

**ST. JOSEPH'S COLLEGE (AUTONOMOUS),
DEVAGIRI, CALICUT-673 008**



SYLLABUS

for

UNDER GRADUATE PROGRAMME

in

BOTANY

(UNDER CHOICE BASED CREDIT SEMESTER SYSTEM)

Effective from 2019 admission onwards

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UG PROGRAMME IN BOTANY

PREFACE

The revised Curriculum for Undergraduate Programme of B.Sc. Botany focuses on imparting knowledge in basic and applied aspects of Botany. Due importance is given to fundamental and modern aspects of Botany, spanning many specialties and interests. An attempt has been made to make the study of Botany interesting and enjoyable, and to keep up with the speed with which technology advances. Formulation of the syllabubs has been done by revamping the existing syllabus, with an understanding that the syllabus is addressing the 'digital native' generation.

The revised syllabus of B.Sc. Botany has been prepared in a participatory manner, after discussions with experts in the subject and by pooling suggestions from the teaching community. As far as possible, the suggested modifications have been incorporated in the syllabus. During the preparation of the syllabus, the existing syllabus, UGC model curriculum, syllabi of other universities, syllabi of XIth & XIIth standards and M.Sc. Botany syllabus of Calicut University have also been referred to. Care has been taken to ensure that the syllabus is compatible with the syllabi of other universities at the same level.

Concern for ever increasing pollution, biodiversity destruction and climate change is at its highest than ever. Keeping these issues in view, revision of the curriculum at the undergraduate level is done focusing towards creating awareness on these aspects.

AIMS AND OBJECTIVES OF THE PROGRAMME

- The fundamental objective of the curriculum is to impart effective science education at the undergraduate level, exposing students to recent trends and developments in the subject.
- Creating scientific temper is another major objective of this curriculum. Incorporating research components along with a sound academic foundation enables students to develop independent creative thinking. Sufficient emphasis is given for training in laboratory skills and instrumentation. The curriculum is

meant to inspire creativity and combine passion with critical thinking skills in students who one day will be the citizens working to convert the world to more sustainable systems.

- Another major thrust given here is to develop an environmental concern in all activities of the students. 'Go green' has been taken as the motto of the syllabus. This emphasizes on creating awareness of the urgent need to conserve nature without destruction of natural resources.

PROGRAMME OUTCOMES (POs)

1. **Critical Thinking:** Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
2. **Problem Solving:** Understand and solve problems of relevance to society to meet the specified needs using the knowledge, skills and attitudes acquired from humanities/ sciences/ mathematics/ social sciences.
3. **Effective Communication:** Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
4. **Effective Citizenship:** Demonstrate empathetic social concern and equity centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
5. **Environment and Sustainability:** Understand the issues of environmental contexts and sustainable development.
6. **Self-directed and Life-long Learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes

PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. **Scope and importance of Botany:** Understand scope and importance of Botany in every field especially in dealing with societal and environmental issues, agriculture, ethics and healthcare.

2. **Environmental concern:** Understand the and the role of plants in sustaining life on earth and the interrelationship between human beings and nature, create awareness on natural resources and their importance in sustainable development, analyze the importance of biodiversity conservation, estimate biodiversity loss and develop conservation strategies.
3. **Scientific temper:** Develop scientific temper and undertake scientific projects.
4. **Practical applications:** Identify and classify plants according to the principles of plant systematics, apply techniques like plant propagation methods, organic farming, mushroom cultivation, preparation of biofertilizers, biopesticides etc.
5. **Awareness on life processes:** Understand plant life processes, biomolecules, basic hereditary and evolutionary principles.

UG PROGRAMME - AN OVER VIEW

DEFINITIONS

- **Programme** means the entire course of study and examinations for the award of a degree.
- **Duration of programme** means the time period required for the conduct of the programme. The duration of a UG degree programme shall be six semesters distributed in a period of 3 years or eight semesters in a period of 4 years.
- **Academic Week** is a unit of five working days in which distribution of work is organized from day one to day five, with five contact hours of one hour duration on each day. A sequence of 18 such academic weeks constitutes a semester.
- **Semester** means a term consisting of 18 weeks (16 instructional weeks and two weeks for examination).
- **Course** means a segment of subject matter to be covered in a semester.
- **Common course** means a course that comes under the category of courses, including compulsory English and additional language courses, the selection of which is compulsory for all students undergoing UG programmes.
- **Core course** means a compulsory course in a subject related to a particular degree programme.
- **Open course** means a course which can be opted by a student at his/her choice.
- **Complementary course** means a course which is generally related to the core course.
- **Improvement course** is a course registered by a student for improving his/her performance in that particular course.

- **Ability Enhancement course/Audit course** is a course which is mandatory as per the directions from the Regulatory authorities like UGC, Supreme Court etc.
- **Credit(C)** is a unit of academic input measured in terms of weekly contact hours/course contents assigned to a course.
- **Extra Credit** is the additional credit awarded to a student over and above the minimum credits required in a programme, for achievements in co-curricular activities and social activities conducted outside the regular class hours, as decided by the University. For calculating CGPA, extra credits will not be considered.
- **Letter Grade** or simply 'Grade' in a course is a letter symbol (O, A+, A, B+, B, C, P, F,I and Ab). Grade shall mean the prescribed alphabetical grade awarded to a student based on his/her performance in various examinations. Each letter grade is assigned a '**Grade point**' (G) which is an integer indicating the numerical equivalent of the broad level of performance of a student in a course.
- **Grade Point** means point given to a letter grade on 10 point scale.
- **Semester Grade Point Average' (SGPA)** is the value obtained by dividing the sum of credit points obtained by a student in the various courses taken in a semester by the total number of credits in that semester. SGPA shall be rounded off to three decimal places. SGPA determines the overall performance of a student at the end of a semester.
- **Credit Point'(P)** of a course is the value obtained by multiplying the grade point (G) by the credit (C) of the course: $P=G \times C$
- **Cumulative Grade Point Average' (CGPA)** is the value obtained by dividing the sum of credit points in all the semesters taken by the student for the entire programme by the total number of credits in the entire programme and shall be rounded off to three decimal places.
- **Grade Card** means the printed record of students' performance, awarded to him/her.
- **Course teacher:** A teacher nominated by the Head of the Department shall be in charge of a particular course.
- **Strike off the roll** A student who is continuously absent for 14 days without sufficient reason and proper intimation to the Principal of the college shall be removed from the roll.

PROGRAMME STRUCTURE (excluding common courses)

- **CORE COURSES:**

Core courses are the courses in the major (core) subject of the degree programme chosen by the student. Core courses are offered by the parent department.

- **COMPLEMENTARY COURSES:**

Complementary courses cover one or two disciplines that are related to the core subject and are distributed in the first four semesters.

- **OPEN COURSES:**

There shall be one open course in core subjects in the fifth semester. The open course shall be open to all the students in the institution except the students in the parent department. The students can opt for open course offered by any other department in the institution. Each department can decide the open course from a pool of three courses offered by the University. Total credit allotted for open course is 3 and the hours allotted is 3. If there is only one programme in a college, they can choose either language courses or physical education as open course.

- **ABILITY ENHANCEMENT COURSES/AUDIT COURSES:**

These are courses which are mandatory for a programme but not counted for the calculation of SGPA or CGPA. There shall be one Audit course each in the first four semesters. These courses are not meant for class room study. The students can attain only pass (Grade P) for these courses. At the end of each semester there shall be examination conducted by the college from a pool of questions (Question Bank) set by the University. The students can also attain these credits through online courses like SWAYAM, MOOC etc. (optional). The list of passed students must be sent to the University from the colleges at least before the fifth semester examination.

Table 1: THE LIST OF AUDIT COURSES IN EACH SEMESTER WITH CREDITS

Sl no	Semester	Course	Credit
1	1	Environment Studies	4
2	2	Disaster Management	4
3	3	*Human Rights/ Intellectual Property Rights/ Consumer Protection	4
4	4	*Gender Studies/ Gerontology	4
Total			16

* Colleges can opt for any one of the courses.

• **CREDITS:**

A student is required to acquire a minimum of 140 credits for the completion of the UG programme, of which 120 credits are to be acquired from class room study and shall only be counted for SGPA and CGPA. Out of the 120 credits, 38 (22 for common (English) courses + 16 for common languages other than English) credits shall be from common courses, 2 credits for project/corresponding paper and 3 credits for the open course. The maximum credits for a course shall not exceed 5. Audit courses shall have 4 credits per course and a total of 16 credits in the entire programme. The maximum credit acquired under extra credit shall be 4. If more Extra credit activities are done by a student, that may be mentioned in the Grade card. The credits of audited courses or extra credits are not counted for SGPA or CGPA.

• **EXTRA CREDIT ACTIVITIES:**

Extra credits are mandatory for the programme. Extra credits will be awarded to students who participate in activities like NCC, NSS and Swatch Bharath. Those students who could not join in any of the above activities have to undergo Calicut University Social Service Programme (CUSSP). Extra credits are not counted for SGPA or CGPA.

Table-2 CREDIT DISTRIBUTION OF B.Sc. BOTANY PROGRAMME

Semester	Common		Core Course	Complementary Courses		Open Course	Total Credits (Class room study)	Audit Course	Extra credits	Total Credits
	English	Additional Language		Chemistry	Zoology					
I	3+4	4	3	2	2		18	4		22
II	3+4	4	3	2	2		18	4		22
III	4	4	3	2	2		15	4		19
IV	4	4	3+4**	2+4**	2+4**		27	4		31
V			3+3+3+3			3	15			15
VI			3+3+3+3+3 2*+5**+5**				27		4	31
Total	22	16	55	12	12	3	120	16	4	140

* Credits of Project Work **Credits of practical paper

- **ATTENDANCE:**

A student shall be permitted to appear for the semester examination, only if he/she secures not less than 75% attendance in each semester. Attendance shall be maintained by the Department concerned. Condonation of shortage of attendance to a maximum of 10% in the case of single condonation and 20% in the case of double condonation in a semester shall be granted by University remitting the required fee. Benefits of attendance may be granted to students who attend the approved activities of the college/university with the prior concurrence of the Head of the institution. Participation in such activities may be treated as presence in lieu of their absence on production of participation/attendance certificate (within two weeks) in curricular/extracurricular activities (maximum 9 days in a semester). Students can avail of condonation of shortage of attendance in a maximum of four semesters during the entire programme (Either four single condonations or one double condonation and two single condonations during the entire programme). If a student fails to get 65% attendance, he/she can move to the next semester only if he/she acquires 50% attendance. In that case, a **provisional registration** is needed. Such students can appear for supplementary examination for such semesters after the completion of the programme. Less than 50% attendance requires Readmission. Readmission is permitted only once during the entire programme.

- **PROJECT WORK/ THEORY COURSE ON RESEARCH METHODOLOGY:**

Every student of a UG degree programme shall have to work on a project of 2 credits or shall write a theory course based on Research Methodology as per the curriculum. College shall have the liberty to choose either of the above. Project work at UG level shall be of group nature, during the tenure of Vth and VIth semester. A group of not more than five students can undertake one project under the supervision of a faculty member as per the curriculum.

- **GRACE MARKS:**

Grace Marks may be awarded to a student for meritorious achievements in co-curricular activities (in Sports/Arts/NSS/NCC/Student Entrepreneurship) carried out besides the regular hours. Such a benefit is applicable and limited to a maximum of 8 courses in an academic year spreading over two semesters. In addition, maximum of 6 marks per semester can be awarded to the students of UG

Programmes, for participating in the College Fitness Education Programme (COFE).

REGISTRATION

Each student shall make an online registration for the courses he/she proposes to take, in consultation with the Faculty Adviser within two weeks from the commencement of each semester. The college shall send a list of students registered for each programme in each semester giving the details of courses registered, including repeat courses, to the University in the prescribed form within 45 days from the commencement of the semester.

A student shall be normally permitted to register for the examination if he/she has required minimum attendance. If the student has a shortage of attendance below 65% in a semester, the student shall be permitted to move to the next semester (if the attendance is more than 50% -Provisional registration) and can write the examination for the entire courses of the semester in which shortage of attendance occurs as supplementary examination only after the completion of the entire programme. In such cases, a request from the student may be forwarded through the Principal of the college to the Controller of Examinations within two weeks of the commencement of the semester. If the attendance is less than 50%, the student is ineligible to continue the programme and has to seek readmission. **There will not be any Repeat semester in CBCSSUG 2019.**

A student who registered for the course shall successfully complete the programme within 6 years from the year of first registration. If not, such candidate has to cancel the existing registration and join afresh as a new candidate.

For open courses there shall be a minimum of 10 and maximum of 75 students per batch. For other courses existing pattern will be followed.

Those students who have followed the UG Programmes in annual pattern or Choice based Credit & Semester System pattern can cancel their earlier registration and register afresh for CBCSSUG 2019 scheme in the same discipline or a different one.

The students who have attendance within the limit prescribed, but could not register for the examination have to apply for **Token registration**, within two weeks of the commencement of the next semester.

EXAMINATION

There shall be University examinations at the end of each semester.

- **PRACTICAL EXAMINATION**

Practical examinations shall be conducted by the University as prescribed by the Board of Studies. There will be practical examinations at the end of 4th semester and 6th semester. Practical examination of 4th semester will be of 3hrs duration. Practical examination of 5th and 6th semesters will be of 4 hrs duration.

- **EXTERNAL VIVA-VOCE,**

External viva voce if any shall be conducted along with the practical examination/project evaluation.

The model of question papers may be prepared by the concerned Board of Studies. Each question should aim at – (1) assessment of the knowledge acquired (2) standard application of knowledge (3) application of knowledge in new situations.

Different types of questions shall possess different marks to quantify their range.

- **PROJECT EVALUATION**

Project evaluation shall be conducted at the end of sixth semester. 20% of marks are awarded through internal assessment. Internal assessment of the project will be based on its content, method of presentation, final conclusion and orientation to research aptitude.

- **AUDIT COURSE:**

The students can attain only pass (Grade P) for these courses. At the end of each semester there shall be examination conducted by the college from a pool of questions set by the University. The students can also attain the credits through online courses like SWAYAM, MOOC etc. The College shall send the list of passed students to the University at least before the commencement of fifth semester examination.

- **IMPROVEMENT COURSE:**

Improvement of a particular semester can be done only once. The student shall avail of the improvement chance in the succeeding year after the successful completion of the semester concerned. The students can improve a maximum of two courses in a particular semester. The internal marks already obtained will be carried forward to determine the new grade/mark in the improvement examination. If the candidate fails to appear for the improvement examination after registration, or if there is no change in the results of the improved examination, the mark/grade obtained in the

first appearance will be retained.

Improvement and supplementary examinations cannot be done simultaneously.

- **MODERATION:**

Moderation is eligible as per the existing rules of the Academic Council.

EVALUATION AND GRADING

Mark system is followed instead of direct grading for each question. For each course in the semester letter grade and grade point are introduced in 10-point indirect grading system as per guidelines given in Annexure-1

- **COURSE EVALUATION**

The evaluation scheme for each course shall contain two parts

1) Internal assessment 2) External Evaluation

20% weight shall be given to the internal assessment. The remaining 80% weight shall be for the external evaluation.

- **INTERNAL ASSESSMENT**

20% of the total marks in each course are for internal examinations. The marks secured for internal assessment only need to be sent to University by the colleges concerned.

The internal assessment shall be based on a predetermined transparent system involving written tests, Class room participation based on attendance in respect of theory courses and lab involvement/records attendance in respect of Practical Courses.

Table-3: COMPONENTS WITH PERCENTAGE OF MARKS OF INTERNAL EVALUATION

	Component	Percentage of marks
Theory	Test paper	40%
	Assignment	20%,
	Seminar	20%
	Class room participation based on attendance	20%.
Practical	Record	60%
	Lab involvement	40%

(if a fraction appears in internal marks, nearest whole number is to be taken)

For the test paper marks, at least one test paper should be conducted. If more test papers are conducted, the mark of the best one should be taken. To ensure transparency of the evaluation process, the internal assessment marks awarded to the students in each course in a semester shall be notified on the notice board at least one week before the commencement of external examination. There shall not be any chance for improvement for internal marks. The course teacher(s) shall maintain the academic record of each student registered for the course, which shall be forwarded to the University by the college Principal after obtaining the signature of both course teacher and Head of the Department.

Table-4: SPLIT UP OF MARKS FOR TEST PAPER

Range of Marks in test paper	Out of 8 (Maximum internalmarks 20)	Out of 6 (Maximum internalmarks 15)
Less than 35%	1	1
35%- 45%	2	2
45% - 55%	3	3
55% - 65%	4	4
65% -85%	6	5
85% -100%	8	6

Table-5: SPLIT UP OF MARKS FOR CLASS ROOM PARTICIPATION

Range of CRP	Out of 4 (Maximum internal marks 20)	Out of 3 (Maximum internal marks 15)
$50\% \leq \text{CRP} < 75\%$	1	1
$75\% \leq \text{CRP} < 85\%$	2	2
85 % and above	4	3

- **EXTERNAL EVALUATION**

External evaluation carries 80% of marks. All question papers shall be set by the University. The external question papers may be of uniform pattern with 80/60 marks (The pattern is given in the Annexure III). The courses with 2/3 credits will have an external examination of 2 hours duration with 60 marks and courses with 4/5 credits will have an external examination of 2.5 hours duration with 80 marks.

The external examination in theory courses is to be conducted by the University with question papers set by external experts. The evaluation of the answer scripts shall be done by examiners based on a well-defined scheme of valuation and answer keys shall be provided by the University.

The external examination in practical courses shall be conducted by two examiners –

one internal and **an external**, the latter appointed by the University. The project evaluation is also to be carried out by two examiners- **one external and one internal**. After the external evaluation only marks are to be entered in the answer scripts. All other calculations including grading are done by the University.

- **REVALUATION**

In the new system of grading, revaluation is permissible. The prevailing rules of revaluation are applicable to CBCSSUG 2019. Students can apply for photocopies of answer scripts of external examinations. Applications for photocopies/scrutiny/revaluation should be submitted within 10 days of publication of results. The fee for this shall be as decided by the University.

- **EVALUATION OF AUDIT COURSES:**

The examination shall be conducted by the college itself. from the Question Bank prepared by the College. The Question paper shall be of 100 marks of 3 hour duration.

INDIRECT GRADING SYSTEM

Indirect grading System based on a 10-point scale is used to evaluate the performance of students.

Each course is evaluated by assigning marks with a letter grade (O, A+, A, B+, B, C, P, F, I or Ab) to that course by the method of indirect grading. An aggregate of P grade (after external and internal put together) is required in each course for a pass and also for awarding a degree (A minimum of 20% marks in external evaluation is needed for a pass in a course. But no separate pass minimum is needed for internal evaluation). No separate grade/mark for internal and external will be displayed in the grade card; only an aggregate grade will be displayed. Also the aggregate marks of internal and external are not displayed in the grade card.

A student who fails to secure a minimum grade for a pass in a course is permitted to write the examination along with the next batch.

After the successful completion of a semester, Semester Grade Point Average (SGPA) of a student in that semester is calculated using the formula given below. For the successful completion of a semester, a student should pass all courses. However, a student is permitted to move to the next semester irrespective of SGPA obtained.

SGPA of the student in that semester is calculated using the formula

$$\text{SGPA} = \frac{\text{Sum of the credit points of all courses in a semester}}{\text{Total credits in that semester}}$$

The Cumulative Grade Point Average (CGPA) of the student is calculated at the end of a programme. The CGPA of a student determines the overall academic level of the student in a programme and is the criterion for ranking the students. CGPA can be calculated by the following formula.

$$\text{CGPA} = \frac{\text{Total credit points obtained in six semesters}}{\text{Total credits acquired (120)}}$$

SGPA and CGPA shall be rounded off to three decimal places. CGPA determines the broad academic level of the student in a programme and is the index for ranking students (in terms of grade points). An overall letter grade (cumulative grade) for the entire programme shall be awarded to a student depending on her/his CGPA

GRADE CARD

The University shall issue to the students grade/marks card (by online) on completion of each semester, which shall contain the following information:

Name of University, name of college, title of UG programme, semester concerned, name and register number of student, code number, title and credits of each course opted in the semester, letter grade in each course in the semester, the total credits, total credit points and SGPA in the semester (corrected to three decimal places).

The final Grade card issued at the end of the final semester shall contain the details of all courses taken during the entire programme including those taken over and above the prescribed minimum credits for obtaining the degree. The final grade card shall show CGPA (corrected to three decimal places), percentage of marks (corrected to two decimal places) and the overall letter grade of a student for the entire programme. The final grade card shall also include the CGPA and percentage of marks of common courses, core courses, complementary courses and open courses separately. This is to be done in a 10- point indirect scale. The final Grade card also contains the list of Audit courses passed and the details of Extra credits.

METHOD OF INDIRECT GRADING

Evaluation (both internal and external) is carried out using Mark system .The Grade on the basis of total internal and external marks will be indicated for each course, for each semester and for the entire programme. Indirect Grading System in 10 -point scale is as below:

Table-6: TEN POINT INDIRECT GRADING SYSTEM

Percentage of Marks (Both Internal & External)	Grade	Interpretation	Grade point Average (G)	Range of grade points	Class
95 and above	O	Outstanding	10	9.5 -10	FirstClass with Distinction
85 to below 95	A+	Excellent	9	8.5 -9.49	
75 to below 85	A	Very good	8	7.5 -8.49	
65 to below 75	B+	Good	7	6.5 -7.49	First Class
55 to below 65	B	Satisfactory	6	5.5 -6.49	
45 to below 55	C	Average	5	4.5 -5.49	Second Class
35 to below 45	P	Pass	4	3.5 -4.49	Third Class
Below 35	F	Failure	0	0	Fail
Incomplete	I	Incomplete	0	0	Fail
Absent	Ab	Absent	0	0	Fail

GUIDELINES FOR THE EVALUATION OF PROJECTS

The evaluation of the project work shall be conducted at the end of the sixth semester, along with the practical examination. Evaluation of the Project Report shall be done under Mark System. The internal to external components is to be taken in the ratio 1:4. The total marks earmarked for the project work is 75 (Internal 15+ External 60). The marks shall be awarded on the basis of the originality, structural and content wise perfection of the work. The evaluation of the project will be done at two stages:

a) **Internal Assessment** (assessed by **Supervising Teachers**)

Internal Assessment should be completed 2 weeks before the last working day of VI Semester. Internal Assessment marks should be published in the Department. Submission of the Project Report and presence of the student for viva are compulsory for internal evaluation. Internal assessment of the project will be based on its content, method of presentation, final conclusion and orientation to research aptitude.

External evaluation (assessed by **External Examiner** appointed by the College)

Grade for the project will be awarded to candidates, combining the internal and external marks. Project evaluation will be done along with practical examinations. External Examiners will be appointed by the College. The Chairman of the VI semester examination should form and coordinate the evaluation teams and their work. The Chairman Board of Examinations, may at his discretion, on urgent requirements, make certain exception in the guidelines for the smooth conduct of the evaluation of project. No marks shall be awarded to a candidate if she/ he fails to submit the project report for external evaluation. Project presentations (10 to 15 minutes) should be supported with electronic presentation methods. (PowerPoint / any other similar presentation making program can be used).

Table-7: ASSESSMENT OF DIFFERENT COMPONENTS OF PROJECT

Components		Percentage of marks
Internal (20%)	External (80%)	
Originality	Relevance of the topic, Statement of objectives	20
Methodology	Reference/ Bibliography, Presentation, quality of Analysis/ Use of Statistical tools.	20
Scheme/ Organization of Report	Findings and recommendations	30
Viva - Voce	Viva - Voce	30

The student should get a minimum P Grade in aggregate of External and Internal. There shall be no improvement chance for the Marks obtained in the Project Report. In the extent of student failing to obtain a minimum of Pass Grade, the project work may be re-done and a new internal mark may be submitted by the Parent Department. External examination may be conducted along with the subsequent batch.

PRACTICAL RECORD

A certified record book is an evidence of the practical works done by the candidate during the course. The entire experiments mentioned in the practical syllabus are expected to be done at the Centre. Those items which do not demand illustrations can be excluded from recording. The records must be treated seriously and it should be valued properly. The genuine work should be appropriately rewarded. The total marks set apart for the records of the programme are **50** i.e., 15 marks for the record of practical papers I & II, 10 marks for paper III, 10 marks for record of elective paper.

Parameters for External evaluation of Record:

- a Content should cover all the practical works mentioned in the syllabus for recording.
- b Neatness, scientific accuracy and perfection.

SUBMISSIONS

Submissions are mandatory for each practical paper and it carries 55 marks altogether. The items to be submitted as part of each practical paper for valuation are appended below.

Practical paper - I

Students are expected to submit any five properly identified specimens belonging to Pathology (either the diseases mentioned in the syllabus or any locally available common diseases of crop plants can be used), duly certified by the HoD.

Practical Paper - II

Every student has to submit (i) A photo album containing original images of properly identified types of fruits and inflorescence and plants at least one each from all families mentioned in the syllabus, with specifications on systematic position, location, date, name and reg. no of the student etc., duly certified by the HoD. Individuality should be strictly maintained while submitting the photo album.
(ii) Study tour report duly certified by the HoD.

Practical Paper -III

Every student has to submit duly certified detailed reports of visit to (i) Plant breeding station (ii) Research station with reference to Biotechnology/Molecular Biology.

Elective Paper Record

There is no practical examination for elective papers; the practical works mentioned in the syllabus have to be done, recorded, certified and to be submitted on the day of Practical examination of Paper III.

Study Tour Report

Every student has to submit a report of study tour conducted as per the conditions mentioned in the syllabus of Systematics under Core Course 6, duly certified by HoD.

Table-8 : MARK DISTRIBUTION OF SUBMISSIONS

Submission	Items	Marks
Pract. P-I	Pathology herbarium sheets	5
Pract. P-II	Photo album of Morphology and Systematics	10
Pract. P-III	Report of visit to (i) Plant breeding station (ii) Research station (Biotech/ Molecular Biol. Lab)	5
Total for submissions		20
Record of Elective Paper		10
Study tour report		5

QUESTION PAPER PATTERNS

QUESTION PAPER TYPE 1

Scheme of Examinations:

The external QP with **80** marks and internal examination is of **20** marks. Duration of each external examination is **2.5** Hrs. The pattern of External Examination is as given below. The students can answer all the questions in Sections A&B. But there shall be Ceiling in each section.

Section A: Short answer type carries 2 marks each - 15 questions, Ceiling - 25

Section B: Paragraph/ Problem type carries 5 marks each - 8 questions, Ceiling - 35

Section C: Essay type carries 10 marks (2 out of 4) $2 \times 10 = 20$

QUESTION PAPER TYPE 2

Scheme of Examinations:

The external QP with **60** marks and internal examination is of **15** marks. Duration of each external examination is **2** Hrs. The pattern of External Examination is as given below. The students can answer all the questions in Sections A & B. But there shall be Ceiling in each section.

Section A: Short answer type carries 2 marks each - 12 questions, Ceiling - 20

Section B: Paragraph/ Problem type carries 5 marks each - 7 questions, Ceiling - 30

Section C: Essay type carries 10 marks (1 out of 2) $1 \times 10 = 10$

Table-9: SEMESTER WISE DISTRIBUTION OF CREDITS

Semester	Course	Credit
I	Common course: English	3
	Common course: English	4
	Common course: Additional Language	4
	Core Course 1: Angiosperm Anatomy & Microtechnique	3
	Complementary course: Chemistry	2
	Complementary course: Zoology	2
	Total credits acquired in the semester	18
II	Common course: English	3
	Common course: English	4
	Common course: Additional Language	4
	Core Course 2: Microbiology, Mycology, Lichenology & Plant Pathology	3
	Complementary course: Chemistry	2
	Complementary course: Zoology	2
	Total credits acquired in the semester	18
III	Common course: English	4
	Common course: Additional Language	4
	Core Course 3: Phycology, Bryology, Pteridology & Gymnosperms	3
	Complementary course: Chemistry	2
	Complementary course: Zoology	2
	Total credits acquired in the semester	15
IV	Common course: English	4
	Common course: Additional Language	4
	Core Course 4: Research Methodology, Reproductive Botany & Palynology	3
	Core Course 5: Practical of Sem 1-4 (Paper- I)	4
	Complementary course: Chemistry	2
	Complementary course: Chemistry Practical	4
	Complementary course: Zoology	2
	Complementary course: Zoology Practical	4
Total credits acquired in the semester	27	

Semester	Course	Credit
V	Core Course 6: Cell Biology, Palaeobotany, Phytogeo. & Evolution	3
	Core Course 7: Angiosperm Morphology & Systematics	3
	Core Course 8: Tissue Culture, Horticulture, Econ. Bot & Ethnobotany	3
	Core Course 9: Plant Physiology	3
	Open course	3
	Total credits acquired in the semester	15
VI	Core Course 10: Genetics & Plant Breeding	3
	Core Course 11: Biotechnology, Molecular Biology &	3
	Core Course 12: Plant Biochemistry	3
	Core Course 13: Environmental Science	3
	Core Course 14: Elective	3
	Core Course 15: Practical of Sem 5 (Paper- II)	5
	Core Course 16: Practical of Sem 6 (Paper- III)	5
	Core Course 17: Project Work	2
	Total credits acquired in the semester	27
	Total credits acquired in all semesters	120
	Audit courses (Sem 1, II, III & IV)	16
	Extra Credits	4
	Grant Total	140

CORE& OPEN COURSES

Total credits 58 (Core courses: 55 + Open course 3)

Table-10.1: COURSE STRUCTURE, WORK LOAD AND CREDIT DISTRIBUTION OF CORE COURSES: (Semesters 1 -4)

Semester	Course Code	Title of Course	Hours/ Semester		Hours/ Week		Credit
S- I	GBOT1B01T	CORE COURSE 1. Angiosperm Anatomy & Microtechnique	36	72	2	4	3
	-	Core Course -1 Practical	36		2		*
S -II	GBOT2B02T	CORE COURSE 2. Microbiology, Mycology, Lichenology & Plant	36	72	2	4	3
	-	Core Course -2 Practical	36		2		*
S-III	GBOT3B03T	CORE COURSE 3. Phycology, Bryology & Pteridology & Gymnosperms	54	90	3	5	3
	-	Core Course -3 Practical	36		2		*
S-IV	GBOT4B04T	CORE COURSE 4 Research Methodology, Reproductive Bot. & Palynology	54	90	3	5	3
	-	Core Course -4 Practical	36		2		*
	GBOT4B05P	CORE COURSE 5: Practical - I Angiosperm Anatomy, Microtechnique, Microbiology, Mycology, Lichenology, Plant Pathology, Phycology, Bryology & Pteridology, Gymnosperms, Research Methodology Reproductive Botany & Palynology					4
TOTAL					18	16	
*Credits of practical (total given against Practical paper GBOT4B05P)							

Table-10.2: COURSE STRUCTURE, WORK LOAD AND CREDIT DISTRIBUTION OF CORE COURSES AND OPEN COURSES (Semester 5)

Course Code	Title of Course	Hours/ Semester		Hours/ Week		Credit
GBOT5B06T	CORE COURSE 6 Cell biology, Palaeobotany, Phytogeography & Evolution	54	90	3	5	3
-	Core Course -6 Practical	36		2		*
GBOT5B07T	CORE COURSE 7 Angiosperm Morphology & Systematics	54	90	3	5	3
-	Core Course-7. Practical	36		2		*
GBOT5B08T	CORE COURSE 8 Tissue culture, Horticulture, Economic Botany& Ethnobotany	54	90	3	5	3
-	Core Course 8. Practical	36		2		*
GBOT5B09T	CORE COURSE. - 9 Plant Physiology	54	90	3	5	3
-	Core Course-9. Practical	36		2		*
-	OPEN COURSE	54	54	3	3	3
GBOT6B16D	PROJECT WORK	36	36	2	2	**
TOTAL					25	15
*Credits of practical (total given against Practical paper GBOT6B14P, in table 10.3)						
** Exam at the end of Semester VI						

Table-10.3: COURSE STRUCTURE, WORK LOAD AND CREDIT DISTRIBUTION OF CORE COURSES: (Semester 6)

Course Code	Title of Course	Hours/ Semester		Hours/ Week		Credit
GBOT6B10T	CORE COURSE 10 Genetics & Plant Breeding	54	90	3	5	3
-	Core Course 10. Practical	36		2		*
GBOT6B11T	CORE COURSE - 11 Biotechnology, Molecular biology & Bioinformatics	54	90	3	5	3
-	Core Course- 11. Practical	36		2		*
GBOT6B12T	CORE COURSE -12 Plant Biochemisrty	54	90	3	5	3
-	Core Course- 12. Practical	36		2		*
GBOT6B13T	CORE COURSE - 13 Environmental Science	54	90	3	5	3
-	Core Course- 13. Practical	36		2		*
GBOT6E01T	CORE COURSE 14 Elective- Choice - I Genetic Engineering	54	90	3	5	3
-	Elective Choice - I. Practical	36		2		*
GBOT6E02T	CORE COURSE 14 Elective- Choice - II Advances in Crop Improvement	54	90	3	5	3
-	Elective Choice - II. Practical	36		2		*
GBOT6E03T	CORE COURSE 14 Elective- Choice - III Advanced Angiosperm Systematics	54	90	3	5	3
-	Elective Choice - III. Practical	36		2		*
GBOT6B14P	CORE COURSE 15: Practical - II: Cell Biology, Palaeobotany, Phytogeography, Angiosperm Morphology, Systematics, Tissue culture, Horticulture, Econ. Botany, Ethnobot., Plant Physiology					5
GBOT6B15P	CORE COURSE 16: Practical - III: Genetics, Pl. Breeding, Biotechnology, Molecular Biology, Plant Biochemistry & Environmental Science					5
GBOT6B16D	CORE COURSE 17: PROJECT WORK	**	**	**	**	2
TOTAL					25	27
*Credits of practical (total given against Practical paper GBOT6B15P)						
** Workload eligible is shown in table 10.2, (semester 5)						

Table-11: INSTRUCTIONAL HOURS, MARK DISTRIBUTION AND SCHEME OF EXAMINATION OF CORE COURSES& OPEN COURSES

Course Code	Instructional Hours		Duration of Exams (hrs)	Marks				Total Marks	
	Theory	Practical		Theory		Practical			
				External	Internal	External	Internal		
GBOT1B01T	36	36	2	60	15	--	--	75	
GBOT2B02T	36	36	2	60	15	--	--	75	
GBOT3B03T	54	36	2	60	15	--	--	75	
GBOT4B04T	54	36	2	60	15	--	--	75	
GBOT4B05P	--	--	3	--	--	80	20	100	
Record	--	--		--	--	15	--		15
Submission	--	--		--	--	5	--		5
GBOT5B06T	54	36	2	60	15	--	--	75	
GBOT5B07T	54	36	2	60	15	--	--	75	
GBOT5B08T	54	36	2	60	15	--	--	75	
GBOT5B09T	54	36	2	60	15	--	--	75	
OPEN COURSE	54	---	2	60	15	--	--	75	
GBOT6B10T	54	36	2	60	15	--	--	75	
GBOT6B11T	54	36	2	60	15	--	--	75	
GBOT6B12T	54	36	2	60	15	--	--	75	
GBOT6B13T	54	36	2	60	15	--	--	75	
GBOT6E01/02/03T	54	36	2	60	15	--	--	75	
GBOT6B14P	--	--	4	--	--	80	20	100	
Record	--	--		--	--	15	--		15
Submission	--	--		--	--	10	--		10
Study tour	--	--		--	--	5	--		5
GBOT6B15P	--	--	4	--	--	80	20	100	
Record	--	--		--	--	10	--		10
Submission	--	--		--	--	5	--		5
Record of Elective	--	--	--	--	--	10	--	10	
GBOT6B16D		36		--	--	60	15	75	
TOTAL				840	210	375	75	1500	

CORE COURSES

CORE COURSE 1 ANGIOSPERM ANATOMY & MICROTECHNIQUE

Semester	Course code	Credits	Hrs/wk	Marks (Ext.+Int.)	Duration of exam
1	GBOT1B01T	3	4	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Demonstrate the ability to differentiate plant organs by observing anatomical features.
2. Understand the non-living inclusions of plants and their significance.
3. Differentiate tissues and their functions.
4. Illustrate primary and secondary (normal and anomalous) structures of plant organs.
5. Explain various developmental details of angiosperms.
6. Realize the significance and applications of microtechnique.

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theory	Practical	Total
1	Angiosperm Anatomy	22	27	49
2	Microtechnique	14	9	23
Total		36	36	72

QUESTION PAPER PATTERN & SUBJECT WISE DISTRIBUTION OF MARKS

Type of questions	Anatomy	Microtechnique	Total marks
2 marks (total 12)	8	4	Ceiling 20
5 marks (total 7)	4	3	Ceiling 30
10 marks (total 2)	1	1	1x10 = 10
TOTAL			60

ANGIOSPERM ANATOMY

Module - I. (5 hrs)

1. Cell Wall - Structure and development; Growth of Cell wall; cell wall materials
(2 hrs)
2. Non-living inclusions
(3 hrs)
 - a. Reserve food materials: carbohydrates, proteins, fats & oils. Carbohydrates:

sugars & starch; Starch grains-structure, types with examples; Proteins- Aleurone grains with examples; Fats & oils examples.

b. Secretory materials

c. Waste materials - Nitrogenous - alkaloids, Non-nitrogenous- gums, resins, tannins, organic acids, essential oils; Mineral crystals - Calcium oxalate, Druses, Raphides, Calcium carbonate -cystoliths with examples

Module-II (5 hrs)

1. Tissues: Definition -Types

a. Meristematic tissues - classification.

(2 hrs)

i. Theories on apical organization - Apical cell theory, Histogen theory, Tunica Corpus theory

ii. Organization of shoot apex and differentiation of tissues (protoderm, procambium and ground meristem).

iii. Organization of root apex in dicots - common types with three sets of initials- in monocots: Maize type with four sets of initials

b. Mature tissues: definition classification - simple, complex and secretory (3hrs)

i. Simple tissues: structure occurrence and function.

ii. Complex tissues: Xylem & Phloem-structure, origin, phylogeny and function

iii. Secretory tissues: glands, glandular hairs, nectaries, hydathodes, schizogenous and lysigenous ducts, resin ducts, laticifers - articulated and non-articulated

Module - III (4 hrs)

1. Vascular bundles - Origin and types - conjoint, collateral, bi-collateral, open closed, radial, concentric - amphicribal and amphivasal.

(2 hrs)

2. Primary structure of root, stem and leaf (brief account only)

(2 hrs)

Module- IV (8 hrs)

1. Normal secondary growth in Dicot stem and Dicot root. Formation of vascular cambial ring - structure and activity of cambium - storied and non-storied, fusiform and ray initials; Formation of secondary wood, secondary phloem, vascular rays, growth ring, heart wood, sapwood. (3 hrs)

2. Extra stelar Secondary thickening in stem and root - Periderm formation. Structure - phellogen, phellem, phelloderm, bark, lenticels - structure & function.

(2 hrs)

3. Anomalous secondary growth - general account with special reference to the anomaly in Dicot stem - *Boerhaavia*, *Bignonia* and Monocot stem- *Dracaena* (3 hrs)

PRACTICAL (ANGIOSPERM ANATOMY)

1. Identification at sight the different types of tissues and vascular bundles.
2. Primary structure of stem, root and leaf of Dicots and Monocots
 - a. Dicot stem : normal - *Eupatorium*; bi-collateral - *Cucurbita*
 - b. Dicot root - *Tinospora*
 - c. Monocot stem - Grass
 - d. Monocot root - *Rhoeo*
 - e. Dicot leaf - *Ixora*
 - f. Monocot leaf - *Kyllinga*
3. Secondary structure of Dicot stem *Polyalthia* and root - *Tinospora*
4. Anomalous secondary thickening in *Boerhaavia*, *Bignonia* and *Dracaena*

REFERENCES (ANGIOSPERM ANATOMY)

1. Cuttler, EG. (1969). Plant Anatomy- Part I Cells & Tissue. Edward Arnold Ltd., London.
2. Cuttler, E.G. (1971). Plant Anatomy, Part III Organs Edward Arnold Ltd., London.
3. Eames, A. J. & L H Mac Daniels (1987) An Introduction to Plant Anatomy. Tata McGraw Hill Publishing Company Ltd. New Delhi.
4. Esau K. (1985) Plant Anatomy (2nd ed.) Wiley Eastern Ltd. New Delhi.
5. Fahn A (2000) Plant Anatomy. Permagon Press.
6. Pandey B.P. (2001) Plant Anatomy, S. Chand & Co. Delhi.
7. Tayal M.S (2012) Plant Anatomy. Rastogi Publishers, Meerut.
8. Vasishta P.C. (1974) Plant Anatomy, Pradeep Publication, Meerut, UP.

MICROTECHNIQUE

Module -1 (8 hrs)

1. Principles of microscopy and parts of microscopes (1 hrs)
2. Types of microscopes: Light microscope- Compound microscope, Phase contrast microscope, Fluorescent microscope; Electron microscope- Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy(SEM) (5 hrs)
3. Micrometry- Stage micrometer, Ocular micrometer, Calibration and working. (1 hrs)
4. Illustrations using digital camera and Photomicrography. (1 hrs)

Module -II (6 hrs)

1. General account of Killing and fixing, agents used for killing and fixing. Common fixatives - Formalin - Acetic - Alcohol, Farmers fluid, Carnoy's fluid, Chromic acid - Acetic acid - Formalin (CRAF) (2 hrs)
2. Dehydration and infiltration - general account of dehydration (Ethanol, Isopropyl alcohol, Acetone, Glycerine). Ethanol - Xylene series and Tertiary Butyl Alcohol Series. (1 hrs)
3. Infiltration - paraffin wax method, embedding. (½ hr)
4. Free hand sectioning; Microtome (Rotary and sledge) serial sectioning and its significance. (1 hrs)
5. Staining - General account, Classification: Natural dyes, Coal-tar dyes. Double staining, Vital staining (1 hrs)
6. Mounting, Whole mounting, Maceration and Smears (½ hr)

PRACTICALS (MICROTECHNIQUE)

1. Parts of microscope and its operation (drawing not required)
2. Free hand sectioning of stem, leaves, Staining and mounting.
3. Measurement of pollen size using micrometer.
4. Demonstration of dehydration, infiltration, embedding and microtomy.

REFERENCES (MICROTECHNIQUE)

1. Johansen, D.A. (1940) Plant Microtechnique. McGraw Hill Book Co., Inc. New York.
2. Kanika, S. (2007) Manual of Microbiology - Tools and Techniques. Ane's student edition.
3. Khasim, S. K. (2002) Botanical Microtechnique ; principles and Practice, Capital Publishing Company, New Delhi.
4. Toji, T. (2004) Essentials of Botanical Microtechnique. Apex Infotec Publ.

CORE COURSE -2

MICROBIOLOGY, MYCOLOGY, LICHENOLOGY AND PLANT PATHOLOGY

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
2	GBOT2B02T	3	4	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Understand basics of microbial life and their economic importance.
2. Develop general awareness on the diversity of microorganisms, fungi and lichens.
3. Analyze the ecological role played by bacteria, fungi and lichens
4. Identify plant diseases and find out control measures.
5. Realize the significance of plant diseases as far as crop production is concerned.

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theory	Practical	Total
1	Microbiology	12	9	21
2	Mycology	12	14	26
3	Lichenology	4	4	8
4	Plant Pathology	8	9	17
Total		36	36	72

QUESTION PAPER PATTERN & SUBJECT WISE DISTRIBUTION OF MARKS

Type of questions	Microbiology	Mycology	Lichenology	Patholog	Total
2 marks (total 12)	3	4	2	3	Ceiling 20
5 marks (total 7)	3	2	1	1	Ceiling 30
10 marks (total 2)	2				1x10 = 10
TOTAL					60

MICROBIOLOGY

1. Introduction to Microbiology (1hr)
2. Bacteria -Classification based on morphology and staining, ultra structure of bacteria; Bacterial growth, Nutrition, Reproduction. (5 hr)
3. Viruses - Classification, architecture and multiplication, Bacteriophages, TMV, retroviruses- HIV, Virioids, Prions. (3hrs)
4. Microbial ecology - Rhizosphere and Phyllosphere. (1 hr)
5. Industrial microbiology -alcohol, acids, milk products single cell proteins (1 hr)
6. Economic importance of bacteria, Vaccines: importance, mechanism. (1 hr)

PRACTICAL (MICROBIOLOGY)

1. Simple staining
2. Gram staining – Curd, root-nodules
3. Culture and isolation of bacteria using nutrient agar medium (demonstration only)

REFERENCES (MICROBIOLOGY)

1. Alain Durieux (2009) Applied Microbiology, Springer International Edition.
2. Dubey R.C. & D.K. Maheswari (2000) A Textbook of Microbiology, Chand & Co, New Delhi.
3. Frazier W.C. (1998) Food Microbiology, Prentice Hall of India, Pvt. Ltd.
4. Hans g Schlegel. (2012) General Microbiology-Cambridge University Press. Low Priced Indian Edition, Replica Press Pvt. Ltd.
5. Kumar H.D. & S. Kumar. (1998) Modern Concepts of Microbiology, Tata McGraw Hill. Delhi.
6. Pelzar M.J., E.C.S. Chan & N.R. Kreig. (1986) Microbiology McGraw Hill, New York.
7. Prescott, L.M., Harley J.P., Klein D. A. (2005) Microbiology, McGraw Hill, India. 6thedition.
8. Rangaswami, R & C.K.J. Paniker. (1998) Textbook of Microbiology, Orient Longman.
9. Ross, F.C. (1983) Introductory Microbiology. Charles E. Merrill Publishing Company.
10. Schlegel (2008). General Microbiology. Cambridge University press India Pvt Ltd
11. Sharma P.D. (2004). Microbiology and Plant Pathology Rastogi Publication.
12. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.

MYCOLOGY

1. General characters and phylogeny of the kingdom Fungi, the concept of anamorph and teleomorph.
(2 hrs)
2. General characters, distribution, and biology of the following groups of fungi
(8 hrs)
 - a) Mastigomycotina. Type: *Pythium*
 - b) Zygomycotina. Type: *Rhizopus*
 - c) Ascomycotina. Type:, *Xylaria, Aspergillus*
 - d) Basidiomycotina. Types: *Agaricus, Puccinia*
3. Economic importance of fungi: medicinal, industrial, agricultural. Fungi as model organisms for research.

(1 hr)

4. Ecological importance of fungi: different modes of nutrition (pathogenic/ parasitic, saprobic, symbiotic) (1 hr)

PRACTICAL (MYCOLOGY)

1. Micropreparation - Lactophenol cotton blue - Slides of the above mentioned types.

REFERENCE (MYCOLOGY)

1. Alexopoulos C.J., Mims, C.W. and Blackwell, M. (1996) *Introductory Mycology*, 4th Edn. John Wiley and Sons, New York.
2. Alexopoulos, C.J. and Mims C.W. (1979) *Introductory Mycology*, 3rd Edition, John Wiley and Sons, New York.
3. Jim Deacon (2007) *Fungal Biology*, 4th edition, Blackwell publishing, Ane Books Pvt Ltd
4. Mehrotra R.S. and Aneja K.R. (1990) *An Introduction to Mycology*, Wiley, Eastern Limited, New Delhi.
5. Sethi, I.K. and Walia, S.K. (2011) *Text book of Fungi and their Allies*, Macmillan Publishers India Ltd.

LICHENOLOGY

1. Introduction: Type of Interaction between the components symbiosis –mutualism. (1 hr)
2. Classification, growth forms, Structure, Reproduction, Economic importance. Type: *Usnea* (2hrs)
3. Toxicology, Lichens as food, Bioremediation, Ecological indicators, Pollution indicators, Lichen in Soil formation and pioneers of Xerosere. (1 hr)

PRACTICAL (LICHENOLOGY)

1. Identification of different forms of Lichens.
2. *Usnea* : structure of thallus, fruiting body

REFERENCES(LICHENOLOGY)

1. Gilbert, O. (2004) *Lichen Hunters*. The Book Guild Ltd. England
2. Kershaw, K.A. (1985) *Physiological Ecology of Lichen* Cambridge University Press.
3. Mamatha Rao, (2009) *Microbes and Non-flowering plants. Impact and applications*. Ane Books, New Delhi.
4. Sanders, W.B. (2001) Lichen interface between mycology and plant morphology. *Bioscience*, 51: 1025-1035.
<http://www.lichen.com>
<http://www.newscientistspace.com>

PLANT PATHOLOGY

1. Introduction - Concepts of plant disease, pathogen, causative agents, symptoms

- (1 hr)
2. Symptoms of diseases: spots, blights, wilts, rots, galls, canker, gummosis, necrosis, chlorosis, smut, rust, damping off. (1 hr)
3. Control measures: Chemical, biological and genetic methods, quarantine measures. (1 hr)
4. Brief study of Plant diseases in South India (Name of disease, pathogen, symptom and control measures need to be studied) (5 hrs)
1. Citrus Canker
 2. Mahali disease of arecanut,
 3. Blast of paddy,
 4. Quickwilt of pepper,
 5. Mosaic disease of tapioca,
 6. Bunchy top of banana.
 7. Grey leaf spot of coconut.

PRACTICAL (PLANT PATHOLOGY)

Identification of the disease, pathogen, symptoms and control measures of the following: (drawing not required)

- a. Citrus canker
- b. Mahali disease
- c. Tapioca mosaic disease
- d. Blast of Paddy
- e. Quick wilt of pepper
- f. Bunchy top of Banana
- g. Grey leaf spot of coconut

SUBMISSION (PLANT PATHOLOGY)

Students are expected to submit five properly identified Pathology specimens /herbarium during the practical examination of Paper-I held at the end of Fourth semester. Diseases mentioned in the syllabus or any locally available common diseases of crop plants can be selected for submission.

REFERENCES (PLANT PATHOLOGY)

1. Agros, G.N. (1997) Plant Pathology (4th ed) Academic Press.
2. Bilgrami K.H. & H.C. Dube. (1976) A textbook of Modern Plant Pathology. International Book Distributing Co. Lucknow.
3. Mehrotra, R.S. (1980) Plant Pathology - TMH, New Delhi.
4. Pandey, B.P. (1999) Plant Pathology. Pathogen and Plant diseases. Chand & Co., New Delhi.
5. Rangaswami, G. (1999) Disease of Crop plants of India Prentice Hall of India Pvt. Ltd.
6. Sharma P.D. (2004) Plant Pathology Rastogi Publishers.

CORE COURSE- 3
PHYCOLOGY, BRYOLOGY, PTERIDOLOGY & GYMNOSPERMS

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
3	GBOT3B03T	3	5	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Appreciate the diversity and evolutionary significance of lower plant groups.
2. Classify algae, bryophytes and pteridophytes.
3. Understand the economic and ecological importance of lower plant groups.
4. Understand the role of gymnosperms as a connecting link between pteridophytes and angiosperms

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theory	Practical	Total
1	Phycology	15	9	24
2	Bryology	11	9	20
3	Pteridology	15	9	24
4	Gymnosperms	13	9	22
Total		54	36	90

QUESTION PAPER PATTERN & SUBJECT WISE DISTRIBUTION OF MARKS

Type of questions	Phycology	Bryology	Pterido	Gymnosperm	Total
2 marks (total 12)	4	2	4	2	Ceiling 20
5 marks (total 7)	2	1	2	2	Ceiling 30
10 marks (total 2)	2				1x10 = 10
TOTAL					60

PHYCOLOGY

1. Introduction, Range of thallus structure (1 hr)
2. General Features: Occurrence, thallus structure, reproduction, and life cycle of the types given below: (12 hrs)
 - a. Cyanophyceae : *Nostoc*
 - b. Chlorophyceae: *Chlorella, Chara.*
 - c. Xanthophyceae: *Vaucheria.*
 - d. Bacillariophyceae: *Pinnularia.*

- e. Phaeophyceae: *Sargassum*.
 - f. Rhodophyceae: *Polysiphonia*.
4. Economic Importance: Algae as food, fodder, green manure, bio-fuels, pollution indicators, research tools, medicinal uses of algae, Commercial Products – carrageenin, agar-agar, alginates, diatomaceous earth. Harmful effects – Water bloom, eutrophication, neurotoxins, and parasitic algae. (2 hrs)

PRACTICAL (PHYCOLOGY)

1. Identification of the vegetative and reproductive structures of the types studied.

REFERENCES (PHYCOLOGY)

1. Anand, N. (1989) Culturing and cultivation of BGA. Handbook of Blue Green Algae Bishen Sing Mahendra Pal Sing.
2. Fritsch, F.E. (1935) The structure and reproduction of the algae. Vol. 1 and II, Cambridge University Press.
3. Kanika Sharma (2007) Manual of Microbiology. Tools and Techniques 2nd Edition. Ane Books India.
4. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi
5. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition
6. Mamatha Rao. (2009) Microbes and Non flowering plants: impact and application. Ane Books Pvt. Ltd., New Delhi.
7. Morris, I. (1967) An Introduction to the algae. Hutchinson and Co. London.
8. Papenfuss, G.F. (1955) Classification of Algae.
9. Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India. 6th edition.
10. Rober Edward Lee (2008) Phycology. Cambridge University Press India Pvt. Ltd. Ansari Road, New Delhi
11. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
12. Van Den Hoek, D.G. Mann and H.M. JaHns (2009) Cambridge University Press India Pvt. Ltd. Ansari Road, New Delhi.

BRYOLOGY

1. Introduction, general characters and classification by Stotler & Stotler (2008) (3 hr)
2. Study the distribution, morphology, anatomy, reproduction, life cycle and affinities of the following types (Developmental details not required) (6 hrs)
 - a. *Riccia* (Marchantiophyta)
 - b. *Anthoceros* (Anthocerotophyta)
 - c. *Funaria* (Bryophyta)

Evolution of gametophyte and sporophyte among bryophytes

3. Economic importance of Bryophytes (1 hr)
4. Fossil Bryophytes (1 hr)

PRACTICAL (BRYOLOGY)

1. *Riccia* - Habit, Anatomy of thallus, V.S. of thallus through antheridium, archegonium and sporophyte.
2. *Anthoceros*- Habit, Anatomy of thallus. V.S. of thallus through antheridium, archegonium and sporophyte.
3. *Bryum*- Habit, structure of antheridial cluster, archegonial cluster, L.S. of sporophyte.

REFERENCES (BRYOLOGY)

1. Campbell H.D.(1940) The Evolution of land plants (Embryophyta), Univ. Press, Stanford.
2. Chopra R.N. and P.K. Kumar, (1988) Biology of Bryophytes. Wiley Eastern Ltd. New Delhi.
3. Crandall-Stotler, B. and R. E. Stotler. (2008) In A. J. Shaw and B. Goffinet, Bryophyte Biology, Cambridge University Press (Revised edition).
4. Gangulee Das and Dutta. (2007) College Botany Vol.1, Central Book Dept. Calcutta.
5. Gangulee, H.C. and Kar A.K. College Botany Vol.II, New Central Book Agency.
6. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
7. Shaw.J.A. and Goffinet B. (2000) Bryophyte Biology, Cambridge University Press.
8. Smith G.M. (1938) Cryptogamic Botany Vol.II. Bryophytes and pteridophytes. McGraw Hill Book Company, London.
9. Sporne K.R. (1967) The Morphology of Bryophytes. Hutchinson University Library, London.
10. Vander-Poorteri (2009) Introduction to Bryophytes. COP.
11. Vasishta B.R. Bryophyta. Revised edition. (2011). S. Chand and Co. New Delhi.
12. Watson E.V. (1971) The structure and life of Bryophytes. Hutchinson University Library, London.

PTERIDOLOGY

1. Introduction, general characters. (1 hrs)
2. Study the distribution, morphology, anatomy, reproduction, life cycle and affinities of the following types (Developmental details are not required) (8 hrs)
 - a. *Psilotum* (Psilotopsida)
 - b. *Selaginella* (Lycopsida).

- c. *Equisetum* (Equisetopsida)
 - d. *Pteris* (Polypodiopsida)
3. Apogamy and apospory in Pteridophytes; Stellar evolution in Pteridophytes; Heterospory and seed habit; Affinities of Pteridophytes; Economic importance of Pteridophytes. (6 hrs)

PRACTICAL (PTERIDOLOGY)

1. *Psilotum*- habit, T.S. of stem, C.S. of synangium (slides only)
2. *Selaginella* - habit, T.S. of stem, T.S. of rhizophore, L.S. of strobilus
3. *Equisetum* - habit, T.S. of stem, L.S. of strobilus
4. *Pteris* - habit, T.S. of stem, C.S. of sporophyll

REFERENCES (PTERIDOLOGY)

1. Bower, F.O. (1935) Primitive Land Plants - Cambridge, London.
2. Chandra S. & Srivastava M. (2003) Pteridology in New Millenium, Kluwer Academic Publishers.
3. Eames, A.J. (1979) Morphology of Vascular Plants, Lower Group. Wiley International edition, New Delhi.
4. Parihar, N.S. (1977) Biology and Morphology of Pteridophytes, Central Book Depot, Allhabad.
5. Rashid, A. (1976) An Introduction to Pteridopyta, Vikas publ. Co. New Delhi.
6. Ranker, T.A. & Haufler, C.H. (eds.) (2008) Biology and Evolution of Ferns and Lycophytes. Cambridge University Press.
7. Mehlreter, K., Walker, L.R. & Sharpe, J.M. (eds.) (2010) Fern Ecology. Cambridge University Press.
8. Smith, A.R., Pryer, K.M., Schuettpelz, E. Korall, P., Schnelder, H. and Wolf, P.G. (2006) A Classification for extant ferns. *Taxon* 53: 705-731.
9. Smith, A.R., Pryer, K.M., Schuettpelz, E. (2008) Fern classification. *In*: T.A. Ranker and C.H. Haufler (eds.). Biology and Evolution of Ferns and Lycophytes. Cambridge University press, U.K.
10. Smith G.M. (1938) Cryptogamic Botany Vol. II. Bryophytes and Pteridophytes. McGraw Hill Book Company, London.
11. Sporne, K.R. (1967) Morphology of Pteridophytes - Hutchinson University Library, London.
12. Vasishta B.R. (1993) Pteridophyta - S. Chand and Co., New Delhi.

GYMNOSPERMS

THEORY (13 Hours)

1. General character of Gymnosperms
2. Distribution, morphology, anatomy, reproduction and life cycle of the following types: a. *Cycas* b. *Pinus* c. *Gentum*
3. Economic importance of Gymnosperms.

PRACTICAL (GYMNOSPERMS)

1. *Cycas*- Habit, coralloid root, T.S. of coralloid root, T.S. of leaflet, T.S. of rachis, male cone and L.S. of male cone , microsporophyll, megasporophyll, T.S. of microsporophyll, L.S. of ovule and seed.
2. *Pinus*- branch of unlimited growth, spur shoot, T.S. of stem and needle, male cone and female cone, L.S. of male cone and female cone, seed.
3. *Gnetum*- Habit, stem T.S., leaf T.S., male and female cones, L.S. of ovule, seed.

REFERENCES(GYMNOSPERMS)

1. Chamberlain C.J. (1935)Gymnosperms -Structure and Evolution, ChicagoUniversity Press.
2. Coutler J.M. and C.J. Chamberlain, (1958) Morphology of Gymnosperms.Central Book Depot, Allahabd.
3. Sporne K.R. (1967) The Morphology of Gymnosperms, Hutchinson and Co. Ltd.London.
4. Sreevastava H.N. (1980) A Text Book of Gymnosperms. S. Chand and Co. Ltd.,NewDelhi.
5. Vasishta P.C. (1980) Gymnosperms. S. Chand and Co., Ltd., New Delhi.

CORE COURSE- 4
RESEARCH METHODOLOGY, REPRODUCTIVE BOTANY & PALYNOLOGY

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
4	GBOT4B04T	3	5	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Develop scientific temper
2. Undertake scientific projects and prepare project reports
3. Analyze statistical data and derive conclusions
4. Prepare permanent slides, applying the histochemical techniques
5. Explain various developmental details of angiosperms.
6. Realize the significance and applications of palynology.

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theory	Practical	Total
1	Scientific Methods	10	9	19
2	Biostatistics	15	9	24
3	Biophysics	15	9	24
4	Reproductive Botany & Palynology	14	9	23
Total		54	36	90

QUESTION PAPER PATTERN & SUBJECT WISE DISTRIBUTION OF MARKS

Type of questions	Methodology	Biostatistics	Biophysics	Reproductive Botany & Palynology	Total
2 marks (total 12)	2	3	4	3	Ceiling 20
5 marks (total 7)	1	2	2	2	Ceiling 30
10 marks (total 2)	2				1x10 = 10
TOTAL					60

SCIENTIFIC METHODS

Module - I

1. Steps in scientific methods (2 hrs)
2. Structure of Research report, Style of citation, Biological Journals, Impact Factor, Sources of reference: Google Scholar, Sodh Ganga, NCBI, Inflibnet, e-pathsala (6 hrs)

3. Latest methods of presentation. (2 hrs)

PRACTICALS (SCIENTIFIC METHODS)

1. Bibliography searches using online tools
2. Familiarizing latest methods of ICT based presentations

REFERENCES (SCIENTIFIC METHODS)

1. P.G. Hewitt, J.A. Suchocki ISBN-10 0805 390385, Conceptual integrated science ISBN-139780805390384.
2. R.G. Newton (1997) The truth of Science Physical theories and reality. Viva Books, New Delhi, II Edition.

BIOSTATISTICS

Module - I (7 hrs)

1. Introduction to Biostatistics: Importance and limitations of Biostatistics (1 hr)
2. Observations: direct and indirect observations, controlled and uncontrolled observations, human and machine observations. (1 hrs)
3. Data collection: Introduction; Sampling; random and non-random. (1 hrs)
4. Representation of data; Tables, Bar diagram, Pie diagram, Histogram, Frequency polygon, Ogive, Frequency curve [both manual and using computer]. (3 hrs)
5. Interpretation and deduction of data, significance of statistical tools in data interpretation, errors and inaccuracies. (1 hrs)

Module II: (8 hrs)

1. Measures of central tendency: mean, median and mode (2 hrs)
2. Measures of dispersion: Range, Mean Deviation, Variance, Standard Deviation, Coefficient of variation. (2 hrs)
3. Correlation and regression (brief account). (2 hrs)
4. Test of hypothesis: Null hypothesis, Alternate hypothesis Chi-square test. (2 hrs)

PRACTICAL (BIOSTATISTICS)

1. Work out problems under all types mentioned in the syllabus. One example each from all categories should be recorded.
2. Familiarize the technique of data representation (bar diagram, histogram, pie-diagram and frequency curve (both manual and using computer).

REFERENCES (BIOSTATISTICS)

1. Jasra. P.K. and Raj Gurdeep (2000). Biostatistics. Krishna Prakashan Media Pvt Ltd.
2. Khan, I.A. and Khayum. Fundamentals of Biostatistics. Wraaz Publ. Hyderabad.
3. Prasad, S. (2003) Elements of Biostatistics. Rastogi Publ.

4. Ramakrishnan, P. Biostatistics, Saras Publishers.
5. Rastogi, V.B. Fundamentals of Biostatistics Ane Book India.
6. Norman T.J. Bailey (2007) Statistical Methods in Biology- Low Priced Edition, Cambridge University Press, Replica Press Private Ltd
7. Zar, J.H. (2012) Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition

BIO PHYSICS

Module 1

1. Solutions: representing concentrations: Molarity, Normality, Percentage and ppm. (2 hrs)
2. Acids and bases, buffers and pH, measurement of pH. Preparation and use of buffers in biological studies. (3 hrs)
3. Photometry: Colorimetry and Spectrophotometry, principle, working and uses. (3 hrs)
4. Centrifugation: Principle, types of centrifuges and their applications (2 hrs)
5. Chromatography - Principle and types: Adsorption chromatography, Partition chromatography, Ion exchange chromatography, Molecular sieving. (5 hrs)

PRACTICAL (BIOPHYSICS)

1. Preparation of solutions of known concentrations using pure samples and stock solutions
2. Preparation of buffers
3. Measurement of pH using pH meter.
4. Demonstration of the working of different kinds of centrifuges

REFERENCES (BIOPHYSICS)

1. Keith Wilson and John Walker (2008). Principles and techniques of Biochemistry and Molecular Biology 6th edition. Cambridge University Press.
2. Hoppe, W., Lohmann W., Markl H. and H. Ziegler. (1983) Biophysics. Springer Verlag.
3. Rogers, A.W. (1969) Techniques of Autoradiography. Elsevier Publishing Company.
4. Roy, R.N. (1996) A Text book of Biophysics. New Central Book Agency Pvt. Ltd., Calcutta.
5. Sasidharan, A. (1984) Selected Topics of Biophysics. Frontier Area Publishers.
6. Slayter. E.M. (1970) Optical methods in Biology. Wiley Intersciences.
7. Wong. C.H. (1965) Radiation Tracer Methodology in Biophysical Sciences. Prentice Hall.

REPRODUCTIVE BOTANY & PALYNOLOGY

- Introduction to angiosperm embryology with special reference to Indian embryologists (1hr)

- Microsporogenesis: structure and function of wall layers, development of male gametophyte, dehiscence of anther (3 hrs)
- Megasporogenesis: development of female gametophyte, embryo sac- development and types- monosporic: *Polygonum* type, bisporic: *Allium* type, tetrasporic: *Adoxa* type. (3 hrs)
- Structure of embryo dicot (*Cypselia*), monocot (*Sagittaria*) and endosperm types, double fertilization (2 hrs)

PALYNOLOGY

- Pollination different types, germination of pollen grains, fertilization, barriers of fertilization (2 hrs)
- Palynology: pollen morphology- structure of pollen wall, shape of pollen grains, apertural morphoforms, exine ornamentation; Pollen allergy, Aropalynology, Melitopalynology Role of Pollengrains in Taxonomic studies (3hrs)

PRACTICAL (REPRODUCTIVE BOTANY & PALYNOLOGY)

1. *Datura* anther T.S. (mature).
2. Types of ovules: Orthotropous, Anatropous and Campylotropous (Slides only, drawing not required)
3. Dicot and monocot embryo of Angiosperms (Slides only, drawing not required)
4. Pollen morphology of *Hibiscus*, and pollinia of *Cryptostegia/ Calotropis* by acetolytic method
5. Viability test for pollen.
 - a. *In vitro* germination using sugar solution. (cavity slide method)
 - b. Tetrazolium test
 - c. Acetocarmine test (Acetocarmine & Glycerine 1:1)

REFERENCES (REPRODUCTIVE BOTANY & PALYNOLOGY)

1. Agarwal S.B. (1984) Embryology of Angiosperms- a fundamental approach, Sahitya Bhavan, Hospital Road, Agra.
2. Bhojwani S S & Bhatnagar S.P. Dantu PK (2015) The Embryology of Angiosperms. 6th edition, Vikas Publishing House (P) Ltd.
3. Davis C.L. (1965) Systematic Embryology of Angiosperms. John Wiley, New York.
4. Eames M.S (1960) Morphology of Angiosperms Mc Graw Hill New York.
5. Erdtman G (1952) Pollen Morphology and Plant Taxonomy Part I. Almquist & Wiksell Stockholm
6. Erdtman G (1969) Hand Book of Palynology. National Botanical Gardens Publication, Lucknow.
7. Johri BD (1984) (ed.) Embryology of Angiosperms Springer-Verlag, Berlin.

8. Maheswari P. 1985. Introduction to Embryology of Angiosperms - McGraw Hill, New York.
9. Nair PKK (1970). Pollen Morphology of Angiosperms Vikas Publishing House, Delhi.
10. Raghavan,V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
11. Saxena M.R. (1993). Palynology -A treatise, Oxford, I.B.H. New Delhi
12. Shivanna KR & Johri.BM (1985) The Angiosperm Pollen, Structure and Function. John Wiley & Sons Pte Ltd.
13. Shivanna KR & Johri.BM (1985) Pollen Biology: A Laboratory Manual, Springer Verlag,NewYrok.
14. Shivanna, K.R. &. Rangaswami, N.S (1993) Pollen Biology Narosa Publishing House, Delhi.
15. Singh V., P.C. Pande & D.K. Jain (2001)Embryology of Angiosperms- Rastogi Publications, Gangothri, Sivaji road, Meerut.

CORE COURSE -6
CELL BIOLOGY, PALAEOBOTANY, PHYTOGEOGRAPHY
& EVOLUTION

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
5	GBOT5B06T	3	5	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Appreciate the ultra-structure of a plant cell.
2. Enumerate the functions of each cell organelle.
3. Appreciate the process of organic evolution.
4. Realize the importance of fossil study.
5. Understand the climatic conditions of the past and realize the changes happened
6. Recognize the phytogeographic zones of India.

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theory	Practical	Total
1	Cell Biology	20	18	38
2	Palaeobotany	08	9	17
3	Phytogeography	13	9	22
4	Evolution	13	-	13
Total		54	36	90

QUESTION PAPER PATTERN & SUBJECT WISE DISTRIBUTION OF MARKS

Type of questions	Cell Biology	Palaeobotany	Phytogeography	Evolution	Total
2 marks (total 12)	4	2	3	3	Ceiling 20
5 marks (total 7)	2	1	2	2	Ceiling 30
10 marks (total 2)	2				1x10 = 10
TOTAL					60

CELL BIOLOGY

Module - I.(10 hrs)

1. Architecture of cells. Prokaryotic and Eukaryotic cells. (1 hr)
2. Structure and function of the following: Cell membrane (fluid mosaic model), Endoplasmicreticulum, Golgicomplex, mitochondria, chloroplast, Lysosomes,

- Glyoxisomes Ribosomes Cytoskeleton Cytosol Vacuole (3 hrs)
3. Nucleus - Nuclear membrane; Nuclear pore complex; organization of interphase Nucleus; Euchromatin and heterochromatin; Nucleolus. (3hrs)
4. Chromosomes - Morphology, classification, Centromere and Telomere, Chemical Composition and organization. (3 hrs)

Module-II(10 hrs)

1. Special types of chromosomes-Polytene chromosomes, lampbrush chromosomes (1 hr)
2. Cell division - cell cycle - Mitosis & Meiosis - significance- molecular control of cell division (3 hrs)
3. Chromosomal changes: structural aberrations: deletion, duplication, inversion, translocation - their meiotic consequences and significance (3 hrs)
4. Numerical aberration - Definition - Basic chromosome number (Genomic Number) Aneuploidy, Haploidy and Polyploidy - their meiotic behaviour and significance. (3 hrs)

PRACTICAL(CELL BIOLOGY)

1. Mitosis - Acetocarmine squash preparation of Onion root tip.
2. Calculation of mitotic index
3. Demonstration of meiosis in Rhoeo/Chlorophytum/ Maize and identification of different stages of Meiosis.

REFERENCE (CELL BIOLOGY)

1. Arumugham. N. (2014) Cell Biology. Sara Publication, Nagercoil.
2. Avinash Upadhyaya & Kakoli Upadhyayo (2005). Basic Molecular Biology. Himalaya Publishers.
3. De Robertis. E.D.P., & De Robertis E.M.S. (1998) Cell and Molecular Biology -Lea & Febiger.
4. Geoffery M. Cooper & Robert E. Haufman. (2007) The cell - a molecular approach. A.S.S. Press Washington, U.S.A.
5. Lewis. J. Kleinsmith & Valerie M. Kish (1995) Principles of Cell & Molecular Biology.
6. Lewin B. (2017) Genes XII. Oxford University press.
7. Lodish. H. *et. al.*, (2000) Molecular Cell Biology, Freeman & Company.
8. Powar C.B. (1988) Essentials of Cytology, Himalaya Publishing House.
9. Rastogi S.G. Cell Biology. Tata Mc Graw Hill Publishing Company New Delhi
10. Rastogi.V.B. (2008) Fundamentals of Molecular Biology, Ane Books India.

PALAEOBOTANY

1. Introduction and objectives (½hr)
2. Fossil formation and types of fossils (1 hr)
3. Geological time scale- sequence of plants in geological time (1 hr)
4. Fossil Pteridophytes-*Rhynia*, *Lepidodendron* and *Calamites* (2 hr)
5. Fossil gymnosperms- *Williamsonia* (1 hr)
6. Important Indian Paleobotanical Institutes. (1 hr)
7. Indian Palaeobotanists: Birbal Sahni and Savithri Sahni (1 hr)
8. Applied aspects of Palaeobotany- exploration of fossil fuels (½ hr)

PRACTICAL (PALAEOBOTANY)

- 1 Fossil Pteridophytes - *Rhynia* stem, *Lepidodendron* and *Calamites*
- 2 Fossil gymnosperms- *Williamsonia*

(Drawings may be replaced by photos with critical notes in the record)

REFERENCES (PALAEOBOTANY)

1. Andrews H.N. (1961) Studies in Paleobotany. John Wiley and Sons Inc., New York.
2. Arnold C.A. (1947) Introduction to Paleobotany, Tata McGraw Hill, New Delhi.
3. Shukla, A.C. & S.P. Misra, (1975) Essential of Palaeobotany, Vikas Publishing House, Pvt. Ltd., Delhi.
4. Sreevastava H.N., (1998) Palaeobotany, Pradeep Publishing Company, Jalandhar. Sewart,
5. Taylor, T.N. Paleobotany. An Introduction to Fossil Plant Biology. Mc Graw Hill, New York.
6. Steward A.C. (1935) Fossil Plants Vol. I to IV. Watson J. An introduction to study of fossil plants. Adams and Charles Black Ltd. London.

PHYTOGEOGRAPHY

1. Definition, concept, scope and significance of phytogeography. (1 hrs)
2. Patterns of plant distribution - continuous distribution and discontinuous distribution, vicarism, migration and extinction (2 hrs)
3. Continental drift -Evidences and impact. (2 hrs)
4. Glaciation: Causes and consequences (2 hrs)
5. Theory of land bridges. (2 hrs)
6. Endemic distribution, theories on endemism, age and area hypothesis. (2 hrs)
7. Phytogeographical zones (phytochoria) of India. (2 hrs)

PRACTICAL(PHYTOGEOGRAPHY)

- 1 Mark the phytogeographic zones of India.

REFERENCES (PHYTOGEOGRAPHY)

1. Ronald Good, (1947) The Geography of Flowering Plants. Longmans, Green and Co, New York
2. Armen Takhtajan, (1986) Floristic Regions of the World. (translated by T.J. Crovello & A. Cronquist). University of California Press, Berkeley.
3. P. D. Sharma, (2009) Ecology and Environment, Rastogi Publications, Meerut

EVOLUTION

1. Theories on Origin of Universe, Earth and Origin of life. Oparin's concept; Miller's experiment. (2 hrs)
2. Evolution of prokaryotic and eukaryotic cells, archaebacteria, early fossilized cells. (2 hrs)
3. Theories on origin and evolution of species: Darwinism; Neo-Darwinism and its objection; Arguments and support for Darwinism, Modern concept of evolution. (2 hrs)
4. Evidences of organic evolution from Morphology, Anatomy, Embryology, Palynology, Genetics and Molecular Biology. (3 hrs)
5. Selection and genetic drift. (2 hrs)
6. Speciation: Isolating mechanism, Modes of speciation: sympatric and allopatric (2 hrs)

REFERENCES (EVOLUTION)

1. Crick F. (1981) Life itself: Its origin and Nature. Simon and Schuster, New York.
2. Drake J.W. (1970) The molecular basis of mutation. Holden - Day - San Francisco.
3. Dott R.H. R.L. Batten, (1981) Evolution of the earth 3rd edn. McGraw Hill New York.
4. Fox S.W. and Dose, K. (1972) Molecular evolution and the origin of life. W.H. Freeman & Co., San Francisco.
5. Gould S.J. (1977) Ontogeny and Phylogeny. Harvard Univ. Press, Cambridge, Mass.
6. Jardine N., D. Mc Kenzie (1972) Continental drift and the dispersal and evolution of organisms. Nature, 234. 20-24.
7. Miller, S.L. (1953) A production of amino acids under possible primitive earth conditions. Science, 117: 528-529.
8. Strickberger, (1990) Evolution, Jones and Bastlett Publishers International, England.

CORE COURSE-7
ANGIOSPERM MORPHOLOGY & SYSTEMATICS

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
5	GBOT5B07T	3	5	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Appreciate the diverse morphology of angiosperms.
2. Identify and classify plants based on taxonomic principles.
3. Make scientific illustrations of vegetative and reproductive structures of plants.
4. Develop the skill of scientific imaging of plants.
5. Realize the importance of field study.
6. Change their attitude towards over exploitation of rare/endemic plants.

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theory	Practical	Total
1	Angiosperm Morphology	14	9	23
2	Systematics	40	27	67
Total		54	36	90

QUESTION PAPER PATTERN & SUBJECT WISE DISTRIBUTION OF MARKS

Type of questions	Angiosperm Morphology	Systematics	Total
2 marks (total 12)	4	8	Ceiling 20
5 marks (total 7)	2	5	Ceiling 30
10 marks (total 2)	2		1x10 = 10
TOTAL			60

ANGIOSPEM MORPHOLOGY

1. Technical description of a flowering plant (brief) (2 hrs)
2. Inflorescence: racemose, cymose and specialised (cyathium, hypanthodium, coenanthium, verticillaster, thyrus) (3 hrs)
3. Flower: Flower as a modified shoot, detailed structure of flowers, floral parts -their arrangement, relative position, cohesion and adhesion - symmetry of flowers. (4 hrs)
4. Fruits- simple, aggregate and multiple with examples; Seed structure - dicot and monocot - albuminous and exalbuminous, aril, caruncle (5 hrs)

PRACTICAL (ANGIOSPEM MORPHOLOGY)

1. Identify the types of inflorescence and fruits mentioned in the syllabus.
2. All the types mentioned under inflorescence and fruits must be represented in the photo album(All drawings in records are replaced by photo album submission).

REFERENCES (ANGIOSPEM MORPHOLOGY)

1. Gangulee, H.C., J.S. Das & C. Dutta. (1982) College Botany (5th Ed.) New Central Book Agency, Calcutta.
2. George, H.M. Lawrence. (1951) Introduction to Plant Taxonomy. Mac Millan comp. Ltd., New York.
3. Simpson, M. G. (2006) Plant Systematics. Elsevier Academic Press, London
4. Sporne, K.R. (1974) Morphology of Angiosperms. Hutchinson University Press London

SYSTEMATICS

Module-I(6 hrs)

1. Components of systematics: identification, description nomenclature and classification; objectives and importance of systematics (2 hrs)
2. Systems of classification: Artificial- Linnaeus; Natural- Bentham and Hooker; Phylogenetic - Hutchinson; Angiosperm Phylogeny Group system (4 hrs)

Module - II(14 hrs)

1. Detailed study (systematic position, distribution, common members, diagnostic features, description from habit to fruit and economic importance of the following families.
Annonaceae, Malvaceae, Meliaceae, Fabaceae with sub families, Myrtaceae, Cucurbitaceae, Rubiaceae, Asteraceae, Apocynaceae, Solanaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Liliaceae, Orchidaceae and Poaceae.

Module- III(8 hrs)

1. Taxonomic structure - Hierarchy; Concepts of taxa: Species - Biological, Phenetic and Phylogenetic; Genus; Family. (2 hrs)
2. Taxonomic character - concept, primitive and advanced characters, sources, comparative morphology, vegetative, reproductive, macro and micromorphology; modern trends in taxonomy, cytotaxonomy, chemotaxonomy, numerical taxonomy, molecular taxonomy and phylogenetics. (4 hrs)
3. Contributions of eminent Taxonomists viz Hendrik van Rhee, William Roxburgh, Robert Wight, J. S. Gamble and EK Janaki Ammal. (2 hrs)

Module - IV(12 hrs)

1. Plant Nomenclature – Limitations of common name, ICN- Principles (introduction only); Typification (holotype, isotype, syntype paratype and lectotype); Priority-merits and demerits; Effective and valid publication; Author citation. (3 hrs)
2. Plant identification – Keys; indented and bracketed, construction and applications. (2 hrs)
3. Taxonomic information resources – Herbarium preparation and maintenance, Herbarium types: International- Kew (K); National-Central national herbarium (CAL), MH Coimbatore, Virtual herbarium, Botanic Gardens: RBG, Kew; IGB Kolkotta; JNTBGRI Thiruvananthapuram and MBGIPS, Kozhikode. (4 hrs)
4. Taxonomic literature- Floras, e-Flora, Monographs, Revisions, Journals and online resources & Databases. (3 hrs)

PRACTICAL (SYSEMATICS)

1. Students are expected to work out at least one member of each family mentioned in the syllabus and make suitable diagrams. Describe them in technical terms and identify up to species using the Flora. Orchidaceae may be excluded from practical examination scheme.
2. Students shall be able to prepare artificial key to segregate any five given plants. This must be recorded.
3. Familiarization of herbarium techniques.
4. Students shall submit not less than 10 properly identified herbarium specimens of varying taxa during time of their practical examination.
5. It is compulsory that every student has to undertake field study trips of 3 -5 days to study vegetation of ecologically different areas, under the guidance of teachers. Visits to standard Herbaria, Organizations/ Institutes involved in exploring plant resources, Botanical museums etc. may be conducted as part of study tour. Local habitats like sacred groves, rice fields, wetlands, forests, grasslands etc. also can be selected for field trips. Avoid visit to tourist places with meager plant diversity and of having only entertainment value. Submit a field visit report countersigned by the Head of the department during the practical examination.
6. If a student fails to undergo the study tour he /she may not be permitted to attend the examination.

REFERENCES (SYSEMATICS)

1. Bharati Bhattacharyya (2009) Systematic Botany, Narosa Publishing House Pvt. Ltd., New Delhi.
2. Burkill, I.H. (1965) Chapters on the History of Botany in India, Delhi.
3. Clive A. Stace (1991) Plant Taxonomy and Biosystematics, Cambridge University

Press.

4. Davis, P.H. & V.H. Heywood, (1963) Principles of Angiosperm Taxonomy. Oliver & Boyd Ltd., London.
5. Gurucharan Singh, (2012) Plant Systematics - Theory and Practice. Oxford & IBH, New Delhi.
6. Jeffrey, C. (1968) An introduction to Plant Taxonomy, London.
7. Mondal A.K. (2009) Advanced Plant Taxonomy, New Central Book agency Pvt.Ltd. KolKota.
8. Nicholas J. Turland *et al.*(2018) International Code of Nomenclature for algae, fungi, and plants- Shenzhen Code (printed/ electronic version) Koeltz Botanical Books.
9. Pandey, S.N. & S.P. Misra. (2008) Taxonomy of Angiosperms. Ane Books India, New Delhi.
10. Radford, A.E. (1986) Fundamentals of Plant Systematics. Harper & Row Publishers, New York.
11. Sambamurthy A.S.S. (2005) Taxonomy of Angiosperms, I.K. International Pvt. Ltd, New Delh.
12. Sharma, B.D. *et al.* (Eds.) (1996) Flora of India vol. I. Botanical Survey of India, Calcutta.
13. Simpson, M.G. (2006) Plant Systematics. Elsevier Academic Press, London
14. Sivarajan, V.V. (1991) Introduction to Principles of Plant Taxonomy. Oxford & IBH, New Delhi.
15. Stuessy, T.F.(1990) Plant Taxonomy-The systematic evaluation of Comparative data. Columbia University Press, New York.

CORE COURSE-8
TISSUE CULTURE, HORTICULTURE, ECONOMIC BOTANY &
ETHNOBOTANY

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
5	GBOT5B08T	3	5	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Critically evaluate the advantages of tissue culture and horticulture over conventional methods of propagation.
2. Apply various horticultural practices in the field.
3. Experiment on the subject and try to become entrepreneurs.
4. Identify the economically important plants.

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theory	Practical	Total
1	Tissue culture	18	12	30
2	Horticulture	18	12	30
3	Economic Botany	9	9	18
4	Ethnobotany	9	3	12
Total		54	36	90

QUESTION PAPER PATTERN & SUBJECT WISE DISTRIBUTION OF MARKS

Type of questions	Tissue culture	Horticulture	Economic Botany	Ethnobotany	Total
2 marks (total 12)	5	5	1	1	Ceiling 20
5 marks (total 7)	3	2	1	1	Ceiling 30
10 marks (total 2)	1	1	-	-	1x10 = 10
TOTAL					60

TISSUE CULTURE

Module-1(12 hrs)

1. Plant tissue culture - Principles and techniques; Cellular totipotency; *invitro* differentiation - de differentiation and re-differentiation. (2 hrs)
2. Tissue culture medium - Basic components in tissue culture medium - Solid and liquid medium; Murashige and Skoog medium - composition and preparation. (2 hrs)
3. Aseptic techniques in *in vitro* culture - sterilization - different methods - sterilization of instruments and glassware, medium, explants; working principle of

- laminar air flow and autoclave. (2 hrs)
4. Preparation of explants- surface sterilization, inoculation, incubation,subculturing. (2 hrs)
 5. Micropropagation - Different methods - apical, axillary bud proliferation,direct and indirect organogenesis and somatic embryogenesis. (2 hrs)
 6. Different phases of micropropagation - multiple shoot induction, shootelongation, *in vitro* and *in vivo* rooting hardening, transplantation and field evaluation; advantages and disadvantages of micropropagation, somaclonal variation. (2 hrs)

Module - II (6 hrs)

1. Methods and Applications of tissue culture:

1. Shoot tip and meristem culture.
2. Somatic embryogenesis and synthetic seed production.
3. Embryo culture.
4. Protoplast isolation culture and regeneration - transformation andtransgenics
5. Somatic cell hybridization, cybridization.
6. *In vitro* secondary metabolite production -- cell immobilization,bioreactors
7. *In vitro* production of haploids - anther and pollen culture
8. *In vitro* preservation of germplasm

PRACTICAL (TISSUE CULTURE)

1. Preparation of nutrient medium - Murashige and Skoog medium using stock solutions,
2. Familiarize the technique of preparation of explants, surface sterilization,inoculation and subculturing.
3. Preparation of synthetic seeds
4. Demonstration of anther culture

REFERENCES (TISSUE CULTURE)

1. Gamborg, O.L. & G.C. Philips (Eds.) (1995). Plant Cell, Tissue and Organ Culture: Fundamental Methods. Narosa Publishing House, New Delhi.
2. Razdan MK (1995) Introduction to Plant Tissue Culture. Oxford & IBH publishing Co. Pvt. Ltd.
3. Reinert & Bajaj. Plant Cell, Tissue and Organ Culture.
4. Edwin F. George,Michael A. Hall and Geert-Jan De Klerk. (2008) Plant propagation by tissue culture Volume 1. The Background. Springer,P.O. Box 17, 3300 AA Dordrecht. The Netherlands.

5. Madhavi Adhav (2010) Practical book of Biotechnology and Plant Tissue culture
6. Bhojwani, San Saran, Danu, Prem Kumar (2013) Tissue Culture : An Introductory Text

HORTICULTURE

Module - I.(5 hrs)

1. Introduction, scope and significance; branches of horticulture. (1 hrs)
2. Soil- components of soil, types of soil. (1 hrs)
3. Fertilizers - Chemical, organic, biofertilizer, compost. (1 hrs)
4. Pots & potting - earthen, fibre, polythene bags, potting mixture, potting, repotting, top dressing. (1 hrs)
5. Irrigation - Surface, sprinkle, drip and gravity irrigation. (1 hrs)

Module - II (7 hrs)

1. Seed propagation -seed quality tests, seed treatment, essential condition for successful propagation: raising of seed beds, transplanting techniques.(3 hrs)
2. Vegetative propagation: (4 hrs)
 1. Cutting (stem, roots)
 2. Grafting (approach, cleft)
 3. Budding (T-budding, patch)
 4. Layering (simple, air).

Module - III.(6 hrs)

1. Gardening - site selection; propagating structure: green house, poly house, moist chamber, net frame - Garden tools and implements. (1 hr)
2. Indoor gardening - selection of indoor plants, care and maintenance of indoor plants, Bonsai - Principle, creating the bonsai. (1 hr)
3. Outdoor gardening; landscaping- goals, types. (1 hr)
4. Cultivation and post-harvest management of vegetables and ornamental plants. (1 hr)
5. Protection of horticultural plants: Precautions to avoid pests and diseases, biopesticides. (1 hr)
6. Mushroom cultivation - Oyster mushroom (1 hr)

PRACTICAL (HORTICULTURE)

1. Preparation of nursery bed and polybag filling.
2. Preparation of potting mixture - Potting, repotting.

3. Field work in cutting, grafting, budding, layering (drawing not required).
4. Familiarizing gardening tools and implements. (drawing not required)
5. Establishment of vegetable garden/ Visit to a horticulture station.
6. A brief report of item no. 5 may be recorded.

REFERENCES(HORTICULTURE)

1. Andiance and Brison. (1971). Propagation Horticultural Plants.
2. Chanda, K.L. and Choudhury, B. Ornamental Horticulture in India.
3. George Acquaaah, (2005) Horticulture: Principles and Practices. Pearson Education, Delhi.
4. Hudson, T. Hartmann, Dale K. Kester, Fred T.Davies, Robert L. Geneve, Plant Propagation, Principles and Practices.
5. Katyal, S.C., Vegetable growing in India, Oxford, New York.
6. Kolay, A.K. Basic Concepts of Soil Science. New Age International Publishers, Delhi.
7. Naik, K.C., South Indian Fruits and their Culture.
8. Nishi Sinha: Gardening in India, Abhinav Publications, New Delhi.
9. Prakash, R and K. Raj Mohan, Jaivakrishi (Organic farming), State Institute of Languages, Thiruvananthapuram.
10. Prasad, S., and U. Kumar. Green house Management for Horticultural Crops, Agrobios, Jodhpur.

ECONOMIC BOTANY

Study the different category of economically important plants their Binomial, Family and Morphology of useful part, products and uses: (9 hrs)

1. Cereals and Millets – Rice, Wheat, Maize and Ragi
2. Pulses and legumes – Green gram, Bengal gram, Black gram,
3. Sugar – Sugar cane
4. Fruits – Apple, Pine Apple, Papaya, Banana, Mango, Guava, Jack, Grapes, Sapota.
5. Vegetables – Carrot, Beet Root, Corm, Potato, bitter gourd, Cucumber, Snake gourd, Ladies finger, Cabbage, *Amaranthus*,
6. Ornamentals – Rose, *Anthurium*, Jasmine.
7. Masticatories – Betel vine, Betel nut, Tobacco.
8. Beverages – Coffee, Tea, Cocoa.
9. Fibre – Coir, Cotton, Jute.
10. Timber – Teak, Rose wood, Jack, *Ailanthus*.
11. Fats and oils – Coconut, Gingelly, Sun flower.

12. Latex – Rubber
13. Gums and Resins – Dammar, Gum Arabic, Asafoetida
14. Spices – Pepper, Ginger, Cardamom, Clove, Nutmeg, Allspice, Cinnamon
15. Medicinal – *Adhatoda*, *Catharanthus*, *Phyllanthus*, *Rauwolfia*, *Aloe*,

PRACTICAL (ECONOMIC BOTANY)

1. Students shall be able to identify plants or plant products (raw or processed) studied in theory and shall be able to write Botanical names, Family and morphology of useful parts of source plants.
2. Students need not make any illustrations but make a table in the record giving the details of the items mentioned in the theory syllabus.

REFERENCES (ECONOMIC BOTANY)

1. Bendre Kumar 2000: Economic Botany' Rastogi Publications, Shivaji road, Meerut.
2. Jain. S. K. 1981. Glimpses of Indian Economic Botany. Oxford.
3. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.

ETHNOBOTANY

1. Introduction, scope and significance (1 hr)
2. Major tribes of South India. Importance of Traditional Botanical Knowledge, TBGRI model of Benefit Sharing. (2 hrs)
3. Ethnobotanical significance of the following: (6 hrs)
 1. *Aegle marmelos*
 2. *Ficus religiosa*
 3. *Curcuma longa*
 4. *Cynadon dactylon*
 5. *Ocimum sanctum*
 6. *Trichopus zeylanicus*

PRACTICAL (ETHNOBOTANY)

Students are expected to identify the plants mentioned in the Ethnobotany syllabus and it must be given as a table showing Common name, Binomial, Family and Ethnobotanical significance in the record book. (Drawing not required)

REFERENCES (ETHNOBOTANY)

1. Baker. H.g. (1970) Plant and Civilization.
2. Jain. S. K. (1995). A Manual of Ethnobotany. Scientific Publishers, Jodhpur.
3. Cotton, C.M. (1996) Ethnobotany – Principles and Applications. Wiley and Sons

CORE COURSE-9:
PLANT PHYSIOLOGY

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
5	GBOT5B09T	3	5	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Identify the physiological responses of plants.
2. Analyze the role of external factors in controlling the physiology of plants.

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theory	Practical	Total
1	Module 1	10	36	10
2	Module II	7		7
3	Module III	20		20
4	Module IV	7		7
5	Module V	10		10
Total		54	36	90

QUESTION PAPER PATTERN & SUBJECT WISE DISTRIBUTION OF MARKS

Type of questions	Mod. 1	Mod. II	Mod. III	Mod. IV	Mod. V	Total
2 marks (total 12)	2	2	4	2	2	Ceiling 20
5 marks (total 7)	1	1	3	1	1	Ceiling 30
10 marks (total 2)	2					1x10 = 10
TOTAL						60

Module-I

1. Plant cell and Water Properties of water; water as a solvent; cohesion and adhesion. Diffusion, osmosis, osmotic pressure, concept of water potential, components of water potential, osmotic potential, turgor pressure, imbibition, matric potential.
2. Transpiration. Types and processes. Mechanism of guard cell movement. K⁺ ion mechanism. Purpose of transpiration, Antitranspirants.
3. Absorption of water by transpiration pull and cohesion of water molecules. Radial movement of water through root. Soil-plant-atmosphere continuum of water.

10 hrs

Module-II

1. The ascent of sap; Transpiration pull and cohesion of water molecules. Merits and

demerits of cohesion-tension theory.

2. Plants and inorganic nutrients, Macro and Micro nutrients. Uptake of mineral elements. Difference between passive uptake and active uptake. Simple and facilitated diffusion. Active uptake. Carrier concept. Evidences. **7 hrs.**

Module-III

1. Photosynthesis in higher plants; Photosynthetic apparatus. Electromagnetic radiation. Absorption of light. Fluorescence and phosphorescence. Organization of light harvesting antenna pigments. Photochemical and chemical phases of photosynthesis and its evidences. Red drop and Emerson enhancement effect. Two pigment systems, components. Redox potentials of the electron carriers. Photosynthetic electron transport and photophosphorylation. Assimilatory powers. ATP and NADPH. Photosynthetic carbon reduction cycle (PCR), RUBISCO, C₃, C₄, and CAM pathways. Ecological significance of C₄, and CAM metabolism. Photorespiration, Law of limiting factors. **10 hrs.**
2. Biological nitrogen fixation, symbiotic nitrogen fixation in leguminous plants. Biochemistry of Nitrogen fixation. Export of fixed nitrogen from nodules. Genetics of nitrogen fixation, Ammonia assimilation, assimilation of nitrate. Biosynthesis of amino acids reductive amination and transamination. **6 hrs.**
3. Translocation and distribution of photo assimilates. Composition of phloem exudates. Mechanism of phloem transport. Phloem loading and unloading; pressure flow hypothesis. **4 hrs.**

Module-IV

1. Plant growth and development. Auxins, gibberellins, cytokinins, abscisic acid and ethylene, their physiological roles. Photoperiodism and vernalization.
2. Plant movements - Phototropism, gravitropism. Nyctinastic and seismonastic movements.
3. Photomorphogenesis: Phytochrome: chemistry and physiological effects.
4. Seed dormancy and germination **7 hrs**

Module-V

1. Circadian rhythms in plants.introduction .Endogenous versus Exogenous rhythms.Occurance of circadian rhythms in plants - Examples . Establishment of endogenous nature of a rhythm.Biological clock
2. Stress physiology .Introduction Water deficit and drought resistance. (A) In xerophytes (B) In mesophytes. Salt stress and salt resistance. Cold injury and cold resistance. (A) Chilling injury and chilling resistance. (B) Freezing (frost) injury

and freezing (frost) resistance. Heat stress and heat resistance. Heavy-metal stress and heavy metal resistance. Biotic stresses in Plants-Hypersensitive response (HR), Secondary acquired resistance (SAR), Jasmonate. **10 hrs.**

PRACTICAL

Students should familiarize experiments and details must be recorded. (Drawing not required)

1. Fruit ripening/Rooting from cuttings (Demonstration).
Determination of water potential by tissue weight change method
Determination of stomatal index
2. Relation between water absorption and transpiration.
3. Separation of leaf pigments by paper chromatography/ column chromatography/TLC.
5. Effects of light intensity on photosynthesis by Wilmot's bubbler.
4. Thistle funnel osmoscope
5. Ganong's Potometer
6. Ganong's light-screen
7. Ganong's respirometer
8. Kuhne's fermentation vessel
9. Mohl's half-leaf experiment
10. Absorbotranspirometer Experiment to demonstrate suction due to transpiration
11. Demonstration of gravitropism using Klinostat.

REFERENCES

1. Frank B. Salisbury and Cleon W. Ross (2002). Plant Physiology 3rd edition. CBS publishers and distributors.
2. Noggle G. R and Fritz G J (1983) Introductory Plant Physiology Prentice Hall.
3. Goodwin Y.W., and Mercer E.I. (2003) Introduction to Plant Biochemistry. 2nd edition. CBS Publishers and distributors.
4. Hopkins WG (1999). Introduction to Plant Physiology, 2nd edition, John Wiley A Sons, Inc. U.S.A. 4th edition
5. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons.
6. Lincoln Taiz and Eduardo Zeiger (2002). Plant Physiology 2nd edition. Sinauer Associates, Inc. Publishers. Sunderland, Massachusetts
7. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A. (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

CORE COURSE- 10
GENETICS & PLANTBREEDING

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
6	GBOT6B10T	3	5	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Appreciate the facts behind heredity and variations.
2. Understand the basic principles of inheritance.
3. Solve problems related to classical genetics.
4. Predict the pattern of inheritance.
5. Understand various plant breeding techniques.
6. Realize the role of plant breeding in increasing crop productivity.

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theory	Practical	Total
1	Genetics	36	27	63
2	Plant breeding	18	9	27
Total		54	36	90

QUESTION PAPER PATTERN & SUBJECT WISE DISTRIBUTION OF MARKS

Type of questions	Genetics	Plant breeding	Total
2 marks (total 12)	8	4	Ceiling 20
5 marks (total 7)	4	3	Ceiling 30
10 marks (total 2)	2		1x10 = 10
Total			60

GENETICS

Module - I(23 hrs)

1. Introduction- Mendel's life history (brief), Mendelian experiments: Monohybrid cross and dihybrid cross, Mendelian ratios, Laws of inheritance; Back cross, test cross. (5 hrs)
2. Modified Mendelian ratios:
 - a. Allelic interactions: dominant - recessive, Incomplete dominance - flower color in *Mirabilis*; Co dominance - Coat colour in cattle, Blood group in human beings; Lethal genes - Sickle cell anemia in Human beings. Modified dihybrid ratios by incomplete dominance of one pair of gene (3:6:3:1:2:1) and both pairs

- (1:2:1:2:4:2:1:2:1). (6 hrs)
- b. Interaction of genes: Non epistatic - Comb pattern inheritance in poultry(9:3:3:1): Epistasis: dominant - Fruit colour in summer squashes; Recessive epistasis - Coat color in mice; Complementary gene interaction- flowercolor in *Lathyrus*. (6 hrs)
3. Multiple alleles- general account: ABO blood group in man, Self sterility in *Nicotiana*, Coat colour in Rabbits. (3 hrs)
4. Quantitative inheritance / polygenic inheritance / continuous variation-Skin color in human beings, Ear size in maize. (3 hrs)

Module -II(13 hrs)

1. Linkage and crossing over- importance of linkage, linkage and independent assortment. Complete and incomplete linkage. Crossing over general account, 2 point and 3 - point crossing over, cytological evidence of genetic crossing over. Determination of gene sequences; interference and coincidence; mapping of chromosomes. (7 hrs)
2. Extra nuclear inheritance- general account- maternal influence- plastid inheritance in *Mirabilis*, Shell coiling in snails. (3 hrs)
3. Population genetics; Hardy -Weinberg law and equation (3 hrs)

PRACTICAL (GENETICS)

1. Students are expected to work out problems related to the theory syllabus. One problem each from all the types mentioned should be recorded.
 - a. Monohybrid cross
 - b. Dihybrid cross
 - c. Test cross and back cross
 - d. Determination of genotypic and phenotypic ratios and genotype of parents
 - e. Non epistasis
 - f. Complementary gene interaction
 - g. Epistasis: dominant and recessive
 - h. Polygenic interaction
 - i. Multiple allelism
 - j. Chromosome mapping
 - k. Calculation of Coincidence and interference

REFERENCE (GENETICS)

1. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
2. Gunther, S. Spend & Richard Calender (1986) - Molecular Genetics CBS Publishers

Delhi.

3. Gupta, P.K. (2018 -19) Genetics. Revised edition. Rastogi Publications, Meerut
4. John Ringo (2004) Fundamental Genetics Cambridge University Press.
5. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
6. Lewin B. (2000) Genes VII Oxford University Press.
7. Rastogi V.B. (2008) Fundamentals of Molecular Biology, Ane Books, India.
8. Sinnot, W.L.C. Dunn & J. Dobzhansky (1996) Principles of Genetics. Tata Mc Graw Hill Publishing Company Ltd., New Delhi.
9. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
10. Verma, P.S. & Agarwal (1999) Text book of Genetics. S. Chand & Co., New Delhi.

PLANT BREEDING

Module-I

(4 Hrs)

1. **Introduction:-** Definition and objectives of Plant breeding - ICAR and its role in plant breeding.
2. **Plant Genetic Resources:-** Components of Plant Genetic Resources.

Module-II

(14 Hrs)

Breeding Techniques -

1. **Plant introduction:-** Procedure, quarantine regulations, acclimatization - major achievements.
2. **Selection:-** Mass selection, pureline selection and clonal selection, significance and achievements.
3. **Hybridization:-** Procedure of intervarietal hybridization - Intergeneric and interspecific hybridization - Composite & synthetic varieties
4. **Heterosis breeding:-** Procedure of heterosis breeding.
5. **Mutation breeding:-** Procedure - achievements.
6. **Polyploidy breeding:-** Procedure, Achievements.
7. **Breeding for disease resistance:-** Types of resistance - Gene for gene hypothesis - Mechanism - Source of genes for resistance - Breeding methods - Screening for disease resistance - Achievements.

PRACTICAL

1. Techniques of emasculation and hybridization of any bisexual flower.
2. Floral biology of Paddy, any one Pulse and Coconut tree.

References

1. Allard. R.W.1960. Principles of Plant breeding, John Wiley & Sons, Inc, New York.
2. Chaudhari. H.K.Elementary Principles of Plant breeding, Oxford & IBH Publishers.
3. Singh, B.D.2005. Plant Breeding - Principles & methods, Kalyani Publishers, New Delhi.
4. Sinha,U. and Sunitha Sinha 2000 - Cytogenetics, Plant breeding & Evolution, Vikas Publishing House.
5. Phundan Singh 1996 Essentials of Plant breeding. Kalyani Publishers, New Delhi.

CORE COURSE- 11
BIOTECHNOLOGY, MOLECULAR BIOLOGY &
BIOINFORMATICS

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
6	GBOT6B11T	3	5	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Analyze the role of biotechnology in daily life.
2. Understand the basic aspects of bioinformatics.
3. Explain the concepts in molecular biology.

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl	Subject	Theory	Practical	Total
1	Biotechnology	18	12	30
2	Molecular Biology	18	12	30
3	Bioinformatics	18	12	30
Total		54	36	90

QUESTION PAPER PATTERN & SUBJECT WISE DISTRIBUTION OF MARKS

Type of questions	Biotechnology	Molecular Biology	Bioinformatics	Total
2 marks (total 12)	4	4	4	Ceiling 20
5 marks (total 7)	2	2	3	Ceiling 30
10 marks (total 2)	2			1x10 = 10
Total				80

BIOTECHNOLOGY

Module -I(13 hrs)

- 1.Introduction, concept, history of biotechnology (1 hr)
- 2.Recombinant DNA Technology: Gene cloning strategies - recombinant DNA construction -cloning vectors -plasmids pBR322, bacteriophage based vectors, Ti plasmids. Restriction endonucleases and ligases transformation and selection of transformants -using antibiotic resistances markers,southern blotting; PCR. (7 hrs)
- 3.Different methods of gene transfer - chemically stimulated DNA uptake by protoplast, electroporation, microinjection, biolistics. Agrobacterium mediate

gene transfer gene library, gene banks.

(5 hrs)

Module -II(5 hrs)

1. Applications of Biotechnology

(5 hrs)

- a. Medicine - Production of human insulin, human growth hormone and
- b. Forensics - DNA finger printing.
- c. Agriculture -Genetically modified crops -Bt crops, Golden rice,Flavr Savr Tomato,Virus, herbicide resistant crops, Edible vaccines.
- d. Environment- Bioremediation- use of genetically engineered bacteria-super bug.
- e. Industry- Horticulture and Floriculture Industry, production of vitamins, amino acids and alcohol.

PRACTICAL (BIOTECHNOLOGY)

1. Extraction of DNA from plant tissue.
2. Study of genetic engineering tools and techniques using photographs/diagram(Southern blotting, DNA finger printing, PCR)

REFERENCES (BIOTECHNOLOGY)

1. Brown T.A. (2006) Gene cloning and DNA analysis; Blackwell scientific publishers
2. Chawla H.S. (2000) Introduction to Plant Biotechnology
3. Das,H.K.(Ed) (2005).TextbookofBiotechnology(2nded)WileyIndia(Pvt.),Ltd. New Delhi.
4. Gupta, P.K. (1996) Elementary Biotechnology. Rastogi & Company, Meerut.
5. Hammond, J., Megary, P *et al.* (2000) Plant Biotechnology. SpringerVerlag.
6. Ignacimuthu S. (1997) Plant Biotechnology, New Hampshire Science Publishers
7. Lewin B. (2004) Genes VIII. Oxford University Press
8. Purohit S.S. (2003) Agricultural Biotechnology, Agrobios (India)
9. Sobti R.C.& Pachauri S.S. (2009) Essentials of Biotechnology; Ane Books, New Delhi.

MOLECULAR BIOLOGY

1. Nucleic acids - DNA - the genetic material; the discovery of DNA as the genetic material; bacterial transformation (Griffith's & Avery's experiments); Hershey and Chase experiment; Structure of DNA, Watson & Crick's Model, Types of DNA-(A,B,Z); Replication: semi conservative replication- Meselson and Stahl's experiment; Molecular mechanism of Replication, RNA- structure, types and properties.

(6 hrs)

2. Gene action - One gene - one enzyme hypothesis, one cistron one polypeptide hypothesis; concept of colinearity; modern concept of gene-cistrons, recons and mutons (2 hrs)
3. Genetic code - Characters of genetic code (2 hrs)
4. Central dogma protein synthesis; Transcription, post-transcriptional modification of RNA, translation; Teminism. (3 hrs)
5. Gene regulation in prokaryotes - operon concept, (Lac operon, trp. operon) (1 hr)
6. Gene regulation in eukaryotes (brief account) (1 hr)
7. Mutation-spontaneous and induced; causes and consequences. Types of mutagens and their effects. Point mutations- molecular mechanism of mutation-Transition, Transversion and substitution (3 hrs)

SUBMISSION (MOLECULAR BIOLOGY)

Visit a research station with well-equipped biotechnology / Molecular biology lab and submit a duly certified detailed report of the same during the practical examination.

REFERENCES (MOLECULAR BIOLOGY)

1. Brown T A. (2003) Genomes. John Willey and Sons.
2. Hawkins, J D. (1996) Gene Structure and Expression. Cambridge University Press
3. Lewin Benjamin. (2017) Gene XII. Oxford University Press
4. Malathi, V. (2010). Essentials of Molecular Biology, Pearson Education Inc.
5. Russell, P. J. (2010). Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
6. Waseem Ahmad, (2009). Genetics and Genomics. Pearson Education Inc.
7. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York. 6th edition.

BIOINFORMATICS

Module-I(3 hrs)

1. IT in teaching, learning and research: Web page designing and web hosting. Academic web sites, e-journals, Open access initiatives and open access publishing, education software, academic services - INFLIBNET, NICNET, BRNET.
2. E-wastes and green computing.
3. Futuristic IT - Artificial intelligence, virtual reality, bio-computing.

Module- II (5 hrs)

1. Introduction to Bioinformatics, brief history, scope and relevance, wet lab to web lab

2. Basics of Genomics, Proteomics and comparative genomics
3. Biological data bases:
Nucleotide sequence database – EMBL, Gen Bank, DDBJ.
Protein database – SwissProt, PDB.
Organismal database /Biodiversity database – Species 2000 /Humangenome database
4. Information retrieval from Biological database, sequence alignment types and tools: pair wise sequence alignment, multiple sequence alignment, BLAST, Clustal W

Module- III(6 hrs)

1. Genomics: DNA sequencing, Sangers procedure, automation of DNA sequencing, genome sequence assembly.
2. Genome projects – Major findings and relevance of the following genome projects – Human, *Arabidopsis thaliana*, Rice, *Haemophilus influenza*.
3. Proteomics : Protein sequencing- automation of sequencing, protein structure prediction and modelling (Brief account only)

Module- IV(4 hrs)

A brief account on

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

PRACTICAL (BIOINFORMATICS)

1. Familiarizing with the different data bases mentioned in the syllabus.
2. Molecular visualization using Rasmol.
3. Blast search of nucleotide sequences.

REFERENCE (BIOINFORMATICS)

1. Jin Xiong (2006): Essential Bioinformatics, Cambridge University Press, Replika Press Pvt. Ltd.
2. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. OxfordUniversity Press.
3. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
4. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. _II Edition. Benjamin Cummings.

**CORE COURSE-12:
PLANT BIOCHEMISTRY**

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
6	GBOT6B12T	3	5	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Draw and explain the structure of biomolecules.
2. Explain the metabolic processes taking place in each cell.
3. Appreciate the energy fixing and energy releasing processes taking place in cells.

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theory	Practical	Total
1	Plant Biochemistry	54	36	54
Total		54	36	90

QUESTION PAPER PATTERN

Type of questions	No of questions	Total marks
2 marks	12	Ceiling 20
5 marks	7	Ceiling 30
10 marks	2	1x10 = 10
Total	21	60

THEORY (54 Hours)

1. **Introduction to Biochemistry:-** Macromolecules, Micromolecules, Metabolic intermediates, Precursor molecules. **2 Hrs.**
2. **Carbohydrates:-** Classification of carbohydrates - Structure of monosaccharides (Glyceraldehyde, Erythrose, Ribose, Glucose, Fructose, Galactose and Mannose) - Structure of Disaccharides (Maltose, Isomaltose, Cellobiose, Lactose, Sucrose and Trehalose) - Structure of Oligosaccharides (Raffinose, Gentianose, Stachyose and Verbascose) - Structure of polysaccharides (Starch, Cellulose, Hayluronic acid and Heparin) - Functions of Simple sugars and compound carbohydrates - Carbohydrate derivatives (Glycosides, Deoxy sugars and Amino sugars). **8 Hrs.**

3. **Lipids:-** Structure and properties of Glycerol - Classification, structure and properties of fatty acids - Classification of lipids by Bloor - Structure of simple lipids (Triglyceride) and Compound lipids (Phosphatidic acid, Lecithin, Cephalin and Sphingomyelin) - Brief account on steroids with emphasis on cholesterol.
5 Hrs.
4. **Amino Acids:-** General structure and properties - Classification based on variable side chain - Structure of protein amino acids - Dipeptide formation - Ionization of amino acids - Brief account on non-protein amino acids.
4 Hrs.
5. **Proteins:-** Structure of protein - Primary structure, Secondary structure (α helical & β pleated sheet structure), Tertiary structure and Quaternary structure - Bonds responsible for stability of protein structure - Denaturation of proteins
5 Hrs.
6. **Nucleotides:-** Chemical composition of nucleotides - Structure of nitrogen bases (Adenine, Guanine, Cytosine, Uracil and Thymine) - Structure of sugar moiety in nucleotides (Ribose and 2-deoxy ribose) - Structure of nucleosides - Structure of nucleotides - Functions of nucleotides - Nucleotide derivatives (NAD⁺, NADP⁺, FAD and FMN).
4 Hrs.
7. **Secondary metabolites:-** A brief account of secondary metabolites - Physiological and ecological significance.
2 Hrs.
8. **Introduction to metabolism:-** Intermediary metabolism Anabolism - Catabolism - Amphibolic pathway s- Anapleurotic reactions.
1 Hr.
9. **Enzymes:-** Introduction - Nomenclature of enzymes - Classification of enzymes by IUB - Physico-chemical nature of enzymes - Mechanism of enzyme action - Lowering of energy of activation - Factors affecting enzyme activity:- Substrate concentration, pH, Temperature, Redox potential and Enzyme inhibitors.
6 Hrs.
10. **Catabolism of carbohydrates:-** Glycolysis:- Two phases of glycolysis - Reactions of glycolysis - Energy balance sheet of glycolysis - Fate of pyruvate under anaerobic and aerobic condition - Citric acid cycle:- Formation of active acetate - Reactions of citric acid cycle - Energy balance sheet of citric acid cycle - Amphibolic nature of citric acid cycle - Anapleurotic reactions of citric acid cycle.
5 Hrs.

11. **Biosynthesis of Lipids:-** Formation of saturated fatty acids in plants - Synthesis of triglycerides. **3 Hrs.**
12. **Catabolism of lipids:-** Hydrolysis of lipids - Fate of glycerol - α and β oxidation of fatty acids. **3 Hrs.**
13. **Catabolism of Proteins:-** Hydrolysis proteins to amino acids - Transformations of amino acid and entry into citric acid cycle. **2 Hrs.**
14. **Electron Transport Chain in mitochondria:-** Definition of ETC - Redox potential - Electron carriers - Multienzyme complex - Electron transport reactions - Energy transfer sites and synthesis of ATP - Oxidative phosphorylation - Terminal oxidation. **4 Hrs.**

PRACTICAL (36 Hours)

1. Schematic qualitative analysis of monosaccharides, reducing sugars, ketoses, starch, proteins and amino acids using suitable biochemical tests.
2. Quantitative estimation of proteins by Biuret test.
3. Quantitative estimation of DNA / RNA
4. Estimation of reducing sugar in germinating seeds.

**CORE COURSE-13:
ENVIRONMENTAL SCIENCE**

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
6	GBOT6B13T	3	5	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Realize the importance of ecological studies.
2. Develop environmental concern in all their actions and practise Reduce, Reuse and Recycle.
3. Try to reduce pollution and environmental hazards and change their attitude towards throwing away plastic wastes.
4. Spread awareness of the need of conservation of biodiversity and natural resources.
5. Analyze the reasons for climate change and find out ways to combat it.

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theory	Practical	Total
1	Module I	14	9	23
2	Module II	13	9	22
3	Module III	14	9	23
4	Module IV	13	9	22
Total		54	36	90

QUESTION PAPER PATTERN & SUBJECT WISE DISTRIBUTION OF MARKS

Type of questions	Module I	Module II	Module III	Module IV	Total
2 marks (total 12)	3	3	3	3	Ceiling 20
5 marks (total 7)	2	2	2	1	Ceiling 30
10 marks (total 2)	2				1x10 = 10
TOTAL					60

ENVIRONMENTAL SCIENCE

Module - I

1. Ecosystem: Definition, abiotic and biotic factors, trophic structure, Foodchain and food web, Ecological pyramids, Energy flow, Productivity of ecosystems. (4 hrs)
2. Biogeochemical cycles (Carbon, Nitrogen, Phosphorous) (3 hrs)
3. Plant adaptations: Adaptations in Hydrophytes, Xerophytes, Halophytes,

- Epiphytes and Parasites. (3 hrs)
4. Plant Succession: Definition – Primary and Secondary succession; Autogenic and allogenic succession; Mechanism of plant succession–Xerosere and Hydrosere (4 hrs)

Module-II

- 1 Biodiversity and Conservation: Definition; Biodiversity - Global and Indian Scenario; Megadiversity nations and hotspots: Biosphere reserves; Biodiversity centres in India. (5 hrs)
- 2 Threats to biodiversity; Endangered and endemic plant species, Red databook, Exotic and indigenous plant species, Keystone species, Flagship species, Umbrella species, Indicator species. (4 hrs)
- 3 Conservation strategies *ex situ* and *in situ* methods. Organizations–IUCN, UNEP & WWF; (NBPGR), Kerala state Biodiversity Board (KSBB). (4 hrs)

Module-III

- 1 Pollution: Sources and types of pollution – air, water, soil, thermal and noise; biodegradable and non-biodegradable pollutants; biomagnification; BOD. (4 hrs)
- 2 Global environmental changes – climatic changes – global warming and greenhouse gases, acid rains, el-nino, efforts of world organizations in the regulation of greenhouse gases emission. (5 hrs)
- 3 Management of environmental pollution – conventional and phytotechnological approaches – solid wastes management including e-wastes–environmental legislations in India (Prevention and Control of Pollution act, 1981). (5 hrs)

Module- IV

- 1 Major ecosystems of the Biosphere; Sea; Estuarine ecosystem; Lentic ecosystem: lake, Pond; Lotic ecosystem: river; Desert; Forest; Grass land. (5 hrs)
- 2 Techniques in plant community studies – Quadrat and transect methods– species area curve– density, frequency, abundance, dominance of populations– importance value index – construction of phytographs. (8 hrs)

PRACTICAL

1. Construct a food web from the given set of data, (Representative of a natural ecosystem). (Drawing not required).
2. Construct ecological pyramids of number, biomass and energy from the given set of data (Representative of a natural ecosystem). (Drawing not required).

3. Study of plant communities: Determination of density, abundance, dominance, frequency by quadrat method.
4. Demonstration of determination of Dissolved Oxygen by Winkler's method.
5. Study of morphological and anatomical characteristics of plant groups: Hydrophytes, Xerophytes, halophytes, epiphytes, parasites. (Drawing not required).

REFERENCES

1. Beeby A. & Brennan A.M. (2004) First Ecology. Ecological Principles and Environmental Issues. Oxford University Press.
2. Cunningham W.P. and M.A. Cunningham (2003). Principles of Environmental Science: Inquiry and Applications. Tata McGraw Hill Pub. N.D.
3. Dash M.C. (1993). Fundamentals of Ecology. Tata McGraw Hill Publishing Company Ltd. New Delhi.
4. Dix J.H. (1989). Environmental Pollution. Atmosphere, Land, Water and Noise. Wiley Chichester.
5. Khitoliya R.K. (2007). Environmental Pollution - Management and Control for Sustainable development S. Chand and Company Ltd., New Delhi.
6. Mishra D.D (2008). Fundamental Concepts in Environmental Studies. S. Chand & Co., New Delhi.
7. Mishra S.P. & S.N. Pandey (2008). Essential Environmental Studies. Ane Books Pvt. Ltd. Thiruvananthapuram.
8. Odum E.P. (1983). Basics of Ecology. Saunders International UN Edition.
9. Shukla R.S. & P.S. Chandel (2005). A Text Book of Plant Ecology S. Chand & Co. Ltd. New Delhi.
10. Wise, D.L. (2005) Global Environmental Biotechnology. Ane Books. Thiruvananthapuram.
11. Bharucha E. (2005) Text Book of Environmental Studies for UG courses. University Press (India) Private Limited Hyderabad.
12. Diamond, J., T.J. Case (1986). Community ecology. Harper & Row, New York.
13. Futuyma P.J., Slatkin M. (1983) Co-evolution. Sinauer Associates, Sunderland Mass.
14. Krebs, C.J. (1985). Ecology 3rd edn. Harper & Row New York.
15. Sharma, P.D. (2008-2009). Ecology and Environment. Rastogi Publication.
16. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.

ELECTIVE COURSES

CORE COURSE-14

ELECTIVE-1: GENETIC ENGINEERING

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
6	GBOT6E01T	3	5	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Appreciate various techniques employed in genetic engineering.
2. Develop general awareness on genetically modified organisms.
3. Understand the ethical, social and legal issues associated with genetic engineering.

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theory	Practical	Total
1	Module I	12	36	48
2	Module II	15		15
3	Module III	15		15
4	Module IV	12		12
Total		54	36	90

QUESTION PAPER PATTERN

Type of questions	No of questions	Total marks
2 marks	12	Ceiling 20
5 marks	7	Ceiling 30
10 marks	2	1x10 = 10
TOTAL	21	60

GENETIC ENGINEERING

Module -I

Introduction to gene cloning (12 hrs)

1. DNA isolation; DNA isolation solutions, isolation buffer pH, concentration and ionic strength, DNase inhibitors, detergents used for isolation, methods for breaking the cells
2. Removal of proteins from cell homogenate; using organic solvents, Kirby method and Marmur method, using CTAB
3. Removal of RNA; using RNase A, RNase T1

4. Concentrating the isolated DNA; precipitating with alcohols, salts added along with alcohol
5. Determination of the concentration and purity of DNA; using UV spectrophotometry
6. Storage of DNA samples
7. Commercially available kits for genomic and plasmid DNA isolation
8. Preparation of genomic DNA from animal cells, plant cells and bacterial cells; protocol for small scale and large scale preparations
9. Isolation of plasmid DNA; protocol for small scale and large scale preparations
10. Isolation and purification of RNA; purification of total RNA, RNase inhibitors, preparation of cell material, preparation of glass wares, guanidinium hot phenol method, high salt lithium chloride method, isolation of poly A RNA

Module-II

Agarose Gel electrophoresis of DNA and RNA (15 hrs)

1. Principles of electrophoresis,
2. Buffers used for electrophoresis of nucleic acids,
3. Gel concentration, sample concentration, sample loading solutions,
4. Gel staining,
5. Determination of molecular weight using molecular weight markers, special precautions and treatments required for electrophoresis of RNA, Elution of DNA from agarose gels; electroelution, using low-melting point agarose.
6. Nucleic acid transfer and hybridization; Southern blot transfer, dot-blot transfer, plaque and colony transfer, Southern blot hybridization, Northern blot transfer and hybridization, in situ hybridization
7. Preparation of probes for hybridization, radioactive labeling, digoxigenin labeling, nick translation, preparation of primer using PCR, RNA probes

Module - III

Principle of DNA cloning (12 hrs)

1. Cloning vectors; essential features of a cloning vector, plasmid derived vectors, bacteriophage derived vectors, hybrid vectors, high capacity cloning vectors; BACs, PACs and YACs, Agrobacterium based vectors, shuttle vectors, expression vectors
2. Enzymes used in recombinant DNA technology; type II restriction endonucleases, ligases, S1 nuclease, alkaline phosphatase, terminal transferase, DNA polymerase I, reverse transcriptase, exonuclease III, bacteriophage λ exonuclease,
3. Finding gene of interest; shot gun cloning followed by screening, construction

and use of genomic DNA library and cDNA library, screening DNA libraries, chromosome walking, in silico gene discovery, cloning of the gene of interest, altering the gene of interest through sitedirected mutagenesis,

4. Preparation of recombinant DNA molecule, blunt ends and sticky ends, using tailing method, using polylinkers
5. Methods to transfer the recombinant DNA molecule into the cloning host; transformation, transfection, transduction, electroporation, microinjection, microprojectiles and DNA gun, Agrobacterium mediated transfer
6. Methods to select the recombinants; antibiotic markers, insertional inactivation, replica plating, blue-white selection, use of reporter genes; GUS, luciferase and GFP genes

Module -IV

Transgenesis; introduction to transgenic organisms and their applications (15 hrs)

1. Mechanism of gene transfer into eukaryotic cells, transfection methods; using polyethylene glycol, chemical transfection using lithium acetate, calcium phosphate, and DEAE-dextran, lipofection, electroporation, microinjection, DNA gun, fate of DNA transferred to eukaryotic cells, random integration transgenesis - gain of function effects and loss of function effects, gene targeting,
2. Examples of transgenic crop plants and animals
3. Antisense and RNAi technology
4. Production of knock out models and their use
5. Applications of recombinant DNA technology
6. Ethical, Social and legal issues associated with recombinant DNA technology

PRACTICAL:

Students should be given sufficient exposure to the experiments listed below either by visiting nearby biotechnology labs or showing video clippings of the same. Centers selecting this elective are supposed to procure the required facilities in the meantime. Protocols of the listed experiments should be recorded.

1. Isolation of genomic DNA from plants and its quantification and purity checking using spectrophotometric method.
2. Agarose gel electrophoresis of the isolated plant genomic DNA, its visualization and photography.
3. Isolation of plasmid DNA from bacterium, and its quantification and purity checking using spectrophotometric method.
4. Agarose gel electrophoresis of the isolated plasmid DNA, its visualization and photography

5. Preparation of competent *E.coli* cells.
6. Preparation of recombinant plasmids, transformation of *E.coli* and selection of transformants.

Record of the practical works done together with the detailed report of the Biotechnology Laboratory visit should be duly certified and submitted for the valuation at the time of practical examination.

REFERENCES

1. Recombinant DNA , JD Watson, (1992) Scientific American Books
2. Recombinant DNA: genes and genomes - a short course, JD Watson et al., (2006) WH Freeman & Co.
3. Recombinant DNA technology and applications, Alex Prokop et al., (1997) McGraw Hill.
4. Principles of Gene Manipulation: An Introduction to Genetic Engineering, by R.W. Old and B001H6L956S.B. Primrose, (2000) Blackwell Scientific
5. Molecular Cloning: a Laboratory Manual. Sambrook J, Russel DW & Maniatis T. (2001) Cold Spring Harbour Laboratory Press.

CORE COURSE-14
ELECTIVE-2: ADVANCES IN CROP IMPROVEMENT

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
6	GBOT6E02T	3	5	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Understand various techniques employed for increasing crop productivity.
2. Identify diseases affecting crop plants.
3. Attain general awareness on various crop research stations of the country.

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theory	Practical	Total
1	Module I	11	36	47
2	Module II	10		10
3	Module III	4		4
4	Module IV	7		7
5	Module V	22		22
Total		54	36	90

QUESTION PAPER PATTERN

Type of questions	No of questions	Total marks
2 marks	12	Ceiling 20
5 marks	7	Ceiling 30
10 marks	2	1x10 = 10
Total	21	60

ADVANCES IN CROP IMPROVEMENT

Module -I

Crop genetics - General account of origin, genetic variability, floral biology, breeding techniques and achievements in: Rice, Coconut, Rubber, Arecanut, Cashew and Pepper. (11 hrs)

Module -II

1. Plant genetic resources- Definition; Classification of Plant Genetic resources. Activities- exploration, conservation, evaluation, documentation and utilization. (2 hrs)
2. Agencies involved in plant genetic resources activities – NBPGR and IPGRI (4 hrs)

3. International institutes for crop improvement - IRRI, ICRISAT, CIMMYT, IITA. Brief account on research activities and achievements of national institutes - IARI, CCMB, IISc, BARC, CPCRI, IISR, RRII, CTCRI, KFRI, JNTBGRI. (4 hrs)

Module- III

1. Methods of crop Improvement (4 hrs)

1. Plant introduction
2. Selection - Principles, Selection of segregating populations, achievements
3. Hybridization - Interspecific hybridization; intergeneric - achievements. Genetics of back crossing, Inbreeding, Inbreeding depression, Heterosis and Heterobeltiosis

Module - IV.

- 1 Heteroploidy in crop improvement - achievements and future prospects - Significance of haploids and polyploids (2 hrs)
- 2 Mutations in crop improvement - achievements and future prospects (2 hrs)
- 3 Genetics of nitrogen fixation - Use of biofertilizers in crop improvement (2 hrs)
- 4 Genetics of photosynthesis (1 hr)

Module- V.

1. Breeding for resistance to abiotic stresses - Introduction, importance of abiotic and biotic stresses and its characteristics. (10 hrs)
 1. Breeding for drought resistance: Genetics of drought resistance; Breeding methods and approaches; Difficulties in breeding for drought resistance.
 2. Breeding for mineral stress resistance: Introduction, Salt affected soils, Management of salt affected soils: Salinity resistance - general account.
2. Breeding for resistance to biotic stresses. (12 hrs)
 1. Disease resistance - History of breeding for disease resistance; Genetics of pathogenicity - Vertical and horizontal resistance; Mechanism of disease resistance; Genetics of disease resistance - Oligogenic, polygenic and cytoplasmic inheritance - Sources of disease resistance - Methods of breeding for disease resistance.
 2. Insect resistance - Introduction, Mechanism, Nature and genetics of insect resistance, Oligogenic, Polygenic and cytoplasmic resistance, sources of insect resistance, Breeding methods for insect resistance, Problems in breeding for insect resistance, Achievements, Breeding for resistance to parasitic weeds.

PRACTICAL

1. Visit a leading breeding station in South India and a detailed report should be included in the practical record. The record duly certified by HoD should be submitted at the time of practical examination.
2. Make illustrations on the floral biology of Rice, Cashew and *Solanum* spp.
3. Demonstration of hybridization in Rice, Cashew and *Solanum* and describe the procedure.
4. Study the variability under induced stress (salinity and moisture) of seedlings of rice and green gram and record the observations.

REFERENCES

- 1 Singh, B D. (2000) Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi.
- 2 Sharma, J R. (1994) Principles and Practice of Plant Breeding. Tata Mcgraw - Hill Publishing Company, New Delhi.
- 3 Benjamin Levin. (2007) Genes VIII.
- 4 Allard, R W. (1960) Principles of Plant Breeding. John Wiley & Sons, New York.
- 5 Chahal, G S & S S Gosal, (1994) Principles and procedures of Plant Breeding. Narosa Publishing House, New Delhi.
- 6 Chrispeels M J and Sadava, D E. (1994) Plants, Genes and Agriculture. Jones and Bartlet Publishers, Boston, USA.

CORE COURSE-14
ELECTIVE-3: ADVANCED ANGIOSPERM SYSTEMATICS

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
6	GBOT6E03T	3	5	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Develop deep knowledge in angiosperm systematics.
2. Demonstrate ability to identify and classify plants in a faster and better way.
3. Apply imaging technologies in plant systematics.

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theory	Practical	Total
1	Module I	12	36	48
2	Module II	22		22
3	Module III	5		5
4	Module IV	15		15
Total		54	36	90

QUESTION PAPER PATTERN

Type of questions	No of questions	Total marks
2 marks	12	Ceiling 20
5 marks	7	Ceiling 30
10 marks	2	1x10 = 10
Total	21	60

ADVANCED ANGIOSPERMSYSTEMATICS

Module -I

1. Scope and importance of Taxonomy.(2 hrs)
2. The history of taxonomy- Ancient classification; Evolution of different concepts in taxonomy. The herbalists; Early taxonomists; Linnaeus; PostLinnaean natural systems; Post Darwinian phylogenic; Modern Phenetic methods (Numerical taxonomy); Modern Phylogenic methods (Cladistics).APG system of classification
(10 hrs)

Module-II

The material basis of Systematics

1. Concept of character; Correlation of characters; character weighting; Character variation, isolation and speciation.
(4 hrs)

2. Sources of Taxonomic characters: Morphology, Anatomy, Palynology, Embryology, Cytology, Phytochemistry, Molecular Taxonomy. Role of the above mentioned branches in taxonomic studies (6 hrs)
3. Identification techniques: Taxonomic literature: Flora, Revision, monograph, use and construction of taxonomic keys. Herbarium: Definition, Steps involved in preparation and maintenance of herbarium, Herbarium consultation; General account of Regional and National herbaria with special emphasis to Kew, CAL, MH, CALI. (5 hrs)
4. Botanic gardens and their importance in taxonomic studies - Important National and International Botanic Gardens - Royal Botanic Gardens, Kew; Indian Botanic Gardens, Calcutta; National Botanic Garden, Lucknow; JNTBGRI Thiruvananthapuram; MBGIPS Kozhikode. (3 hrs)
5. Digital resources in taxonomy: Softwares, Databases, Online tools; use of TROPICOS, IPNI, Virtual herbaria, Digital flora/databases of Flora of Kerala. (4 hrs)

Module - III

Plant Nomenclature (5 hrs)

1. History of nomenclature - Polynomial and binomial systems
2. Brief outline of ICN
3. Major rules; Typification; Rule of priority; Effective and valid publication; author citation

Module - IV

Taxonomic review of selected families (15 hrs)

Critical study of the following families with emphasis on identification of local members, economic importance, inter relationships and evolutionary trends: Nymphaeaceae, Capparidaceae, Sterculiaceae, Rutaceae, Combretaceae, Lythraceae, Scrophulariaceae, Convolvulaceae, Bignoniaceae, Asclepiadaceae, Verbenaceae, Amaranthaceae, Urticaceae, Amaryllidaceae, Arecaceae, Cyperaceae

PRACTICAL:

1. Identification of locally available plants belonging to the families mentioned under module - IV using local Floras.
2. Familiarize local flora and study the preparation of taxonomic keys and taxon card for plants coming under the families in module IV.
3. Students must work out at least one member of the every families mentioned in module IV, and has to submit a photo album instead of record. The photo album should carry details like systematic position, GPS location, date, name and reg. no. of the student etc. Separate images clearly showing habitat, habit, inflorescence type, single flower, floral parts etc. of the plant should be represented.

REFERENCES

1. Gurucharan Singh, (2012) Plant Systematics - Theory and Practice. Oxford & IBH, New Delhi.
2. Henry & Chandrabose.(1997) An aid to International code of Botanical Nomenclature. BSI.
3. Heywood, V H & Moore, D M. (Eds) (1984) Current concepts in Plant Taxonomy
4. Lawrance, G H M. Taxonomy of vascular plants. Oxford & IBH
5. Mondal A.K. (2009) Advanced Plant Taxonomy, New Central Book agency Pvt.Ltd. KolKota.
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MODEL QUESTION PAPERS (THEORY)

FIRST SEMESTER B. Sc. BOTANY DEGREE PROGRAMME
CORE COURSE 1
GBOT1B01T: ANGIOSPERM ANATOMY AND MICROTECHNIQUE

TIME: 2 Hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. Describe the structure of hydathodes
2. Add a note on Coal-tar dyes.
3. What is protoderm?
4. Give an account of lysigenous ducts in plants.
5. Why are vital stains important?
6. What is a casparian strip? What is its role?
7. Describe the importance of maceration
8. Where can you find raphides? How is it formed?
9. Describe the various fixing agents used in preservation of specimens
10. Write short note on aleurone grains.
11. Explain Histogen theory.
12. What is meant by Killing in microtechnique?

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Discuss the specialties of meristematic cells.
14. Give an account of cell wall materials.
15. Explain Dehydration and infiltration.
16. Give an account of organisation of root apex in dicots.
17. Describe the working of micrometer.
18. Describe the structure of collenchyma. Where do you find it in a plant body?
Add a note on its functions.
19. Give an account of Vital staining.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. Give a detailed account of complex tissues in angiosperms. Discuss the phylogenetic significance of complex tissues. .
21. Write an essay on the principles and types of microscopy.

SECOND SEMESTER B. Sc. BOTANY DEGREE PROGRAMME
CORE COURSE- 2
GBOT2B02T: MICROBIOLOGY, MYCOLOGY, LICHENOLOGY AND PLANT
PATHOLOGY

TIME: 2 Hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. Differentiate between isidium and soredium.
2. Define facultative saprophyte. Give an example.
3. What are plasmids?
4. Describe Prions.
5. Write a short note on symbiotic associations between algae and fungi with one example.
6. What is dikaryotization?
7. What are heterocious fungi?
8. Give an account of viral capsid.
9. Differentiate between rust and smut.
10. Describe apothecium in *Peziza*
11. Define systemic fungicide, with an example.
12. Give an account of quarantine measures adopted for disease control

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Write a brief account of the salient features of Ascomycetes.
14. Explain living and non-living characters of virus.
15. Enumerate the economic importance of Fungi.
16. Briefly explain reproduction in lichens.
17. Describe the gene transfer methods in bacteria.
18. Give an account of application of microbes in industry.
19. Explain the symptoms and control measures of citrus canker disease.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. Briefly explain the life cycle of the pathogen of damping off disease, with suitable diagrams.
21. Describe the structure and reproduction of Bacteriophages.

THIRD SEMESTER B. Sc. BOTANY DEGREE PROGRAMME
CORE COURSE - 3
GBOT3B03T: PHYCOLOGY, BRYOLOGY PTERIDOLOGY AND GYMNOSPERMS

TIME: 2 hrs

Max. Marks 60

SECTION A

Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. What is circinate vernation? Give an example of a pteridophyte showing this.
2. Differentiate between conceptacles and receptacles in *Sargassum*.
3. Write notes on Apogamy in pteridophytes.
4. Comment on the role of *Nostoc* in agriculture. Which part of the thallus helps perform the role?
5. Describe the structure of cystocarp in *Polysiphonia*.
6. Describe the features of the male gametophyte of *Pinus*.
7. Explain the cell structure of *Pinnularia*.
8. Enumerate the angiosperm features of *Gnetum*.
9. Write notes on the evolutionary importance of Bryophytes.
10. Critically evaluate the synangium in *Psilotum*.
11. Describe the reproduction in *Voucharia*.
12. What are trabeculae? How are they formed?

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Comment on the sporophyte of *Funaria*.
14. Give an account of the post fertilization changes in *Polysiphonia*.
15. Describe the anatomical features of *Equisetum*.
16. Comment on the evolutionary position of gymnosperms.
17. Critically evaluate the attempt of seed formation observed in *Selaginella*.
18. Describe the economic importance of algae.
19. Explain the economic importance of gymnosperms.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. Critically analyse the thallus variation and types of reproduction seen in Chlorophyceae.
21. Give a detailed account of the stellar evolution in Pteridophytes with diagrams.

FOURTH SEMESTER B. Sc. BOTANY DEGREE PROGRAMME

CORE COURSE- 4

GBOT4B04T: RESEARCH METHODOLOGY, REPRODUCTIVE BOTANY & PALYNOLOGY

TIME: 2 Hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. Define Shodhganga and elaborate its importance.
2. What does an Impact Factor indicate?
3. Differentiate between Central tendency and Dispersion.
4. How is a Chi-square test used in biological experiments?
5. What are Ogives?
6. Is pH of any solution relevant? Why?
7. What is molecular sieving?
8. What are the different kinds of centrifuges?
9. What is 'ppm', why is it commonly used in preparation of solutions?
10. What is tapetum? Add a note on its types and functions.
11. Discuss how the study of pollen grains becomes important in taxonomy.
12. What is an embryosac?

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Elaborate the steps involved in Scientific methods and preparation of scientific reports
14. Describe the various data collection methods
15. Explain the importance of Correlation and Regression
16. Describe the principle and applications of different photometric methods
17. Write a short note on the importance of buffers in biological experiments
18. Describe the structure of a dicot embryo.
19. Give an account of barriers of fertilization.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. Explain the prospects and limitations of Biostatistics, emphasizing on the different tools used for statistical analysis.
21. Describe the principles and different types of chromatography

FIFTH SEMESTER B. Sc. BOTANY DEGREE PROGRAMME
CORE COURSE -6
GBOT5B06T: CELL BIOLOGY, PALAEOBOTANY, PHYTOGEOGRAPHY,
EVOLUTION

TIME: 2 Hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. Describe the function of nucleolus
2. Mention the features of nucleosomes.
3. Differentiate between euchromatin and heterochromatin
4. Describe any two features of fluid mosaic model of plasma membrane.
5. What is crossing over? Mention its significance.
6. Describe Geological time scale.
7. What is meant by continental drift? Explain.
8. What are the causes and consequences of glaciation?
9. Give a brief account of phytogeographical zones of India.
10. What is endemism? Explain with an example.
11. What is discontinuous distribution?
12. Describe the Modern concept of evolution.

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Write a brief note on polytene chromosome and its significance.
14. Describe the morphology and chemical composition of chromosomes.
15. Enumerate the contributions of Birbal Sahni and Savithri Sahni.
16. Define migration. What is its impact on biodiversity of a particular region? Explain with example.
17. Explain the theory of land bridges.
18. Describe the evolution of prokaryotic cells.
19. Explain speciation.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. Give an account of numerical aberration of chromosomes and its significance.
21. Explain the theories on origin and evolution of species.

FIFTH SEMESTER B. Sc. BOTANY DEGREE PROGRAMME
CORE COURSE-7
GBOT5B07T: ANGIOSPERM MORPHOLOGY & SYSTEMATICS

TIME: 2 hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. Describe the structure of a coenanthium.
2. Explain the rule of priority.
3. A flower can be considered as a modified shoot. Justify.
4. Describe the vegetative features of Lamiaceae.
5. Differentiate between definable and non-definable families with examples.
6. Briefly describe the contributions of EK Janaki Ammal to the field of angiosperm taxonomy.
7. What is caruncle? Where can you find it? Describe its function.
8. What is meant by virtual herbarium?
9. What is meant by effective publication?
10. What type of structural adaptations can you find in a coconut seed that helps its easy dispersal?
11. What is resupination? Where can you find it?
12. Give an account of taxonomic hierarchy.

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Give an account of the various types of racemose inflorescences found in angiosperms with examples.
14. Write notes on typification.
15. Give an account of the APG system of classification. Enumerate its advantages.
16. Describe the concept of species.
17. What is numerical taxonomy?
18. Describe the types of flowers based on the relative position of ovary and other floral parts.
19. Give an account of ICN principles.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. Give an account of various types of fruits produced by angiosperms with special reference to the types of placentations observed in these, citing suitable examples.
21. Critically evaluate the reasons for the successful establishment of Asteraceae.

FIFTH SEMESTER B. Sc. BOTANY DEGREE PROGRAMME
CORE COURSE- 8
GBOT5B08T: TISSUE CULTURE, HORTICULTURE, ECONOMIC BOTANY AND
ETHANOBOTANY

TIME: 2 Hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. What is the principle of plant tissue culture?
2. Define organogenesis? Explain the different types.
3. Write a short note on haploids, their production and significance?
4. What are the different branches of horticulture?
5. What is a gelling agent? Give examples.
6. Name two plants of ethnobotanical significance and their uses.
7. Comment on the formation of humus.
8. Explain the different types of green houses.
9. Write the binomial and family of four oil yielding plants.
10. Comment on compost activators.
11. What are the advantages of drip irrigation?
12. Explain the types and advantages of biofertilisers.

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Explain the steps involved in creating bonsai.
14. What are the different types of soil?
15. What is a nutrient medium, and what are its components? Cite an example of a commonly used medium.
16. Name four plants used for their medicinal importance, and the chemical constituents responsible for these properties?
17. Give an account of various tribal communities of Kerala.
18. Explain the major stages in micropropagation.
19. Explain how you can obtain virus free plants through tissue culture,

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. Explain the different methods of vegetative propagation in plants? Compare nature of such plants with sexually propagated plants.
21. Explain the steps involved in somatic hybridization and the relevance of the technique.

**SIXTH SEMESTER B. Sc. BOTANY DEGREE PROGRAMME
CORE COURSE-9**

GBOT6B09T: PLANT PHYSIOLOGY

TIME: 2 Hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

- 1 Describe facilitated diffusion.
- 2 What are antitranspirants? Give examples.
- 3 Comment on seismonastic movements.
- 4 Differentiate between osmosis and diffusion.
- 5 Give an account of Ascent of sap.
- 6 Discuss Soil-plant-atmosphere continuum.
- 7 Difference between active and passive uptake of mineral ions.
- 8 What is RUBISCO? What is its importance?
- 9 Discuss the importance of assimilatory power.
- 10 Give an account of physiological role of abscisic acid.
- 11 Comment on turgor pressure.
- 12 Define photosystem. Add a note on its significance.

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

- 13 Critically analyse the significance of photorespiration.
- 14 Comment on Phloem loading and unloading.
- 15 What is water potential? Explain its components
- 16 Explain transpiration pull theory. Comment on its merits and demerits
- 17 Examine the special photosynthetic pathway that helps xerophytic plants to survive in desert condition.
- 18 Summarise the biological nitrogen fixation in leguminous plants.
- 19 Phytochromes are the key photomorphogenic pigment in a plant system. Justify.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

- 20 Describe the chemistry and physiological effects of Phytochrome.
- 21 Explain Photosynthetic electron transport and photophosphorylation.

**SIXTH SEMESTER B. Sc. BOTANY DEGREE PROGRAMME
CORE COURSE- 10
GBOT6B10T: GENETICS AND PLANT BREEDING**

TIME: 2 Hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. Differentiate between sex chromosomes and autosomes.
2. Define lethal genes. Cite one example.
3. Define heterosis. Write a suitable example
4. Differentiate between pure line and pure breeding.
5. Explain the significance of linkage.
6. What are multiple alleles?
7. Enumerate the characteristics of quantitative inheritance.
8. Explain the complementary gene action.
9. Write an account on clonal selection.
10. What is the significance of crossing over?
11. State Hardey Weinberg law.
12. Differentiate between back cross and test cross.

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Describe extra nuclear inheritance with suitable example.
14. What is the role of polyploidy in plant breeding?
15. What is recessive epistasis? Explain it with example.
16. Explain the genetics of inheritance of Fruit colour in summer squashes.
17. What is incomplete dominance? Explain with examples.
18. Write the achievements of mutation breeding.
19. Explain the various steps involved in pure line selection.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. Explain the various steps involved in plant introduction?
21. Explain the pattern of extranuclear inheritance with suitable examples

SIXTH SEMESTER B. Sc. BOTANY DEGREE PROGRAMME
CORE COURSE- 11
GBOT6B11T: BIOTECHNOLOGY, MOLECULAR BIOLOGY & BIOINFORMATICS

TIME: 2 Hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. Write a short note on Bioremediation.
2. Explain the relevance of Flavr Savr tomato.
3. Define Protein databases and highlight the relevance of any one.
4. What are the different types of gene banks?
5. Explain one-gene one-enzyme hypothesis.
6. What are point mutations?
7. Give a short note on pBR322.
8. What are the highlights of Semi-conservative replication.
9. Explain Teminism.
10. Write a note on the future of AI.
11. Define and explain the importance of any one of the Genome projects.
12. What is the importance of ClustalW?

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Describe the different gene transfer methods.
14. Explain the process of rDNA synthesis.
15. Explain the various Open access initiatives and discuss the advantages of these.
16. Describe the characteristics of a Genetic Code.
17. How would you differentiate genomics and Proteomics?
18. Explain the various DNA sequencing methods.
19. Explain the process of gene regulation and expression in *lac* operon.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. Explain the principle, topology, types and importance of phylogenetic trees.
21. Describe how Biotechnology has been applied for human welfare.

FIFTH SEMESTER B. Sc. BOTANY DEGREE PROGRAMME
CORE COURSE-12:
GBOT6B12T: PLANT BIOCHEMISTRY

TIME: 2 hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. What are isoenzymes? Give an example.
2. What are sphingolipids?
3. Differentiate between purines and pyrimidines.
4. What are dipeptides?
5. Write any two applications of steroids.
6. What is aldose?
7. Give any two properties of amino acids.
8. What are coenzymes? Give examples.
9. Describe zwitter ions.
10. What are peptide bonds? How is it formed?
11. What are polysaccharides? Give two examples.
12. What are allosteric enzymes?

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Explain the structure and function of ATP.
14. Explain the tertiary structure of proteins.
15. Differentiate between furanose and pyranose forms of sugars.
16. Analyse the ecological importance of secondary metabolites.
17. Comment on covalently modulated enzymes.
18. Explain the structure and functions of phospholipids.
19. Comment on denaturation and renaturation of proteins.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. Give an account of IUB classification of enzymes. Explain the mechanism of enzyme action.
21. Explain the structure and biological functions of proteins.

SIXTH SEMESTER B. Sc. BOTANY DEGREE PROGRAMME
CORE COURSE-13
GBOT6B13T: ENVIRONMENTAL SCIENCE

TIME: 2 Hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. Give an account of the biological factors of an ecosystem.
2. Describe the morphological adaptations in epiphytes.
3. What are biogeochemical cycles? Give an example.
4. Comment on biodiversity hotspots.
5. What is a flagship species?
6. Discuss the role of IUCN in biodiversity conservation.
7. Analyze the impacts of water pollution.
8. Give critical analysis of global warming and greenhouse gases.
9. Define biomagnification and explain its biological significance.
10. Write short note on importance value index.
11. Describe the ecological significance of estuarine ecosystem.
12. What is meant by dominance of populations?

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Discuss the ecological relevance of Grass lands.
14. Discuss e-waste accumulation. Suggest methods to manage this.
15. What is El Niño?
16. Discuss *ex situ* and *in situ* methods of conservation.
17. What is meant by Red Data Book?
18. Describe Energy flow in an ecosystem.
19. Discuss the anatomical adaptations in hydrophytes.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. Discuss the strategies of solid waste management.
21. Give a detailed account of the process and mechanism of ecological succession.

SIXTH SEMESTER B. Sc. BOTANY DEGREE PROGRAMME
CORE COURSE-14: Elective-1
GBOT6E01T: GENETIC ENGINEERING

TIME: 2 hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. How is DNA precipitated after isolation?
2. Distinguish between electroporation and microinjection
3. List out any two GM crops and note down their special feature.
4. Comment on site directed mutagenesis
5. What is CTAB?
6. Define a probe. Mention its use
7. What are reporter genes? Give one example
8. Write critical notes on chromosome walking
9. What is RNase? Mention its use.
10. Mention the buffers used for electrophoresis of nucleic acids?
11. Comment on knock out models
12. Mention two methods adopted for cell lysis

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Give an account on southern blotting
14. Briefly describe RNAi technology
15. Mention the use and procedure of blue white selection
16. How will you alter the gene of interest through site directed mutagenesis
17. Give an account on Agrobacterium mediated gene transfer
18. Comment on Type II Restriction endonuclease, alkaline phosphatase and DNA polymerase I
19. Write a critical note on ethical and social issues associated with rDNA technology

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. Write an account on vectors used in genetic engineering
21. Give a detailed account on construction and use of genomic DNA library and cDNA library.

SIXTH SEMESTER B. Sc. BOTANY DEGREE PROGRAMME
CORE COURSE-14: Elective-2
GBOT6E02T: GENETICS AND CROP IMPROVEMENT

TIME: 2 hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. Write a note on the origin of Pepper.
2. Expand NPBGR and add a note on its activities.
3. What are *nif* genes?
4. Mention the importance of making saline tolerant crops.
5. Give an account of biopesticides.
6. What are the causes of abiotic stress in plants?
7. Differentiate between vertical and horizontal resistance.
8. Expand ICRISAT and add a note on its activities.
9. What are the methods adopted for emasculation.
10. Write a note on the achievements on rice breeding programmes.
11. Define plant introduction and explain its relevance.
12. Explain the role of somaclonal variations in crop improvement.

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Explain the genetics of chloroplast.
14. Write briefly on selection as a method of crop improvement.
15. What is the role of IISR in pepper breeding?
16. Describe the breeding techniques and achievements in Coconut.
17. What is the role of IISc in plant research and development?
18. Give an account on the exploration and documentation of plant genetic resources.
19. Explain the genetics of salt tolerance.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. Write an essay on mutation breeding. Comment on its major advantages over the other methods of breeding
21. Explain different types of hybridization and the steps involved the process.

SIXTH SEMESTER B. Sc. BOTANY DEGREE PROGRAMME
CORE COURSE-14: Elective-3
GBOT6E03T: ADVANCED ANGIOSPERM SYTEMATICS

TIME: 2 hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. What is meant by acronym?
2. Define tautonym. Give an example.
3. Write notes on taxonomic indices.
4. Describe obdiplostemony. Give an example.
5. Write short notes on herbalists.
6. Explain virtual herbarium.
7. Enumerate the primitive traits of Nymphaeaceae
8. What is mean by effective publication?
9. Explain character correlation.
10. What are the identifying features of Amaranthaceae?
11. Explain the Rule of priority.
12. Write short note on DNA Barcoding.

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Differentiate Cladistics and Phenetics.
14. Give an account of five major databases used in Taxonomic studies
15. What is meant by character weighing?
16. Explain how phytochemical evidences are utilized in Taxonomy?
17. Give an account of five major herbaria in India.
18. Differentiate Bignoniaceae and Verbenaceae
19. Enumerate the characteristic features of the family Arecaceae giving special emphasis on its economic value.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. Give the structure of ICN. What is Typification? Explain the various types used in plant nomenclature
21. What are Botanic Gardens? Explain the role of Botanic Gardens and enumerate the major Botanic Gardens in India.

MODEL QUESTION PAPERS (PRACTICAL)

B.Sc. BOTANY CORE PRACTICAL EXAMINATION

Paper-I : GBOT4B05P

(Angiosperm Anatomy, Microtechnique, Reproductive Botany, Palynology, Microbiology, Mycology, Lichenology, Plant Pathology, Phycology, Bryology, Pteridology & Gymnosperms)

Time: 3Hours

Max: 80 Marks

1. Prepare a T.S. of the given specimen **A, B and C**, draw the ground plan and cellular diagram of a portion enlarged and identify the specimen.
(Preparation-4; Drawing-3; Identification-1; Reasons-2) 10×3 = 30 Marks
2. Identify the given bacteria **D** and submit the micro preparation for valuation.
(Preparation-3) 3 x1 = 3 Marks
3. Prepare Histogram/Frequency polygon/ using the given data **E**
OR
Workout the given problem **E** (Chi square test) 5 x1 = 5 Marks
4. Identify the disease, pathogen and list out the symptoms from the given specimen **F** and **G**
(Disease identification-1, Pathogen - 1, Symptoms-1) 3×2=6 Marks
5. Determine the pollen viability of the sample **H** 6 x1 = 6 Marks
6. Spot at sight **I to W** 2×15=30 Marks

Practical examination	: 80 Marks
Record	: 15 Marks
Submission	: 5 Marks
Total	: 100 Marks

B.Sc. BOTANY CORE PRACTICAL EXAMINATION

Paper - II : GBOT6B14P

(Palaeobotany, Phytogeography, Angiosperm Morphology, Systematics, Tissue culture, Horticulture, Economic Botany, Ethnobotany, Cell Biology & Plant Physiology)

Time: 4 Hours

Max: 80 Marks

1. Prepare a unidirectional chromatogram using the given extract **A** and calculate the Rf value of each component
10 x1 = 10marks
2. Submit any two stages of mitosis using the given material **B**
(Preparation-2×2=4; Identification-2×2=4; Diagram-1×2=2)
5x2 =10 Marks
3. Describe the given taxon **C**, determine the family and list out the salient features
(Identification-1; Technical description-4; Salient features-3)
8 x1 =8 Marks
4. Draw a labeled diagram of the V.S. of the flower **D**
4 x1 =4 Marks
6. Give the binomial, family and morphology of the following: **F, G & H**
(Binomial-1½; Family-1; Morphology-1½)
4×3=12Marks
7. Give the binomial, family and ethnobotanical significance of the following: **I and J**
(Binomial-1; Family-1; Ethnobotanical significance-1)
3×2=6 Marks
8. Write down the binomial and family of **K, L, M and N**
(Binomial-1; Family ½)
1 ½ ×4=6 Marks
9. Comment on the morphology of the specimen **O and P**
2.5 x 2=5 Marks
10. Add critical note on the given specimen **Q and R**
1.5 x 2 =3 Marks
11. Spot at sight **S - Z**
8 x 2= 16 Marks

Practical	: 80 Marks
Record	: 15 Marks
Submission	: 10 Marks
Study tour	: 5 Marks
Total	: 110 Marks

B.SC. BOTANY CORE PRACTICAL EXAMINATION

Paper - III:GBOT6B15P

(Genetics, Pl. Breeding, Biotechnology, Molecular Biology, Biochemistry & Environmental Science)

Time: 4 Hours

Max: 80 Marks

- | | |
|--|----------------|
| 1. Prepare the explants A and demonstrate inoculation | 5 +3 =8 marks |
| 2. Workout the genetics problems B and C | 8 +7 =15 marks |
| 3. Identify the given sample E qualitatively | 10 x1= 10marks |
| 4. Isolate the DNA from the given sample G | 10 x1= 10marks |
| 5. Demonstrate hybridization in Specimen H | 7 x1 = 7 marks |
| 6. Read the Gel from the diagram provided in I | 5 x 1 =5 marks |
| 7. Find out the ecological group of J and add a note on its adaptations | 5x1 = 5marks |
| 8. Spot at sights K - T | 2x10=20 marks |

Practical	: 80 Marks
Record	: 10 Marks
Submission	: 5 Marks
Total	: 95 Marks

Elective Record : 10 Marks

COMPLEMENTARY COURSES

Table 12. COURSE STRUCTURE, WORK LOAD AND CREDIT DISTRIBUTION

Semester	Paper Code	Title of Paper	Hours/ Semester	Hours/ Week	Credit
SI	GBOT1C01T	COMPLEMENTARY COURSE 1. Angiosperm Anatomy & Micro technique	36 hrs	2	2
	-	Complementary Course -1 Practical	36 hrs	2	*
SII	GBOT2C02T	COMPLEMENTARY COURSE 2. Cryptogams, Gymnosperms & Plant Pathology	36 hrs	2	2
	-	Complementary Course -2 Practical	36 hrs	2	*
SIII	GBOT3C03T	COMPLEMENTARY COURSE - 3 Morphology, Systematic Botany, Eco. Botany, Plant Breeding & Horticulture	54 hrs	3	2
	-	Complementary Course-3 Practical	36 hrs	2	*
SIV	GBOT4C04T	COMPLEMENTARY COURSE - 4 Plant Physiology, Ecology & Genetics	54 hrs	3	2
	-	Complementary Course - 4 Practical	36 hrs	2	*
	GBOT4C05P	COMPLEMENTARY COURSE- 5 Botany Practicals Angiosperm Anatomy, Micro technique, Cryptogams, Gymnosperms, Plant Pathology, Morphology, Systematic Botany, Plant Physiology, Ecology, Genetics, Eco. Botany, Plant Breeding & Horticulture			4
TOTAL					12
<ul style="list-style-type: none"> • Credits of practical paper (total given against Practical paper GBOT4C05P) 					

Table 13. COURSE STRUCTURE, MARK DISTRIBUTION, SCHEME OF EXAMINATION

Course code & Title of course	Total Hours		Duration of Exams	Marks				Total Marks
	Theory	Practical		Theory		Practical		
				External	Internal	External	Internal	
Semester -1 :GBOT1C01T Anatomy & Microtechnique	36	36	2 hrs	60	15	--	--	75
Semester-2: GBOT2C02T Cryptogams, Gymnosperms & Plant Pathology	36	36	2 hrs	60	15	--	--	75
Semester-3: GBOT3C03T Morphology, Syst. Botany, Economic Botany, Plant Breeding & Horticulture	54	36	2 hrs	60	15	--	--	75
Semester- 4:GBOT4C04T Plant Physiology, Ecology & Genetics	54	36	2 hrs	60	15	--	--	75
Semester- 4: GBOT4C05P Comple. Course Practical External Practical Exam Record Submission	--	--	3 hrs	--	--	60 15 10	15	100
Total	180	144		240	60	85	15	400

Table 14. DISTRIBUTION OF INTERNAL MARKS

Theory : Marks 15 (20% of total)		Practical : Marks 15 (20% of total)	
Components	Percentage	Components	Percentage
Test paper	40%	Record	60%
Assignment	20%,	Lab involvement	40%
Seminar	20%		
Class room participation based on attendance	20%.		

COMPLEMENTARY COURSE: 1
ANGIOSPERM ANATOMY AND MICROTECHNIQUE

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
1	GBOT1C01T	2	4	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Explain the types, structure and functions of plant tissues
2. Explain primary and secondary (normal and anomalous) structures of plant organs.
3. Identify plant organs by observing anatomical features.
4. Illustrate primary and secondary (normal and anomalous) structures of plant organs.
5. Apply the histochemical techniques in laboratory works

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theory	Practical	Total
1	Angiosperm Anatomy	27	30	57
2	Microtechnique	9	6	15
Total		36	36	72

QUESTION PAPER PATTERN & SUBJECT WISE DISTRIBUTION OF MARKS

Type of questions	Angiosperm Anatomy	Microtechnique	Total
2 marks (total 12)	9	3	Ceiling 20
5 marks (total 7)	5	2	Ceiling 30
10 marks (total 2)	2		1x10 = 10
TOTAL			60

ANGIOSPERM ANATOMY

Module - I(9 hrs)

- 1 Tissues - Definition, Kinds - Meristematic & Permanent (8 hrs)
 1. Meristematic tissues - Classification – based on origin & position; Organization of root apex and differentiation of tissue - Histogen theory; Organization of stem apex and differentiation of tissues - Tunica & Corpus theory.
 2. Permanent tissues - Definition - classification; Simple tissues (Parenchyma, Collenchyma and Sclerenchyma), Complex tissues (Xylem & Pholem) Secretory tissues - Glandular tissues (Nectaries in *Euphorbiapulcherrima*, Stinging hairs in

Tragia) Oil glands in *Citrus*, *Eucalyptus*; Digestive glands in *Nepenthes*; Laticiferous tissues (Non-articulate latex ducts in *Euphorbia* and articulate latex duct - latex vessels in *Hevea*). Hydathodes

- 2 Vascular bundles - types: conjoint - collateral, bicollateral, concentric and radial. (1 hr)

Module - II(6 hrs)

1. Primary structure of dicot and monocot root, dicot and monocot stem and leaf in dicot and monocot (6 hrs)

Module - III(12 hrs)

1. Normal secondary thickening in dicot stem (*Vernonia*) (10 hrs)
- Intra stelar thickening: formation of cambial ring, its structure, fusiform and ray initials, storied and non - storied cambium, activity of the cambium, formation and structure of secondary wood, secondary phloem and vascular rays.
 - Extra stelar thickening: formation, structure and activity of the phellogen, formation of periderm in stem and root; bark and lenticel.
 - Growth rings, ring and diffuse porous wood, sapwood and heart wood, tyloses.
 - Normal secondary thickening in dicot root (*Tinospora*)
- 2 Anomalous secondary growth in *Boerhaavia*. (2 hrs)

PRACTICAL (ANGIOSPERM ANATOMY)

- Identify simple and complex tissues and determine the type of vascular bundles using microscope.
- Make suitable micro preparations to study the anatomy of the following:
 - Dicot stem: *Cephalandra* *Centella* (Primary); *Vernonia* (secondary).
 - Monocot stem: Bamboo
 - Dicot root: *Tinospora* (young -Primary; mature-Secondary)
 - Monocot root: *Colocasia*,
 - Anomalous secondary growth (*Boerhaavia*).
 - Dicot leaf: *Ixora* and Monocot leaf: grass

REFERENCES: (ANGIOSPERM ANATOMY)

- Cuttler, EG. 1969. Plant Anatomy - Part I Cells & Tissue. Edward Arnold Ltd., London.
- Cuttler, E.G. 1971. Plant Anatomy, Part III Organs Edward Arnold Ltd., London.
- Esau K. 1985. Plant Anatomy (2nd ed.) Wiley Eastern Ltd. New Delhi.

4. Pandey B.P. Plant Anatomy, S. Chand & Co. Delhi.
5. Vasishta P.C. 1974. Plant Anatomy, Pradeep Publication, Jalandhar.
6. Tayal M.S Plant Anatomy. Rastogi Publishers, Meerut.

MICROTECHNIQUE

Module - I(9 hrs)

1. Microtechnique - Brief Introduction
2. Microscopy: simple, compound and electron microscope
3. Microtomy: Rotary type, serial sectioning, paraffin method,significance.
4. Killing and fixing: Killing and fixing agents and their composition (Farmer's fluid and FAA.)
3. Dehydration and clearing - reagents (mention only)
4. Stains – Saffranin and acetocarmine, preparation and use.

PRACTICAL (MICROTECHNIQUE)

- 1 Familiarise the structure and working of compound microscope (drawings not required)
- 2 Preparation of Safranin, FAA and Acetocarmine

REFERENCES (MICROTECHNIQUE)

1. Johansen, D.A. (1940) Plant Microtehnique. Mc Graw – Hill Book Company, Inc. New York.
2. Kanika, S. (2007) Manual of Microbiology – Tools and Techniques. Ane’s student edition.
3. Khasim,S.K. (2002) Botanical Microtechnique; principles and Practice, Capital Publishing Company, New Delhi.
4. Toji, T. (2004) Essentials of Botanical Microtechnique. Apex Infotec Publ.

COMPLEMENTARY COURSE: 2
CRYPTOGAMS, GYMNOSPERMS AND PLANT PATHOLOGY

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
2	GBOT2C02T	2	4	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Analyze the role of the lower plants in the process of evolution.
2. Explain the ecological significance of lower plants
3. Identify plant diseases and take remedial measures to control them.

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theor	Practical	Total
1	Module I: Virus, Bacteria, BGA	9	5	14
2	Module II: Phycology, Mycology,	12	13	25
3	Module III: Bryology, Pteridology ,	12	13	25
4	Plant Pathology	3	5	8
Total		36	36	72

QUESTION PAPER PATTERN & SUBJECT WISE DISTRIBUTION OF MARKS

Type of questions	Mod I	Mod II	Mod III	Mod IV	Total marks
2 marks (total 12)	2	4	4	2	Ceiling 20
5 marks (total 7)	2	2	2	1	Ceiling 30
10 marks (total 2)	2				1x10 = 10
TOTAL					60

CRYPTOGAMS & GYMNOSPERMS

Module - I: Virus, Bacteria, BGA(9hrs)

1. Virus: General account of viruses, including structure of TMV & Bacteriophage.
(2 hrs)
2. Bacteria: Classification based on shape of flagella, structure, nutrition (brief account), reproduction and economic importance - agriculture, industry and medicine.
(5 hrs)
3. Cyanobacteria: General Account structure, life - history and economic importance of *Nostoc*.
(2 hrs)

Module - II:Phycology, Mycology, Lichenology(12hrs)

1. Phycology: General characters, classification, evolutionary trends in algae. (2 hrs)
2. Structure, reproduction, life history and economic importance of the following classes with suitable examples: (4 hrs)
 - a) Chlorophyceae (*Spirogyra*)
 - b) Phaeophyceae (*Sargassum*)
 - c) Rhodophyceae (*Polysiphonia*).
3. Mycology: General characters, classification (Alexopoulos, 1979) (brief mention only) and evolutionary trends, economic importance in fungi. (2 hrs)
4. Important features of the following divisions (brief account only) (1 hr)
 - a) Mastigomycotina
 - b) Zygomycotina
 - c) Ascomycotina
 - d) Basidiomycotina.
5. Structure and life history of *Puccinia* (developmental details not required) (2 hrs)
6. Lichenology: General account and economic importance of Lichens with special reference to *Usnea*. (1 hrs)

Module - III : Bryology, Pteridology , Gymnosperms(12 hrs)

1. Bryology: General account, morphology and life - history of *Riccia* (4 hrs)
2. Pteridology: General account, morphology and life history of *Selaginella* (4 hrs)
3. Gymnosperms: General account, morphology and life history of *Cycas* (4 hrs)

PRACTICAL (CRYPTOGAMS & GYMNOSPERMS)

1. Make suitable micro preparations of vegetative and reproductive structures of *Sargassum*, *Puccinia*, *Riccia*, *Selaginella* and *Cycas*
2. Identify and draw labeled diagrams of all the types mentioned in the syllabus

REFERENCES (CRYPTOGAMS & GYMNOSPERMS)

- 1 Fritsch, F.E. (1935). The structure and reproduction of the algae. Vol. 1 and II, Uni. Press. Cambridge.
- 2 Morris, I. (1967) An Introduction to the algae. Hutchinson and Co. London.
- 3 Papenfuss, G.F. (1955) Classification of Algae.
- 4 B.R. Vasishta. Introduction to Algae
- 5 Mamatha Rao, (2009) - Microbes and Non-flowering plants. Impact and applications. Ane Books, New Delhi.
- 6 Sanders, W.B. (2001) Lichen interface between mycology and plant morphology. Bioscience, 51: 1025-1035.

- 7 B.R. Vasishta. Introduction to Fungi.
- 8 P.C. Vasishta Introduction to Bryophytes.
- 9 B.P. Pandey Introduction to Pteridophytes
- 10 Chamberlain C.J., (1935) Gymnosperms - Structure and Evolution, Chicago University Press.
- 11 Sreevastava H.N. (1980) A Text Book of Gymnosperms. S. Chand and Co. Ltd., New Delhi.
- 12 Vasishta P.C. (1980) Gymnosperms. S. Chand and Co., Ltd., New Delhi.

PLANT PATHOLOGY

Module - I(3 hrs)

1. Plant Pathology: Study the following plant diseases with special reference to pathogens, symptoms, method of spreading and control measures.
 - 1) Leaf mosaic of Tapioca
 - 2) Citrus canker
 - 3) Blast of paddy

PRACTICAL (PLANT PATHOLOGY)

1. Identify the diseases (mentioned in the theory syllabus) on the basis of symptoms and causal organisms.(Drawings can be replaced by photos pasted in the record)

REFERENCES: PLANT PATHOLOGY

1. Agros, G.N. (1997) Plant Pathology (4th ed) Academic Press.
2. Bilgrami K.H. & H.C. Dube. (1976) A textbook of Modern Plant Pathology. International Book Distributing Co. Lucknow.
3. Pandey, B.P. (1999) Plant Pathology. Pathogen and Plant diseases. Chand & Co. New Delhi.

**COMPLEMENTARY COURSE 3:
MORPHOLOGY, SYSTEMATIC BOTANY, ECONOMIC BOTANY,
PLANT BREEDING AND HORTICULTURE**

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
3	GBOT3C03T	2	5	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Appreciate the diverse morphology of angiosperms.
2. Identify and classify plants based on taxonomic principles
3. Make scientific illustrations of vegetative and reproductive structures of plants
4. Identify the economically important plants
5. Understand the basic principles of plant breeding
6. Apply various horticultural practices in the field.

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theory	Practical	Total
1	Morphology	8	4	12
2	Systematic Botany	28	20	48
3	Economic Botany	4	4	8
4	Plant Breeding	7	4	11
5	Horticulture	7	4	11
Total		54	36	90

QUESTION PAPER PATTERN & SUBJECT WISE DISTRIBUTION OF MARKS

Type of questions	Morphology	Systematic Botany	Economic Botany	Plant Breeding	Horticulture	Total
2 marks(total 12)	2	4	2	2	2	Ceiling 20
5 marks (total 7)	1	3	1	1	1	Ceiling 30
10 marks(total 2)	2					1x10 = 10
TOTAL						60

MORPHOLOGY

Module - I

1. Leaf - Structure, simple, compound, venation and phyllotaxy. (2 hrs)
2. Inflorescence - racemose, cymose, special, types with examples (3 hrs)
3. Flower - as a modified shoot- structure of flower - floral parts, their arrangement, relative position, cohesion and adhesion of stamens, symmetry of flowers, types of

aestivation and placentation.

(3 hrs)

PRACTICAL (MORPHOLOGY)

1. Identify the types of inflorescence mentioned in the syllabus. All the types mentioned must be represented in the photo album. (All drawings in records are replaced by photo album submission).

REFERENCE (MORPHOLOGY)

- 1 Sporne, K.R. (1974) Morphology of Angiosperms. Hutchinson.

SYSTEMATIC BOTANY

Module- I

1. Introduction, scope and importance (1 hrs)
2. Herbarium techniques: collection, drying, poisoning, mounting & labeling. Significance of herbaria and botanical gardens; important herbaria and botanical gardens in India. (3 hrs)
3. Nomenclature - Binomial system of nomenclature, basic rules of nomenclature (validity, effectivity and priority), ICN for algae, fungi and plants. (4 hrs)
4. Systems of classification - Artificial, Natural of Phylogenetic (Brief account only). Bentham & Hooker's system of classification in detail. (4 hrs)
5. Modern trends in taxonomy - Chemotaxonomy, Numerical taxonomy and Cytotaxonomy (brief account only) (4 hrs)
6. Study the following families: Malvaceae, Fabaceae (with sub-families) Rubiaceae, Apocynaceae, Euphorbiaceae and Poaceae. (12 hrs)

PRACTICAL (SYSTEMATIC BOTANY)

1. Determine the systematic position of local plants comes under the syllabus base on their vegetative and floral characters.
2. Students shall be able to describe the plants in technical terms and draw the L.S. of flower, floral diagrams and the floral formula of one plants belong to each family and record the same.
3. The photo album containing images of inflorescence mentioned under morphology to be submitted during practical examination.
4. Students are expected to submit eight properly identified duly certified herbarium specimens belonging to families included in the syllabus during the practical examination.

REFERENCES (SYSTEMATIC BOTANY)

- 1 Radford, A.E. (1986) Fundamentals of Plant Systematics. Harpor & Row Publishers, New York.
- 2 Sivarajan, V.V. (1991) Introduction to Principles of Plant Taxonomy. Oxford & IBH, New Delhi.
- 3 Jeffrey, C. (1968) An introduction to Plant Taxonomy, London
- 4 Gurucharan Singh, (2001) Plant Systematics. Theory and practice. Oxford & IBH Publications New Delhi.
- 5 Sharma O.P. (1990) Plant Taxonomy - Tata McGraw Hills. Publishing company Ltd
- 6 Subramanyam N.S. (1999) Modern Plant Taxonomy. Vikas Publishing House Pvt Ltd.
- 7 Pandey & Misra. (2008) Taxonomy of Angiosperms. Ane books Pvt Ltd.

ECONOMIC BOTANY

Module -I(4hrs)

- 1 Brief account on the various categories of plants based on their economic importance
2. Study the following plants with special reference to their binomial, family, morphology of the useful part and their uses.
 1. Cereals: Paddy, Wheat
 2. Pulses: Black gram, Green gram
 3. Oil: Coconut, Gingelly
 4. Fibre: Cotton
 5. Latex: Rubber
 6. Beverages : Tea, Coffee
 7. Spices: Pepper, Cardamom, Clove
 8. Medicinal plants: *Rauwolfia serpentina*, *Justicia adhatoda*, *Santalum album* and *Curcuma longa*.

PRACTICALS (ECONOMIC BOTANY)

- 1 Identify at sight the economically important plant products and products mentioned in module III, and learn the binomial and family of the source plants, morphology of the useful parts and uses. (Drawing not required)

REFERENCES (ECONOMIC BOTANY)

1. Pandey B. P (1987) - Economic Botany
2. Verma V. (1984) - Economic Botany
3. Hill A.W (1981) - Economic Botany, McGraw Hill Pub

PLANT BREEDING

1. Objectives of plant breeding (1 hrs)
2. Methods of plant breeding: a) Plant introduction b) Selection - Mass, Pureline and clonal, c) Hybridization : intervarietal, interspecific and intergeneric hybridization. d) Mutation breeding e) polyploidy breeding and f) breeding for disease resistance. (6 hrs)

PRACTICAL (PLANT BREEDING)

- 1 Demonstration of hybridization technique

REFERENCES (PLANT BREEDING)

- 1 Allard. R.W. (1960) Principles of Plant breeding, John Wiley & Sons, Inc, New York.
- 2 Singh, B.D. (2005) Plant Breeding - Principles & methods , Kalyani Publishers, New Delhi.
- 3 Chaudhari. H.K. Elementary Principles of Plant breeding, Publishers. Oxford & IBH

HORTICULTURE

1. Horticulture- introduction: definition, branches, significance (1hrs)
2. Methods of plant propagation(6hrs)
 - a. Seed propagation
 - b. Vegetative propagation
 1. Cutting - stem, root, leaf
 2. Layering -air layering
 3. Grafting: Approach grafting, Tongue grafting
 4. Budding: Patch and T-budding

PRACTICAL (HORTICULTURE)

- 1 Demonstration of layering, grafting and budding References:- Horticulture
- 2 Text book of Horticulture - K. Manibhushan Rao - Macmillan India Ltd.
- 3 Introduction to Horticulture - N. Kumar (First Edition, Rajalakshmi Publication,1996)

**COMPLEMENTARY COURSE 4:
PLANT PHYSIOLOGY, ECOLOGY AND GENETICS**

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
4	GBOT4C04T	2	5	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Explain the physiological processes in plants.
2. Understand the basic principles of heredity and variation.
3. Realize the importance of ecology.
4. Spread awareness of the necessity of conservation of biodiversity and natural resources
5. Solve problems related to classical genetics

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Theory	Practical	Total
1	Plant physiology	36	18	54
2	Ecology	9	9	18
3	Genetics	9	9	18
Total		54	36	90

QUESTION PAPER PATTERN & SUBJECT WISE DISTRIBUTION OF MARKS

Type of questions	Plant physiology	Ecology	Genetics	Total
2 marks (total 12)	8	2	2	Ceiling 20
5 marks (total 7)	4	1	2	Ceiling 30
10 marks (total 2)	2			1x10 = 10
TOTAL				60

PLANT PHYSIOLOGY

Module - I

(16 hrs)

1. Structure of plant cell and cell organelles (Brief account only)
2. Water relations - Permeability, Imbibition, Diffusion, Osmosis and waterpotential
3. Absorption of water- Active and passive mechanisms
4. Ascent of sap -Root pressure theory, Transpiration pull or cohesion-tension theory.

5. Transpiration -Types, mechanism of stomatal movement: K^+ ion theory,significance of transpiration, antitranspirants.
6. Mineral nutrition- General account on Micro and macro nutrients. Methods of studying plant nutrition- solution culture-The essential elements - criteria of essentiality. function and deficiency symptoms of the following mineral nutrients: N, P, K, Mg, Fe, Zn, Mn

Module - II (10 hrs)

1. Photosynthesis-Introduction, significance, Two pigment systems, red drop,Emerson enhancement effect, action and absorption spectra, Mechanism of photosynthesis - Light reaction, cyclic & non-cyclic photo phosphorylation,Dark reactions-Calvin cycle, C_4 cycle, photorespiration (a brief account only).Factors affecting photosynthesis. Respiration-definition, kinds of respiration-aerobic and anaerobic, Glycolysis, Krebs cycle, Terminal Oxidation, Fermentation.

Module - III (10 hrs)

1. Plant growth-Definition, phases of growth, natural plant hormones, synthetic auxins (Brief account only)
2. Senescence and abscission, Photo-periodism & vernalization.
3. Dormancy of seeds- Factors causing dormancy, photoblastin, techniques to break dormancy, physiology of fruit ripening.

PRACTICAL (PLANT PHYSIOLOGY)

Learn the principle and working of the following apparatus/experiments

1. Thistle funnel osmoscope
2. Ganong's potometer
3. Ganong's light-screen
4. Ganongs respirometer
5. Absorbo transpirometer
6. Kuhne's fermentation vessel
7. Mohl's half-leaf experiment
8. Experiment to demonstrate suction due to transpiration
9. Experiment to show evolution of O_2 during photosynthesis

REFERENCES (PLANT PHYSIOLOGY)

- 1 William G. I-lopkins,(1999). Introduction to Plant Physiology, 2ndedition, John Wiley A Sons, Inc.
- 2 Frank B. Salisbury and Cleon W. Ross (2002). Plant Physiology 3rdedition. CBS publishers and distributors.

- 3 G. Ray Noggle and George J.Fritz (1983) Introductory Plant Physiology Prentice Hall.
- 4 Goodwin Y.W., and Mercer E.I. (2003) Introduction to Plant Biochemistry. 2nd edition. CBS Publishers and distributors.

PLANT ECOLOGY

Module - I

(9 hrs)

1. Ecology-Definition, Ecosystem: ecological factors –biotic and abiotic.
2. Ecological adaptations: Morphological, anatomical and physiological adaptations of the following types: Hydrophyte (*Vallisneria*, *Hydrilla*), Xerophyte (*Opuntia*, *Nerium*), Halophyte (*Avicennia*), Epiphytes (*Vanda*) and parasites. (*Cuscuta*).
3. Ecological succession –Process of succession, types of succession, Hydrosere Xerosere (with examples)

PRACTICAL (PLANT ECOLOGY)

Study the morphological and anatomical adaptations of the hydrophytes, xerophytes, halophytes, epiphytes and parasites mentioned in the syllabus (drawing not required)

REFERENCES (PLANT ECOLOGY)

- 1 Ambasht R.S. 1988. A text book of Plant Ecology. Students Friends Co. Varanasi.
- 2 Dash M.C. 1993. Fundamentals of Ecology. Tata McGraw Hill Publishing Company Ltd. New Delhi.
- 3 Michael S. 1996. Ecology. Oxford University Press, London.
- 4 Sharma, P.D. 2008-2009. Ecology and Environment. Rastogi Publication.
- 5 Kumar H.D. 1977. Modern Concepts of Ecology. Vikas Publications. New Delhi.

GENETICS

(9 hrs)

1. Introduction and brief history of genetics
2. Mendel's experiments, symbolisation, terminology, heredity and variation;
3. Monohybrid cross, Dihybrid cross, Laws of Mendel, test cross and back cross.
4. Modified Mendelian ratios 1) Incomplete dominance in *Mirabilis jalapa*
5. Gene interactions: Complementary genes -flower colour in *Lathyrus odoratus* (9:7ratio), Epistasis - Fruit colour in *Cucurbita pepo* (12:3:1 ratio).

PRACTICAL (GENETICS)

- 1 Students are expected to work out problems related to Monohybrid, Dihybrid, Test cross, Incomplete dominance and Modified Mendelian ratios and has to be recorded.

REFERENCES (GENETICS)

1. Sinnot, W.L.C. Dunn & J. Dobzhansky (1996) Principles of Genetics. Tata Mc Graw Hill Publishing Company Ltd., New Delhi.
2. Verma, P.S. & Agarwal (1999). Text book of Genetics. S. Chand & Co., New Delhi.
- 3 RastogiV.B. (2008), Fundamentals of Molecular Biology, Ane Books, India.
- 4 Gupta, P.K. Text Book of Genetics. Rastogi Publications, Meerut.

MODEL QUESTION PAPERS: (THEORY)

FIRST SEMESTER B.Sc. DEGREE PROGRAMME
COMPLEMENTARY COURSE I
GBOT1C01T: ANGIOSPERM ANATOMY AND MICROTECHNIQUE

TIME: 2 hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. Differentiate between lateral meristem and intercalary meristem.
2. What is FAA? How is it prepared?
3. Explain Tunica Corpus theory
4. What is quiescent centre?
5. How do tracheids differ from vessels?
6. What are hydathodes?
7. Explain the structure and function of bulliform cells.
8. What are annual rings? What is its relevance?
9. What are tyloses?
10. Write short note on rotary microtome.
11. Different between protoxylem and metaxylem
12. What is acetocarmine? What is its use?

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Write short note on simple tissues.
14. What are the different types of vascular bundles?
15. Explain the principle and types of electron microscopes.
16. Describe the laticiferous tissues in plants.
17. Explain the structure of a dicot leaf.
18. With a neat labeled diagram, explain the primary structure of monocot root.
19. Explain killing and fixing. Add a note on various agents used for it.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. What are permanent tissues? Explain the major classes with their functions.
21. Explain the secondary growth in dicot stem with the help of a diagram.

**SECOND SEMESTER COMPLEMENTARY BOTANY
COMPLEMENTARY COURSE: 2
GBOT2C02T: CRYPTOGAMS, GYMNOSPERMS & PLANT PATHOLOGY**

TIME: 2 hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. Differentiate between fimbriae and pili.
2. What are plasmids? Mention the different types.
3. Explain the structure of cell wall of bacteria.
4. Give an account of morphology of *Sargassum* thallus.
5. What are heterocysts? Give its function.
6. Briefly explain scalariform conjugation in *Spirogyra*.
7. Comment on the structure and function of ligule in *Selaginella*.
8. Write a short note about the sporogonium of *Riccia*.
9. What are coralloid roots? What is its function?
10. List out the important symptoms of Leaf mosaic disease of Tapioca.
11. Describe vegetative reproduction in bryophytes.
12. Enumerate the important control measures of citrus canker.

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Give an account of the multiplication of bacteriophages
14. Name the pathogen, symptoms and control measures of Blast of Paddy.
15. With the help of a labelled diagram explain the anatomy of *Riccia* thallus.
16. What is the ecological and economic importance of lichens?
17. How are bacteria classified based on flagella? Add a note on bacterial growth.
18. Briefly explain the post fertilization changes in *Polysiphonia*.
19. Write about the sexual reproduction in *Cycas*.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. Write an essay on the vegetative, asexual and sexual reproduction of bacteria.
21. With the help of suitable diagrams describe the stages of life cycle of *Puccinia*

**THIRD SEMESTER B.Sc. DEGREE PROGRAMME
COMPLEMENTARY COURSE 3
GBOT3C03T: MORPHOLOGY, SYSTEMATIC BOTANY, ECONOMIC BOTANY,
PLANT BREEDING AND HORTICULTURE**

TIME: 2 hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. Differentiate between stock and scion.
2. Write a short note on the inflorescence of Poaceae.
3. Explain the significance of quarantine.
4. What are the advantages of seed propagation?
5. What is aestivation? What are the different types?
6. Name any two chemicals used for the poisoning of specimens.
7. Differentiate between synandrous stamens and syngeneceious anthers.
8. Name any two major herbaria in India.
9. Differentiate between numerical taxonomy and chemotaxonomy?
10. Write the binomial and family of clove and turmeric.
11. What are beverages?
12. Describe emasculation. What are the different types of emasculation?

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Expand ICN? What are the major rules of ICN?
14. What are the different types of inflorescences?
15. Write short note on cereals and pulses.
16. Enumerate the characteristic features of family Fabaceae.
17. Describe polyploidy breeding. What are their applications in crop improvement?
18. What are the important vegetative propagation methods in plants?
19. Comment on the phylogenetic system of classification

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. What is a natural system of classification? Explain with an example. Write down the major merits and demerits.
21. Describe the different selection processes in plant breeding? Explain.

**FOURTH SEMESTER COMPLEMENTARY BOTANY
COMPLEMENTARY COURSE 4:
GBOT4C04T: PLANT PHYSIOLOGY, ECOLOGY AND GENETICS**

TIME: 2 hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. What are antitranspirants? Give examples.
2. Define water potential? Write about its components.
3. Explain vernalization in brief.
4. Give an account of ATPase.
5. What is transpiration pull? Explain its role in plants.
6. Write about senescence and abscission. Add a note their significance.
7. Describe two important adaptations seen in halophytes.
8. What are haustoria? Mention its physiological importance.
9. Differentiate test cross and back cross.
10. What are complementary genes? Give example.
11. Write about Krantz anatomy.
12. Give an account of Hydroponics.

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Give an account of non-cyclic photophosphorylation.
14. Describe the K⁺ ion theory of stomatal movements.
15. Write in detail about the adaptations of xerophytes.
16. List out the roles played by gibberellins in plant development.
17. Give an account of the epistatic interaction found in plants with an example.
18. Briefly explain the dihybrid cross conducted by Mendel and a note on the discovery of law of independent assortment.
19. Give an account of the causes and methods to overcome seed dormancy.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. Define plant succession. Describe the stages of hydrosere in detail with suitable plant examples
21. With the help of schematic diagram describe the path of carbon in Photosynthesis.

MODEL QUESTION PAPER: (PRACTICAL)

B.Sc. COMPLEMENTARY BOTANY PRACTICAL EXAMINATION
(GBOT4C05T: Angiosperm Anatomy, Micro technique, Cryptogams, Gymnosperms,
Plant Pathology, Morphology, Systematic Botany, Plant Physiology, Ecology,
Genetics, Economic Botany, Plant Breeding & Horticulture)

Time: 3 hrs

Max: 60 marks

1. Prepare a T.S. of specimen **A**. Stain and mount in glycerine. Draw cellular diagram and label the parts. Identify giving reasons. Leave the preparation for valuation.
(Preparation-2; Diagram-2; Reasons-2; Identification-1) 7x1=7 Marks
2. Refer specimen **B** to its family, giving diagnostic characters
(Identification-1; Reasons-2) 3x1=3 Marks
3. Take a V.S. of flower **C**. Draw a labeled diagram 2x1=2 Marks
4. Make suitable micro-preparations of **D**. Draw labeled diagram. Identify giving reasons. Leave the preparation for valuation.
(Preparation-2; Diagram-2; Identification-1; Reasons-1) 6x1=6 Marks
5. Determine the ecological group of specimen **E**, with important adaptations.
(Identification-1; Adaptations-2) 3x1=3 Marks
6. Identify the experiment **F and G**. Explain the aim and working
(Identification-1; Aim-1; Working - 1) 3x 2= 6 Marks
7. Give the binomial, family and morphology of useful parts in **H and I**
(Binomial-1; Family- ½ ; Morphology of useful part- ½) 2x2=4 Marks
8. Name the disease, pathogen and important symptoms in **J**
(Name- 1; Pathogen- 1 ; Symptoms-1) 3x1=3 Marks
9. Give the binomial and family of **K and L**
(Binomial-1; Family ½) 2x1 ½ =3 Marks
10. Work out the problem 5x1=5 Marks
11. Spot at sight **N to V** 9 X 2=18 marks

Practical	: 60 Marks
Record	: 15 Marks
Submission	: 10 Marks
Total	: 85 Marks

OPEN COURSES

OPEN COURSE CHOICE-1: GENERAL BOTANY

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
5	GBOT5D01T	3	3	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Have a general awareness on various branches of plant science
2. Develop environmental concern in all their activities.
3. Realize the importance of plants in everyday life.

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Total
1	Module 1: Living World	4
2	Module 2: Morphology of Angiosperms	6
3	Module 3: Anatomy	6
4	Module 4: Plant Physiology	12
5	Module 5: Genetics	7
6	Module 6: Plant Biotechnology	7
7	Module 7: Environmental Science	12
Total		54

QUESTION PAPER PATTERN

Type of questions	No of questions	Total
2 marks	12	Ceiling 20
5 marks	7	Ceiling 30
10 marks	2	1x10 = 10
Total		60

Module -1: Living World

Living and Non Living: Plants and Animals; Classification of plants: Eichler's system, general characters of each group with one example. An introduction to the Life cycle of plants.

Module - 2: Morphology of Angiosperms

Typical angiosperm plant: Functions of each organ viz. Root, Stem, leaves, inflorescence, flowers, fruit and seed. Flower: Basic structure - essential and non essential parts, symmetry. Pollination, seed dispersal of fruits and seeds.

Module - 3: Anatomy

Definition, general structure, Cell division- mitosis and meiosis, significance, cell cycle. Tissues: simple, compound; structure and functions; Structure and functions of root, stem and leaves. Monocot and Dicot stem- general features; Secondary thickening. Annual rings, heart wood and sap wood.

Module- 4: Plant Physiology

General account on methods of absorption of water and nutrients; Osmosis, Diffusion, Imbibition. Transport of water and nutrients; transpiration and its significance. Mineral nutrients: macro and micro; deficiency symptoms Symbiotic nitrogen fixation and its significance. Photosynthesis- Light and Dark reactions-brief description, Respiration and Growth Hormones.

Module - 5: Genetics

Heredity, variation; Mendelian experiments and principles. Exceptions of Mendelism, Structure and significance of DNA; Mutation. DNA: as the Genetic Material; Blood groupism in man; Sex determination in man.

Module - 6: Plant Biotechnology

Tissue culture - Principle and procedure; Transgenic plants: Scope and applications, BT Cotton, BT Brinjal, Golden Rice; Bioreactors and their significance.

Module - 7 Environmental Science

Ecosystem: Structure - Abiotic and Biotic Factors, Ecosystem, Types of plant interactions; Mutualism, Commensalism, Predation, Symbiosis, Parasitism, Competition. Biodiversity, Conservation, *In situ* and *Ex situ* methods, National Parks, Sanctuaries, IUCN, Threat Categories, Red list. Green House Effect, Ozone depletion, Deforestation and Reforestation, Alternative energy resources, Sustainable development and Utilization of resources.

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OPEN COURSE CHOICE- 2
APPLIED BOTANY

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
5	GBOT5D02T	3	3	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Develop general awareness on applied aspects of Plant science.
2. Realize the role of plants in everyday life.
3. Apply vegetative propagation methods in everyday life.
4. Realize the economic importance of plants

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Total
1	Module -I Plant Propagation	12
2	Module - II Steps of growing plants	12
3	Module - III. Botany in Everyday life	24
4	Module - IV. Economic Botany	6
Total		54

QUESTION PAPER PATTERN

Type of questions	No of questions	Total
2 marks	12	Ceiling 20
5 marks	7	Ceiling 30
10 marks	2	1x10 = 10
Total		60

Module -I Plant Propagation

1. Seed propagation - Seed dormancy, seed treatment, conditions for successful propagation, rising of seed beds, care of seedling, transplanting techniques.
2. Vegetative propagation:
 - (a) Cutting (stem, roots)
 - (b) Grafting (approach, cleft)
 - (c) Budding (T-budding, patch)
 - (d) Layering (simple, air)
3. Micro propagation- General account

Module - II Steps of Growing Plants

1. Soil- Composition, Types, Texture, Soil pH, Correcting pH, Humus
2. Pots & Potting - Earthen, Fibre, Polythene bags, Potting mixture, Potting, Depotting, Repotting.
3. Chemical fertilizers: types, application, merits and demerits
4. Organic manure; types, application, merits and demerits
5. Need of water: Irrigation - Surface, spray, drip irrigation, sprinklers.
6. Plant protection: Biological, Physical and mechanical, Chemical, biopesticide

Module - III. Botany in Everyday life

1. Vegetable gardening
2. Mushroom cultivation
3. Vermi composting- technique
4. Biofertilizer Technology
5. Orchid and Anthurium cultivation
6. Creating Bonsai

Module - IV. Economic Botany

1. General account on various plants of economic importance
2. Study the Binomial, Family, Morphology of the useful part of the following plants.
Cereals and Millets - Rice, Wheat
Pulses -Greengram, Bengalgram, Blackgram
Beverages - Coffee, Tea, Cocoa.
Fibre - Coir, Cotton
Timber - Teak, Rose wood, Jack
Spices - Pepper, Ginger, Cardamom
Medicinal - Adhatoda, Phyllanthus, Rauwolfia
Oil- coconut, Gingelly
Ornamental plants of economic importance - Rose, jasmine
Fruit - Mango, Banana

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OPEN COURSECHOICE-3
BASIC TISSUE CULTURE

Semester	Course code	Credits	Hrs/wk	Marks(Ext.+Int.)	Duration of exam
5	GBOT5D03T	3	3	60 + 15	2 hrs

COURSE OUTCOMES (COs)

By the end of the course, students are expected to:

1. Understand plant tissue culture as a rapid propagation method.
2. Explain the steps involved in tissue culture.
3. Realize the applications of plant tissue culture

DISTRIBUTION OF TEACHING HOURS (18 hrs/Semester = 1hr/week)

Sl no	Subject	Total
1	Module 1	7
2	Module 2	12
3	Module 3	9
4	Module 4	18
5	Module 5	8
Total		54

QUESTION PAPER PATTERN

Type of questions	No of questions	Total
2 marks	12	Ceiling 20
5 marks	7	Ceiling 30
10 marks	2	1x10 = 10
Total		60

Module - I .

1. Introduction; Aims and objectives of Plant Tissue Culture.
2. Organization and facilities of a Tissue culture Laboratory.
3. Equipment and apparatus in a tissue culture lab.
4. Sterilization techniques - Autoclaving Flame sterilization, UV irradiation, Chemical sterilization. Sterilization of instruments and glass wares, medium, explants

Module-II

1. Plant tissue culture - Principles and techniques: Cellular totipotency, *in vitro* differentiation -de differentiation and re-differentiation.
2. Tissue culture medium - Basic components in tissue culture medium - Solid and

liquid medium- suspension culture. Murashige and Skoog medium- composition and preparation.

3. Aseptic techniques in tissue culture - preparation of explants - surface sterilization. Inoculation, incubation and subculturing.

Module-III

1. Micropropagation - Different methods - axillary bud proliferation, direct and indirect organogenesis and somatic embryogenesis.
2. Different phases of micropropagation - hardening, transplantation and field Evaluation: Advantages and disadvantages of micro propagation.
3. Somaclonal variation.

Module - IV

1. Applications of plant tissue culture: Micropropagation; Somatic embryogenesis; Artificial seeds, Germplasm conservation, Embryo rescue culture, Protoplast isolation, culture and fusion, Anther, pollen and Ovary culture for production of haploids, Cryopreservation. Shoot apical meristem culture and production of pathogen free stocks and somaclonal variation.

Module -V

1. Transformation technology - Transgenic plant production, Gene transfer methods in plants, Multiple gene transfers, Vector less or direct gene transfer techniques.

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MODEL QUESTION PAPERS: OPEN COURSES

FIFTH SEMESTER UG DEGREE PROGRAMME
OPEN COURSE - Choice -1
GBOT5D01T: GENERAL BOTANY

TIME: 2 Hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

- 1 Which plant group is known as 'amphibians of the plant kingdom? Why?
- 2 Name the first cell of sporophytic generation. Give its genetic constitution.
- 3 Distinguish between actinomorphic and zygomorphic flowers.
- 4 Comment on annual rings.
- 5 Distinguish between diffusion and osmosis.
- 6 Name any two major nutrients and their deficiency symptoms.
- 7 Name a gaseous hormone. What is its significance?
- 8 Write the names of any two alternative energy resources.
- 9 Distinguish between autosomes and allosomes.
- 10 Name any two transgenic plants. Mention their special feature.
- 11 With suitable examples distinguish between commensalism and symbiosis.
- 12 What is greenhouse effect? Name two major greenhouse gases.

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

- 13 Comment on symbiotic nitrogen fixation.
- 14 Compare the internal structure of dicot and monocot stem.
- 15 Outline Eichler's system of classification of plants.
- 16 Distinguish between heart wood and sap wood.
- 17 Give an illustration on mitosis.
- 18 Discuss the genetics of blood groupism in man.
- 19 Write a critical account on *In situ* and *Ex situ* methods of biodiversity conservation.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

- 20 Give a detailed account on light and dark reactions of photosynthesis.
- 21 Discuss secondary thickening in a dicot stem with labeled sketches

FIFTH SEMESTER B. Sc. BOTANY DEGREE PROGRAMME
OPEN COURSE - Choice - 2
GBOT5D02T: APPLIED BOTANY

TIME: 2 Hrs

Max. Marks 60

SECTION A

(Answer all questions, each question carries 2 marks. Ceiling: 20 Marks)

1. Distinguish between loamy soil and clay soil.
2. What is the composition of commonly used potting mixture?
3. What is 'Humus'? Give its significance.
4. Comment on legume-rhizobium association
5. Commonly used earthworms for vermicomposting technique
6. Give the binomial of medicinal plant used against jaundice
7. Why *Azolla* is grown in paddy fields?
8. Which spice is known as 'queen of spices'? Give its binomial.
9. Distinguish between depotting and repotting
10. Name two chemical fertilizers rich in phosphorus
11. Specify the hormones used for root and shoot differentiation in tissue culture
12. How will you correct soil pH?

SECTION B

(Answer all questions, each question carries 5 marks. Ceiling: 30 Marks)

13. Give an account on *Anthurium* cultivation
14. Write critical notes on seed dormancy
15. Compare the merits and demerits of chemical fertilizers and organic manures.
16. Briefly outline the art of making bonsai
17. Give the binomial, family and morphology of the useful parts of any two pulses.
18. Outline the procedure of cultivation of oyster mushroom.
19. What are biopesticides? Give the composition and procedure for the preparation of any two.

SECTION C

(Answer any one question, each question carries 10 marks. 1x10 = 10 Marks)

20. Give a detailed account on various practices of vegetative propagation
21. Discuss various types of irrigation and their significance

FIFTH SEMESTER B. Sc. BOTANY DEGREE PROGRAMME
OPEN COURSE-Choice -3
GBOT5D03T: BASIC TISSUE CULTURE

TIME: 2Hrs

Max. Marks 60

SECTION A

(Answer all questions. Each question carries 2 marks. Ceiling: 20 Marks)

1. What are synseeds?
2. What is cryopreservation? Write examples for cryoprotectants.
3. Write the various instruments/ equipment used in tissue culture lab.
4. Explain the steps involved in hardening?
5. Define organogenesis. What are the different types of organogenesis?
6. What is a Cybrid? How is it produced?
7. What is an autoclave? Explain its principle and use.
8. Explain the role microelements in tissue culture.
9. Define incineration, and its usage in tissue culture?
10. Mention the categories of chemical sterilants used in plant tissue culture
11. What are the principles involved in plant tissue culture?
12. What is meristem culture? Explain its importance.

SECTION B

(Answer all questions. Each question carries 5 marks. Ceiling: 30 Marks)

13. Explain the various steps involved in microproagation.
14. Define Haploids. What are steps involved in haploid production?
15. What are secondary metabolites? Write its applications.
16. What are the various methods adopted to test protoplast viability.
17. What is LAF? Write the working principle of LAF.
18. Write an account on different sterilization methods adopted in plant tissue culture?
19. What are nutrient media, explain its components and role?

SECTION C

(Answer any one. Each question carries 10 marks. 1x10=10 Marks)

20. Explain the various gene transfer methods.
21. Describe the applications of plant tissue culture in overcoming specific problems.