | $1\frac{1}{2}$   | $1\frac{1}{2} \times 2=3\text{marks}$     |
| 4.  | Write the binomial, family and morphology of the useful part of <b>E</b> and <b>F</b>                               |                  |   |
|     | Binomial  | 1                |   |
|     | Family  | $\frac{1}{2}$    |   |
|     | Morphology  | $\frac{1}{2}$    | 2x2= 4marks                               |
| 5.  | Make stained transverse section of specimen <b>G</b> , mount in glycerin and identify giving diagnostic characters. |                  |   |
|     | Preparation   | 2                |   |
|     | Diagram,  | 1                |   |
|     | Identification with reasons   | 2                | 1x5= 5marks                               |
| 6.  | Identify the given T S of the material <b>H</b>   | $\frac{1}{2}$    | $\frac{1}{2} \times 1 = \frac{1}{2}$ mark |
| 7.  | Identify the cell inclusion 'I' with reason.  | 1/2              | 1/2x1= 1/2 mark                           |
| 8.  | Assign ' <b>J</b> ' to the ecological group with reasons.   |                  |   |
|     | Ecological group  | 1/2              |   |
|     | Reasons   | 1/2              | $\frac{1}{2} \times 2= 1$ marks           |
| 9.  | Carry out emasculation / budding / grafting / layering in ' <b>K</b> '  |                  |   |
|     | Demonstration   | 2                |   |
|     | Aim & procedure   | 1                | 3x1= 3marks                               |
| 10. | Viva  |                  | 2 marks                                   |
| 11. | Record  |                  | 4 marks                                   |

**Instructions to the Examiners**

- I. **A** - typical plant twigs with flowers included in the syllabus from different subclasses of dicotyledons.
- II. **B** - Fresh large flowers included in the syllabus.
- III. **C** - from inflorescences, D from fruits
- IV. **E** and **F** - Economic Botany specimens included in the syllabus.
- V. **G** - Stem or Root – Normal secondary thickening or Anomalous secondary thickening in *Bignonia*
- VI. **H** - Slides of Primary Structure of Stem or Root.
- VII. **I** - Non living inclusion (Cystolith/ Raphide)
- VIII. **J** - Specimens from ecological group mentioned in the syllabus.
- IX. **K** - Suitable materials for emasculation/ budding / grafting/ layering