ST. THOMAS' COLLEGE (AUTONOMOUS)
THRISSUR, KERALA – 680001

Affiliated to University of Calicut
Nationally reaccredited with 'A' Grade

CURRICULUM AND SYLLABUS
FOR
POSTGRADUATE PROGRAMME IN BOTANY

UNDER CHOICE BASED CREDIT AND SEMESTER SYSTEM
(w.e.f. 2020 Admission onwards)

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Aims and Objectives of the Programme

The Board of Studies in Botany recognizes that curriculum, course content and assessment of scholastic achievement play complementary roles in shaping education. The revised Curriculum for Postgraduate Programme of Botany envisages Postgraduate Education as a combination of general and specialized education, simultaneously introducing the concepts in-depth learning. The present attempt is to prepare the students for lifelong learning by drawing attention to the vast world of knowledge of plants and introducing them to the methodology of systematic academic enquiry. The crew of the syllabus ensures firm footing in fundamental aspects of Botany and wide exposure to modern branches of Botany to the students.

At the end of Post Graduate Program at St. Thomas College (Autonomous), a student would have:

PO1:	Attain profound **Expertise in Discipline**.
PO2:	Acquire **Ability to function in multidisciplinary Domains**.
PO3:	Attaine ability to exercise **Research Intelligence** in investigations and Innovations.
PO4:	Learn Ethical Principles and be committed to **Professional Ethics**.
PO5:	Incorporate **Self-directed and Life-long Learning**.
PO6:	Obtain Ability to maneuver in diverse contexts with **Global Perspective**.
PO7:	Attain **Maturity to respond to one's calling**.

Program Specific Outcome – M.Sc. Botany

PSO1. Differentiate plant groups according to their morphology, anatomy and genetics.

PSO2. Practice the methodology followed in plant protection, propagation and improvement.

PSO3. Understand the advanced concepts of physiology, biochemistry and molecular biology of plant and microbes.

PSO4. Employ problem solving and laboratory skills pertaining to biological techniques and apply strategies for environmental conservation.

PSO5. Adapt scientific methods in plant research and create entrepreneurships.

ADMISSION:

Admission for the programme shall be as per the CBCSS PG Regulations in force.

ATTENDANCE:

The requirement of attendance shall be as per the CBCSS PG Regulation in force.

EVALUATION AND GRADING

EVALUATION: The evaluation scheme for each course shall contain two parts; (a) Internal / Continuous Assessment (CA) and (b) External / End Semester Evaluation (ESE). Of the total, 20% weightage shall be given to internal evaluation / Continuous assessment and the remaining 80% to External/ESE and the ratio and weightage between Internal and External is 1:4. Primary evaluation for Internal and External shall be based on 6 letter grades (A+, A, B, C, D and E) with numerical values (Grade Points) of 5, 4, 3, 2, 1 & 0 respectively.

Grade Point Average: Internal and External components are separately graded and the combined grade point with weightage 1 for Internal and 4 for external shall be applied to calculate the Grade Point Average (GPA) of each course. Letter grade shall be assigned to each course based on the categorization based on ten point scale.

Evaluation of Audit Courses: The examination and evaluation shall be conducted by the college in a common pattern for all the PG programmes. The question paper shall be for minimum 20 weightage and a minimum of 2 hour duration for the examination. The result has to be intimated/ uploaded to the Institute website during the Third Semester as per the notification of the Institute.

Evaluation of Certificate Courses: The examination and evaluation shall be conducted by the college in a common pattern for all the PG programmes. The question paper shall be for minimum 30 weightage and a minimum of 2 hour duration for the examination. The result has to be intimated/ uploaded to the Institute website during the Third Semester as per the notification of the Institute.

INTERNAL EVALUATION / CONTINUOUS ASSESSMENT (CA)

This assessment shall be based on a predetermined transparent system involving periodic written tests, assignments, seminars and viva-voce in respect of theory courses and based on tests, lab skill and records/viva in respect of practical courses.

The criteria and percentage of weightage assigned to various components for internal evaluation are as follows:

(a) Theory : (Total weightage -5)			
Sl.No	**Component**	**Percentage**	**Weightage**
1	Examination /Test	40%	**2**
2	Seminars / Presentation	20%	**1**
3	Assignment	20%	**1**

4	Attendance	20%	**1**
(b) Practical			
1	Lab Skill	40%	**4**
2	Records	30%	**3**
3	Practical Test	30%	**3**

The 'better' of the two examinations/tests can be used to obtain the letter grades as per the following table

Percentage obtained in 'better' of two examinations	Grade	Grade point
90 - 100% ….**(4.5 to 5)**	**A+**	**5**
75 – 89.99%...**(3.75-4.49)**	**A**	**4**
60 – 74.99%...**(3.0 to 3.74)**	**B**	**3**
40 – 59.99%...**(2 to 2.99)**	**C**	**2**
Below 40% **(Below 2.0)**	**D**	**1**
Absent	**E**	**0**

Letter grades of attendance can be derived as per the following table

Range of attendance	Grading	Grade point
>=90%	**A+**	**5**
85% >=Attendance<90%	**A**	**4**
80% >=Attendance<85%	**B**	**3**
75% >=Attendance<80%	**C**	**2**
50% >=Attendance<75%	**D**	**1**
<50%	**E**	**0**

Grades shall be given for the internal evaluation based on the grades A+, A, B, C, D & E with grade points 5, 4, 3, 2, 1 & 0 respectively. The overall grades shall be as per the Ten point scale. There shall be no separate minimum Grade Point for internal evaluation. To ensure transparency of the evaluation process, the internal assessment marks awarded to the students in each course in a semester shall be published on the notice board before 5 days of commencement of external examination. There shall not be any chance for improvement of internal marks. The course teacher shall maintain the academic record of each student registered for the course, which shall be forwarded to the University, through the college Principal, after being endorsed by the Head of the Department. Class tests for internal evaluation should be spread during the semester and the grades displayed on the notice board. Valued answer scripts shall be made available to the students for perusal. Each student shall be required to do at least one assignment for each course. Assignments after valuation must be returned to the students. The teacher shall define the expected quality of the above in terms of structure, content, presentation etc. and inform the same to the students. Punctuality in submission is to be considered. Every student shall deliver one seminar / presentation as an internal component for every course and must be evaluated by the respective course teacher in terms of structure, content, presentation and interaction. The soft and hard copies of the seminar report are to be submitted to the course teacher.

EXTERNAL / END SEMESTER EVALUATION (ESE)

The semester-end examinations in theory courses shall be conducted by the College 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. After the external evaluation, only Grades are to be entered in the space provided in the answer script for individual questions and calculations need to be done only up to the Cumulative Grade Point (CGP) and all other calculations including grades are to be done by the College. Students shall have the right to apply for scrutiny, as per rules, within stipulated time limit. Photocopies of the answer scripts of the external examination shall be made available to the students for scrutiny on request by them as per rules. The external evaluation shall be done immediately after the examination preferably in a Centralized Valuation Camp.

PATTERN OF QUESTIONS FOR EXTERNAL (ESE)

Questions shall be set to assess the knowledge acquired, standard, and application of knowledge, application of knowledge in new situations, critical evaluation of knowledge and the ability to synthesize knowledge. Due weightage shall be given to each module based on content/teaching hours allotted to each module. It has to be ensured that questions covering all skills are set. The setter shall also submit a detailed scheme of evaluation along with the question paper. A question paper shall be a judicious mix of short answer type, short essay type /problem solving type and long essay type questions. The question shall be prepared in such a way that the answers can be awarded A+, A, B, C, D & E Grades. End Semester Evaluation in Practical Courses shall be conducted and evaluated by two examiners of which one should be an External Examiner and the other examiner should be the teacher who offers the course/ the senior most teacher who offers the course. Different types of questions shall be given different weightages to quantify their range given in the following model:

Number of questions to be answered:

1. **Theory**

Sl. No.	Type of Individual Questions	Total No. of Questions	Weightage
1.	Short answer	4 out of 7	2x4=8
2.	Short essay/problem solving	4 out of 7	3x4=12
3	Long Essay type	2 out of 4	5x2=10
	Total	10 out of 18	30

(All questions should be in such a way that 6 grades could be awarded. Short answer questions should have a minimum of 4 value points, short essays a minimum of 6 value points and long essays a minimum of 10 value points)

2. **Practical**

Sl. No.	Type of Individual Questions	Total No. of Questions	Weightage
1.	Major Experiments/ Problems	3	3x5=15

2.	Minor Experiments/ Problems	3	3x2=6
3	Spotters/ Identifications	5	5x1=5
4	Lab Records	1	2
5	Submissions/Tour Reports	1	2
	Total	13	30

EVALUATION OF PROJECT WORK | DISSERTATION

There shall be External and Internal evaluation with the same criteria for Project Work done and the grading system shall be followed as per the specific guidelines. For a pass in Project Work, a student has to secure a minimum of P Grade in External and Internal evaluation combined. If the students could not secure minimum P Grade in the Project work, they will be treated as failed in that attempt and the students may be allowed to rework and resubmit the same in accordance with the University exam stipulations. There shall be no improvement chance for Project Work.

The External and Internal evaluation of the Project Work shall be done based on the following criteria and weightages as detailed below:

Sl. No.	Criteria	% of Weightage	Weightage External	Weightage Internal
1	Relevance of the Topic and statement of problem	60	8	2
2	Methodology &Analysis		8	2
3	Quality report and presentation		8	3
4	Viva Voce (on the project)	40	16	4
	Total	100	40	10

COMPREHENSIVE VIVA-VOCE

There shall be an External Comprehensive Viva-Voce at the end of the Fourth Semester. The External Viva Voce shall be conducted by one External Examiner appointed by the Controller of examination of the institute and the Head of the Department as the Internal Examiner. For a pass in comprehensive viva- voce, a student has to secure a minimum of P Grade or a pass. Failed candidates can reappear for the same next time in accordance with the University exam stipulations. There shall be no improvement chance for comprehensive viva-voce.

DIRECT GRADING SYSTEM

Direct Grading System based on a 10 Point scale is used to evaluate the performance (External and Internal Examinations of students) for all courses (Theory & Practical)/Semester/Overall Programme, Letter grades and GPA/SGPA/CGPA are given on the following way:

a) First Stage Evaluation for both Internal and External will be done by the teachers concerned in the following

Scale:	A+	5
	A	4
	B	3
	C	2
	D	1
	E	0

b) The Grade Range for both Internal & External shall be:

Letter Grade	Grade Range	Range of %	Merit Indicator
O	4.25 - 5.00	85-100	Outstanding
A+	3.75 - 4.24	75-84.99	Excellent
A	3.25 - 3.74	65-74.99	Very Good
B+	2.75 - 3.24	55-64.99	Good
B	2.50 - 2.74	50-54.99	Above Average
C	2.25 - 2.49	45-49.99	Average
P	2.00 -2.24	40-44.99	Pass
F	< 2.00	Below 40	Fail
I	0		Incomplete
Ab	0		Absent

No separate minimum is required for Internal Evaluation for a pass, but a minimum P Grade is required for a pass in the external evaluation. However, a minimum P grade is required for pass in a course. A student who fails to secure a minimum grade for a pass in a course will be permitted to write the examination along with the next batch.

IMPROVEMENT OF COURSE

The candidates who wish to improve the grade / grade point of the external examination of a course they have passed already can do the same by appearing in the external examination of the concerned semester along with the immediate junior batch. A candidate will be permitted to improve the CGPA of the Programme within a continuous period of four semesters immediately following the completion of the programme allowing only once for a particular semester. The CGPA for the betterment appearance will be computed based on the SGPA secured in the original or betterment appearance of each semester whichever is higher.

SGPA CALCULATION

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

by a student. 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: SGPA (Sj) = Σ(Ci x Gi) /Cr
Where 'Sj' is the j semester , 'Gi ' is the grade point scored by the student in the i course 'ci ' is the credit of the I course, 'Cr ' is the total credits of the semester .

CGPA CALCULATION

CGPA = Σ(Ci x Si) / Cr

Where Ci is the credit of the ith semester, Si is the SGPA of the ith semester and Cr is the total number of credits in the programme. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme. The SGPA and CGPA shall be rounded off to 2 decimal points. For the successful completion of a semester, a student should pass all courses and score a minimum SGPA of 2.0. However, the students are permitted to move to the next semester irrespective of their SGPA.

ST.THOMAS COLLEGE (AUTONOMOUS), THRISSUR				
M.Sc. Programme in Botany (CBCSS) (2020 admissions onwards)				
Programme, structure of courses and distribution of credits				
Course	Title	Credits		
		Internal	External	Total credit
Semester I				
BOT1C01	Phycology, Bryology, Pteridology and Gymnosperms	20%	80%	5
BOT1C02	Mycology and Lichenology, Microbiology and Plant Pathology	20%	80%	5
BOT1C03	Angiosperm Anatomy, Embryology, Palynology and Lab Techniques	20%	80%	5
BOT1L01	Practicals of Phycology, Bryology, Pteridology, Gymnosperms, Mycology and Lichenology	20%	80%	2.5
BOT1L02	Practicals of Microbiology, Plant Pathology, Angiosperm anatomy, Embryology, Palynology and Lab Techniques.	20%	80%	2.5
Semester II				
BOT2C04	Cell Biology, Molecular Biology and Biophysics	20%	80%	5
BOT2C05	Cytogenetics, Genetics, Biostatistics, Plant Breeding and Evolution	20%	80%	5
BOT2C06	Plant Ecology, Conservation Biology, Phytogeography and Forest Botany	20%	80%	5
BOT2L03	Practicals of Cell Biology, Molecular Biology, Biophysics and Cytogenetics	20%	80%	2.5
BOT2L04	Practicals of Genetics, Biostatistics, Plant Breeding, Plant Ecology, Conservation Biology, Phytogeography and Forest Botany	20%	80%	2.5
Semester III				
BOT3C07	Plant Physiology, Metabolism and Biochemistry	20%	80%	5
BOT3C08	Angiosperm Morphology, Taxonomy and Plant Resources	20%	80%	5
BOT3C09	Biotechnology and Bioinformatics	20%	80%	5
BOT3L05	Practicals of Plant Physiology, Metabolism, Biochemistry Angiosperm Morphology and Taxonomy	20%	80%	2.5
BOT3L06	Practicals of Plant Resources, Biotechnology and Bioinformatics	20%	80%	2.5
Semester IV				
BOT4E01	Elective I (Environmental biology and biodiversity conservation)	20%	80%	5
BOT4E02	Elective II (Genetic engineering)	20%	80%	5

BOT4L07	Practicals of Electives	20%	80%	2
BOT4P01	Dissertation	20%	80%	5
BOT4V01	Viva voce	0%	100%	3
Total				80 Credits
Audit Courses (To be completed within the first three semesters by the students)				
ACIAEC	Ability Enhancement Course(Scientific Documentation and Report writing)	100%	0%	4
AC2PCC	Professional Competency (Intellectual Property Rights)	100%	0%	4
(The credits earned through the audit courses will not be added for SGPA/CGPA)				
Duration of Theory Examinations (External) as well as Practical Examinations (External) will be 3 hours				
1 credit = 1.25 hours of teaching; There will be no regular classes/workload for audit courses.				
I theory/dissertation hour= 1.5 hours of workload; 1 practical hour= 1 hour of workload				

DETAILED SYLLABUS

BOT1C01. PHYCOLOGY, BRYOLOGY, PTERIDOLOGY AND GYMNOSPERMS (1.5+1+2+1.5 =6 hours per week)

FIRST SEMESTER				
Course code	**BOT1C01**			
Name of the course	Phycology, Bryology, Pteridology and Gymnosperms			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Total marks (Int+Ext)**
01	**CORE**	**3**	**3**	**35** (Internal 5+ External 30)

Course outcomes

1. Understand life cycles of lower groups and Gymnosperms.
2. Understand the structure and habitats of lower groups and gymnosperms.
3. Discuss the economic importance of lower groups and gymnosperms.
4. Differentiate the types of Algae, Bryophytes, Pteridophytes and Gymnosperms based on morphology and internal anatomy.
5. Identify the contributions of Indian Phycologists and Pteridologists.

6. Understand the significance of geological time scale in the history and evolution of earth's flora.
7. Compare the living lower groups and gymnosperms with fossil types to decipher their evolutionary affinities.

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand life cycles of lower groups and Gymnosperms.	36	U	C	1	1
CO2	Understand the structure and habitats of lower groups and gymnosperms.	36	U	F	1	1
CO3	Discuss the economic importance of lower groups and gymnosperms	16	Ap	C	1	2
CO4	Differentiate the types of Algae, Bryophytes, Pteridophytes and Gymnosperms based on morphology and internal anatomy.	16	An	C	1	1
CO5	Identify the contributions of Indian Phycologists and Pteridophytes.	8	U	C	1	1
CO6	Understand the significance of geological time scale in the history and evolution of earths flora	8	Ap	C	6	1
CO7	Compare the living lower groups and gymnosperms with fossil types to decipher their evolutionary affinities	22	An	P	6	4

Phycology

Module1 **13 hr**

1. Classification of Algae – comparative Survey of important systems – Fritsch – Smith - Round. Criteria for algal classification-Phylogenetic considerations, Modern trends in systematics. Fossil algae
2. Algal cytology – Basic ideas of cell features – Electron microscopic studies of algal cell, cell wall, flagella, chloroplast, pyrenoid, eyespot- their importance in classification.
3. Reproduction-Different types of life cycles in algae.
4. General account of energy sources and pigments in algae.

Module 2 **14 hr**

1. Economic importance of algae – Role of algae in soil fertility, algae in industry, algae in experimental studies, Biological importance of phytoplanktons and water blooms.
2. General account of thallus structure, cell ultra-structure, reproduction, relationships and evolutionary trends in the following groups: Chlorophyta, Xanthophyta, Bacillariophyta, Phaeophyta, Rhodophyta.
3. Algal research in India - contributions of Indian phycologists – M.O.P. Iyengar, V. Krishnamurthy, T.V. Desikachary.

4. Algal culture: methods, media.

References:

1. Fritsch, F.E. The structure and Reproduction of Algae.
2. Smith, G.M. Manual of Phycology
3. Round, F.E. The Biology of Algae.
4. Pold and Wyane. Introduction of Algae.

Advanced reading:

1. Centres of algal research in India
2. Fossil algae

Bryology

Module 3 **18 hr**

1. General characters and systems of classifications of Bryophytes
2. General account of the anatomy, reproduction, life history and phylogeny of Sphaerocarpales, Marchantiales (Asterella, Targionia, Cyathodium, Lunularia, Dumortiera), Jungermanniales (Pallavicinia, Porella), Calobryales, Anthocerotales (Anthoceros), Sphagnales (Sphagnum), Andreales, Funariales (Bryum) and Polytrichales
3. Origin and evolution of Bryophytes- gametophytic and sporophytic.
4. A general account of fossil Bryophytes and their affinities.
5. Economic importance of Bryophytes.

References

l. Watson E.V. The structure and life of Bryophytes. Hutchinson Univ. Press, London.
2. Cavers F. The interrelationship of Bryophytes.New Phytologist.
3. Kashyap S.R. The Liverworts of Western Himalaya and the Punjab Plains, Vol. I & II. Chronica Botanica
4. Smith G.M. Cryptogamic Botany. McGraw Hill Book Co., N.Y.
5. Parihar N.S. An introduction of Embryophyta: Bryophyta. General Book House, Allahabad.
6. Verdoon, F.M. Manual of Bryology. Ashor & Co., Amsterdam.
7. Shaw, J. and Goffinet, B. Bryophyte Biology. Cambridge University Press.
8. Manju C. Nair, K.P. Rajesh and Madhusoodanan, P.V. Bryophytes of Wayanad in Western Ghats. Malabar Natural History Society, Kozhikode.

Advanced reading:

1. Bryophytes- absorption & conduction, xerophytic adaptation, drought tolerance, dessication & dehydration.
2. Ectophytic, endophytic & myxohydric bryophytes.

Pteridology

Module 4 **12 hr**

1. General characters and life history of Pteridophytes.

2. Cytology of Pteridophytes- Chromosome number and polyploidy.
3. Structure and evolution of stele in Pteridophytes.

Module 5 **12 hr**

1. Origin and evolution of Sporangium.
2. Heterospory and seed habit.
3. Development and evolutionary trends in the Gametophytes of Pteridophytes.
4. Apogamy, Apospory and Parthenogenesis.
5. Classification of Pteridophytes: Holttum, Pichi-Sermolli.

Module 6 **12 hr**

1. Comparative morphology, ecology and phylogeny of the following:
   a) Psilopsida : Rhyniales, Psilophytales and Psilotales
   b) Lycopsida: Lycopodiales and lsoetales
   c) Sphenopsida: Hyeniales, Pseudobomiales, Sphenophyllales, Calamitales and Equisetales.
   d) Filicopsida: Primofilicales, Ophioglossales, Marattiales, Osmundales, Schizaeales, Cyatheales, Gleicheniales, Marsileales andSalviniales.
2. Economic importance of Pteridophytes-Medicinal, Horticulture, Biofertilizer, weeds.
3. General account of the contribution of Indian pteridologists.

References

1. Bierhost, D.W. Morphology of Vascular Plants. Mac Miilan Co., New York.
2. Dyer, A.C. The Experimental Biology of Ferns. Academic Press, London.
3. Jermy, A.C. (Ed.): The phylogeny and Classification of Ferns.
4. Kramer, K.U. and Green, P.S. The Families and Genera of Vascular Plants. Narosa, New Delhi.
5. Nampy, S. and Madhusoodanan, P.V. Fern Flora of South India-Taxonomic Revision of Polypodioid Ferns. Daya Publishing House, New Delhi.
6. Abdul Hameed C., Rajesh K.P. and Madhusoodanan P.V. Filmy Ferns of South India. Penta Book Publishers & Distributors, Calicut.
7. Azeez K., Venugopalakrishna Kurup V. and P.V. Madhusoodanan. Spleenworts (Aspleniaceae) of South lndia. Malabar Natural History Society, Calicut.
8. Venugopalakrishna Kurup V., Azeez K. and P.V. Madhusoodanan. Primitive Ferns of South India. 'V'Publishers, Kottayam.

Gymnosperms

Module 7 **12 hr**

1. Geological time scale and correlated predominant Gymnosperm flora. Classification of Gymnosperms- Chamberlain's system, Christenhusz et al. (2011). Distribution of living Gymnosperms in India.
2. Phylogenetic relationship of Gymnosperms.
3. Economic importance of Gymnosperms.

Module 8 **15 hr**

1. Geological horizons, Distribution, morphology, anatomy, reproduction and interrelationship of the following orders (Study of families and types not required)

   a. Pteridospermales; b. Glossopteridales; c. Caytoniales; d. Cycadaeoidales; e. Pentoxylales; f.

Cycadales, g. Ginkgoales; h. Cordaitales; i. Coniferales; j. Taxales; k. Ephedrales; l. Welwitschiales; m. Gnetales.

References:

1. Andrews, H.N. Studies in Paleobotany, Wiley, N.Y.
2. Banks, H.P. Evolution and plants of the past. Wadsworth.
3. Bierhost, D.W. Morphology of Vascular Plants. Macmillan.
4. Bower, F.O. Primitive Plants. Macmillan.
5. Chamberlain, C.J. Gymnosperms- Structure and Evolution. Univ. of Chicago Press.
6. Foster, A.S. & E.M. Gifford. Comparative morphology of vascular plants. Freeman.
7. Maheshwari, P &V. Vasil. Gnetum. CSIR, New Delhi.
8. Ramanujam, C.G.K. Indian Gymnosperms in time and space. Today &Tomorrow, DehraDun.
9. Sewart, W.N. Paleobotany and the Evolution of Plants. Cambridge Univ. Press.
10. Stockey, R.S. Some comments on the origin and evolution of conifers. Canadian J. Bot. 59:75-82.
11. Taylor, T.N. Reproductive biology in early seed plants. Bioscience32:23-28.
12. Walton. An Introduction to the Study of Fossil plants.

BOT1C02: MYCOLOGY & LICHENOLOGY, MICROBIOLOGY AND PLANT PATHOLOGY (2.5+2.5+1= 6 hours per week)

FIRST SEMESTER				
Course code	**BOT1C02**			
Name of the course	Mycology and Lichenology, Microbiology and Plant Pathology			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Total marks (Int+Ext)**
02	**CORE**	**3**	**3**	**35** (Internal 5+ External 30)

Course outcomes

1. Understand the classification and characteristic features of fungi, lichens, and microbes.
2. Understand the principles of plant pathology and disease management.
3. Discuss the use of fungi as saprophytes and symbionts.
4. Discuss the application of microbiology in agriculture, industry and medicine.
5. Identify different types of fungi and microbes through field collection, micro preparation and herbarium.
6. Apply the skill to identify plant diseases based on symptoms.

7. Apply the knowledge attained in food microbiology to improve dietary quality and health.

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand the classification and characteristic features of fungi, lichens, and microbes.	36	U	C	1	1
CO2	Understand the principles of plant pathology and disease management.	36	U	C	1	2
CO3	Discuss the use of fungi as saprophytes and symbionts.	16	U	F	1	1
CO4	Discuss the application of microbiology in agriculture, industry and medicine	16	Ap	C	2	2
CO5	Identify different types of fungi and microbes through field collection, micro preparation and herbarium	16	Ap	P	1	1
CO6	Apply the skill to identify plant diseases based on symptoms	16	Ap	P	1	2
CO7	Apply the knowledge attained in food microbiology to improve dietary quality and health	8	Ap	P	2	2

Mycology

Module 1 **15 hr**

1. General characters of Fungi: cell-ultra structure, unicellular and multicellular organization, hyphal growth, cell wall composition, nutrition (saprobic, biotrophic, symbiotic, predacious) reproduction (vegetative, asexual, sexual), heterothallism, parasexuality. Economic importance - edible and poisonous fungi.
2. Fungi as saprophytes: details of the fungal decomposition of organic matter, coprophilous fungi, lignin degrading fungi, role of fungi in degradation of pesticides.

Module 2 **15 hr**

1. Classification of fungi by Ainsworth & Bisby (1983), Alexopoulos et al. (1996)- Phylogeny of fungi- Characters used in classification.
2. General account of Myxomycota, Mastigomycota, Zygomycota, Ascomycota, Basidiomycota and Dueteromycota. Different kinds of spores and their dispersal.

Module 3 **15 hr**

1. Fungi as symbionts: Mycorrhiza – ectotrophic, orchidaceous and Ericoidmycorrhiza, Vesicular Arbuscular Mycorrhiza - their distribution and significance. Endophytes.
2. Lichenology: General account and systematics of lichens, thallus structure, reproductive bodies, ecological significance and economic importance of lichens - Toxicology, Lichens as food, Bioremediation, ecological indicators, Pollution indicators, Lichen in soil formation and pioneers of xerosere.

References:

1. Alexopoulos C.J., Mims, C.W. & Blackwell, M. lntroductory Mycology. 4th edition. John Wiley & Sons lnc.
2. Ainsworth, G.C., Sparrow, K.F. & Susmann, A.S.(Eds.). The Fungi - An Advanced Treatise. Vol 1-4. Academic Press.
3. Burnett, J.H. Fundamentals of Mycology. Edward Amolds.
4. Cariile, M. J. &Watkinson S.C. The Fungi. Academic Press.
5. Deacon, J.W. Introduction to Modem Mycology. Blackwell.
6. Dubey, H.C. An lntroduction to Fungi. Vikas Publishers, NewDelhi.
7. Hale Mason, E. The Biology of Lichens. 3rd Ed. Edward Arnold, London.
8. Jennigs, D.H. & Lysek, G. Fungal |Biology. Bios Scientific Publishers.
9. Mehrotra, R.S. & Aneja, K.R. An lntroductión to Mycology. New Age International Publishers.
10. Landecker, Elizabeth Moore. Fundamentals of Fungi. 4th Ed. Prentice Hall.
11. Nair, M.C. & Balakrishnan, S. Beneficial fungi and their utilization. Scientific Publishers, Jodhpur.
12. Nash, T.H. Lichen Biology. Cambridge University Press.
13. Webster, John. Lntroduction to Fungi. cambridge University Press.

Advanced reading:

1. Agricultural significance of Fungi- Mycoparasite, mycoherbicide

Microbiology

Module 4 **9hr**

1. Microscopy and the discovery of Microbes; Golden age of Microbiology, Contributions of Robert Koch & Louis Pasteur
2. Special groups of microorganisms, characteristics and economic importance - prions, viroids, mycoplasmas and actinomycetes.
3. Cyanobacteria- salient features, morphology, ultrastructure, classification and economic importance

Module 5 **16hr**

1. Bacteria - Morphology; structure of bacterial cell wall, structures external to the cell wall (glycocalyx, flagella, axial filament, fimbriae and pili), structures internal to the cell wall (cytoplasm, nuclear area, ribosomes, inclusions, endospores), Plasmids and their classification classification based on Bergey's Manuel. Archaeobacteria and Eubacteria. types of nutrition, genetics (conjugation, transformation and transduction)
2. Viruses – Classification (Baltimore system), General account of plant and animal viruses, bacteriophages (T- even phages and λ phage). Isolation, purification, infection, replication and transmission of plant viruses. Detailed study of TMV, T4 Phage, Retroviruses (HIV, HPV).

Module 6 **20hr**

1. Microbial ecology- microbiology of rhizosphere and phylloplane. Sewage disposal, Bioremediation. Microbial degradation of xenobiotics.

2. Agricultural microbiology - management of agricultural soils, bio fertilizers, Microbes as biocontrol agents.
3. Food Microbiology -.Food spoilage and preservation methods. Microbiology of fermented food - dairy products, bread and other fermented plant products. Microorganisms as source of food-single cell protein.
4. Industrial Microbiology - Production of alcohol, antibiotics, vitamins, steroids.

References:

1. Adams, M R & Moss, M.O. Food Microbiology. New Age International Publishing Ltd., New Delhi.
2. Brock, T. D. Biology of Microorganisms. Prentice Hall.
3. Campbell, R. Microbiology. ELBS-Edward Arnold, London.
4. Carpemter, P.L. Microbiology. W.B. Sunders &Company, Philadelphia.
5. Dubey, R.C. & Maheswari, D.K. A text book of Microbiology.
6. S. Chand. Desikachary. Cyanophyta- Monograph
7. Goodfellow, M. et.al. The Biology of Actinomyçetes. Academic press.
8. Kumar, H.D. & Swati Kumar. Modern Concepts of Microbiology.
9. Mathew, R.E.F. Plant Virology, Academic press.
10. Pelzar, M.J., Chan, E.C.S. & Krieg, N.R. Microbiology. Tata Mc Graw Hill.
11. Sharma, P.D. Microbiology & Plant Pathology. Rastogi Publishers, Meerut.

Advanced reading:

1. Methods for isolating pure culture, types of culture media, enrichment culture technique, maintenance & preservation of pure culture.

Plant Pathology

Module 7 **12hr**

1. Principles of Plant Pathology- Causal agents of plant diseases - Biotic causes (fungi, bacteria, virus, mycoplasma, nematodes, angiospermic parasites. Abiotic causes (nutrient and mineral deficiencies, effect of pollution). Koch's postulates. Iatrogenic diseases.
2. Details of different symptoms of plant diseases. Process of infection- Disease cycle – Inoculation-Penetration and entry of pathogen into host tissue – mechanical, physiological and enzymatic
3. Host-parasite interaction. Enzymes and toxins in pathogenesis.
4. Defense mechanisms in plants-Horizontal and vertical resistance- structural and biochemical-Hypersensitive response-Systemic Acquired resistance.
5. Details of different ways of spread and transmission of plant diseases- wind and water-mediated, seed-borne and vector-borne.

Module 8 **6hr**

1. Plant disease management- Physical, Chemical, Biological. Genetically engineering disease resistant plants –with plant derived genes, with pathogen derived genes, defense through RNA silencing by pathogen derived genes

References

1. Agrios, G.N. Plant pathology. 4th Ed., Academic Press.
2. Bilgrami, K.H. & Dube, H C. A Text Book of Modem Plant Pathology. Vikas Publishers, New Delhi.
3. Chaube, H.S. & Ramji Singh .Introductory Plant Pathology. lnternational Book Distributing Co., Lucknow.
4. Gareth-Jones, D. Plant Pathology: Principles and Practice. Open University Press.
5. Horsfall J.G. & Cowling E. B. (Ed.). Plant Disease: An Advanced Treatise. Academic Press.
6. Lucas, J. A. Plant Pathology and Plant pathogens. Blackwell.
7. Manners, J.G. Principles of Plant Pathology. Cambridge Univ Press.
8. Mehrotra, R.S. Plant Pathology. Tata Mc Graw Hill.
9. Pandey, B. P. Plant Pathology -pathogen and plant disease. S. Chand & Co.
10. Pathak, V.N., Khatri, N.K. & Pathak, M. Fundamentals of Plant Pathology. Agro- bios India.
11. Rangaswami, G. Diseases of Crop Plants of lndia. Prentice Hall lndia.
12. Tarr, S.A. J. The Principles of Plant Patholgy. Winchester Press.
13. Wheeler, H. Plant Pathogenesis. Springer Verlag.
14. Wood, R.K.S. Physiological Plant Pathology. Blackwell

BOT1C03. ANGIOSPERM ANATOMY, ANGIOSPERM EMBRYOLOGY, PALYNOLOGY & LAB TECHNIQUES (2+2+1+1= 6 hours per week)

FIRST SEMESTER				
Course code	**BOT1C03**			
Name of the course	Angiosperm Anatomy, Embryology, Palynology and Lab Techniques			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Total marks (Int+Ext)**
03	**CORE**	**3**	**3**	**35** (Internal 5+ External 30)

Course outcomes

1. Understand the structure, development and differentiation of tissues.
2. Understand the reproductive biology of angiosperms.
3. Demonstrate skill in sectioning and to prepare permanent micro and macro preparations.
4. Comparison of the taxonomic evidences from anatomy, embryology and palynology.
5. Distinguish different taxa and identify stress related signatures in plant anatomy through the study of wood anatomy.

6. Apply the knowledge of reproductive biology to solve issues related to sexual incompatibility of seed plants.

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand the development and differentiation of tissues.	9	U	F	1	1
CO2	Understand the reproductive biology of angiosperms.	36	U	C	1	1
CO3	Demonstrate skill in sectioning and to prepare permanent micro and macro preparations.	36	Ap	P	1	4
CO4	Comparison of the taxonomic evidences from anatomy, embryology and palynology	27	An	C	1	1
CO5	Distinguish different taxa and identify stress related signatures in plant Anatomy through the wood Anatomy	18	Ap	P	5	1
CO6	Apply the knowledge of reproductive biology to solve issues related to sexual incompatibility of seed plants	18	Ap	P	5	4

Angiosperm Anatomy

Module 1 **12hr**

1. Cell wall and its development. Chemistry of cell wall- cellulose, hemicellulose, polysaccharides, cell wall proteins, water. Organisation of primary wall. Cytokinesis and growth. Plasmodesmata. Secondary wall chemical constituents- lignin, suberin, callose; organisation of secondary wall.
2. Node - nodalpatterns: Unilacunar, trilacunar, multilacunar and split lateral. Phylogenetic considerations. Leaf trace and branch trace- origin, departure; effect on stele and pith. Secondary growth in leaf traces.
3. Cambium: Development of vascular cambium and cork cambium in root and stem; cell types in vascular cambium, infected vascular cambia, seasonal variations in cambial activity; role of cambium in wound healing and grafting. Conversion of fusiform initials in to ray initials; cambium in arborescent monocotyledons (Liliflorae).

Module 2 **12hr**

1. Development and differentiation: The structure of specialized cells. Vascular differentiation (procambium, residual meristem, interfascicular and intrafascicular cambia); acropetal and basipetal differentiation in leaves, stem and roots. Sieve tube differentiation. Control of phloem differentiation. Tracheary elements differentiation. Ultra-structure of phloem and xylem, brief account of transfer cells. Secondary wall thickening, cytoplasmic changes and autolysis. Control of differentiation. Genetic aspects- lnduction of vessel elements. lnduction of secondary xylem structure in relation to function in water conduction.
2. Anomalous secondary growth: Concepts; modification of the common type of vascular cambium, unequal activity of the vascular cambium. Successive cambia. Anomalous placement of vascular cambium. Discontinuous, unidirectional and bidirectional activity of cambium.

Anomalous secondary growth in storage roots (Beet root, sweet potato).

Module 3 **12hr**

1. Seedling anatomy: Concepts: anatomy of cotyledons, hypocotyl, seedling root, mesocotyl differentiation
2. Leaf anatomy: Unifacial, bifacial and centric leaf (onion); structure of epidermis, stomatal types; foliar sclerieds; oil cells; crystal idioblasts.
3. Anatomy in relation to taxonomy.
4. Wood anatomy- general account.

References

1. Easu, K. Plant Anatomy - Wiley Eastern Limited.
2. Fahn, A. Plant Anatomy. Pergamon Press.
3. Cutter, E.G. & Edward, E. Plant Anatomy: Experiment and Interpretations Part I and II.
4. Mauseth, J.D. Plant Anatomy - The Nenjamin Cumming Publishing Co.
5. Forester, A.S. Practical Plant Anatomy. D. Van Nostrand Company lnc.
6. Roberts, L.W. Cyto differentiation in Plants - Cambridge University Press, Cambridge.

Advanced reading:

1. Application of anatomy in systematic (histotaxonomy) and pharmacognosy, research prospects in anatomy.

Angiosperm Embryology

Module 4 **8 hr**

1. Introduction to angiosperm embryology - structure of dithecous and monothecous anther.
2. Microsporogenesis: Structure and function of wall layers, role of tapetum in pollen development
3. Male gametophyte: Pollen mitosis, division of generative cells, heterospory.
4. Megasporogenesis: Megaspore triad, dyad, coenomegaspore.

Module 5 **20 hr**

1. Embryo sac- different types- ultra-structure of components- synergid and antipodal. Theories of the morphological nature of embryosac.
2. Pollination -Artificial pollination - ultra-structural and dis-ultrastructural and histo-chemical sigma. Significance of pollen - pistil interaction. Role of pollen wall proteins and stigma. In vitro pollination and fertilization.
3. Fertilization: Role of synergids - filiform apparatus, heterospermy and triple fusion.
4. Structure and development of typical dicot and monocot embryos- structure and function of suspensor.
5. Endosperm: classification and type- ruminate endosperm- mosaic endosperm- endosperm haustoria- physiology and cytology of endosperm.

Module 6 **8 hr**

1. Polyembryony - classification – practical value.
2. Apomixis - general account, genetics of apomixis.
3. Parthenocarpy –seedless fruits
4. Experimental embryology-embryo culture, anther culture, ovule culture.

5. Embryology in relation to taxonomy.

References:

1. Bouman F. Ovule initiation, ovule development and seed coat a structure in angiosperms. Today and Tomorrow Publishers, New Delhi.
2. Bhojwani S.S. and Bhatnagar S.S. The embryology of Angiosperms. Vikas Publication, New Delhi.
3. Davis C.L. Systematic embryology of Angiosperms. John Wiley.
4. Eames A.J. Morphology of Angiosperms. Mc Graw Hill.
5. Johanson D. Plant Embryology. Waltham, Massachusetts.
6. John B.D. (Ed.). Embryology of Angiosperms. Springer Verlag.
7. Maheswari P. An introduction to the Embryology of Angiosperms. Mc Graw Hill.
8. Raghavan V. Experimental embryogenesis in plants. Academic Press.
9. Wardlaw C.W. Embryogenesis in Plants. Methusen, London.

Palynology

Module 7 **18hr**

1. Introduction- contributions of Erdtman and P K K Nair.
2. Development and structure of pollen wall. Pollen morphology and its application. Pollen evolution
3. Aero-palynology- methods of aerospore survey and analysis
4. Melitto palynology- nutritional and medical value of honey- unifloral and multifloral honey.
5. Recent advances in palynological studies- forensic-pollen allergy-oil exploration- paleo palynology.
6. Palynology in relation to taxonomy- eurypalynous and stenopalynous taxa.

References:

1. Sripad N. Agashe. Palynology and its Application.
2. Kahinath Bhattacharya et. al. A Text Book of Palynology.

Laboratory Techniques

Module 8 **18hr**

1. Study of the following instruments - their uses and principles:
   a. Microscope: microscopic measurements - camera lucida, micrometry.
   b. Microtomes- Sledge, Rocking, Rotary.
2. Killing, fixing and staining of plant tissues:
   a. Important reagents and chemicals used in the preparation of fixatives and their properties.
   b. Fixatives - FAA, Carnoy's fluid, chrome acetic, Nawaschins fluid, Craf, Flemings- composition, preparation and specific uses.
   c. Dehydrating agents, clearing agents, mounting media. Examples and brief description.
   d. Stains - classification, composition and specific uses - saffranin, crystal violet, cotton blue, fast green, Orange - G, hematoxylin and carmine.
   e. Brief account of vital staining.
   f. Staining techniques – Double staining.
   g. Saffranin - Fastgreen

h. Crystal violet – Orange G
i. Methods of embedding plant materials in paraffin wax-TBA method; embedding for Electron microscopy.
j. Sectioning of embedded paraffin wax materials using Rotary Microtome.
k. Double staining of microtome serial sections embedding in paraffin wax - Saffranin - fast green; Crystal violet - Orange G/Erythrosin.

i. Whole mounts – general account
ii. Maceration, smears
iii. Histochemical tests–
a. PAS Test – insoluble polysaccharides.
b. Sudan black-lipids
c. Fuelgen reaction – Nucleic Acids.

References:

1. Peter Gray. Hand book of Basic microtechnique. Mcgraw –Hill.
2. John E. Sass. Botanical Microtechnique, Oxford & IBH Publishing Co.
3. John R. Baker. Principles of Biological Microtechnique. Methuen young books
4. A.V. Grimstone and R.J. Saker. A guide book to microscopical methods. Cambridge Univ.press.
5. K.V. Krishnamurthy. Methods in Plant Histochemistry. S Viswanathan Printers & Publishers.

BOT1L01. PRACTICALS OF PHYCOLOGY, BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS, MYCOLOGY AND LICHENOLOGY (0.5x6= 3 hours)

Phycology

1. Collection, preparation and submission of algal herbarium (5numbers).
2. Collection and study of the types mentioned below and their identification up to generic level using algal monographs:

Chlorophyta: Pediastrum, Scenidesmus, Hydrodyctyon, Ulva, Cladophora, Pithophora, Bulbochaeta, Cephaleuros, Draparnaldiopsis, Bryopsis, Codium, Caulerpa, Halimeda, Desmids (Closterium, Cosmarium), Nitella.

Xanthophyta: Botrydium.

Bacillariophyta: Biddulphia, Coscinodiscus, Cymbella.

Phaeophyta: Ectocarpus, Dictyota, Padina, Turbinaria. Rhodophyta: Batrachospermum, Gracilaria, Champia.

Bryology

1. Morphological and structural study of representative members of the following groups using whole mount preparations, dissections and transactions: Asterella, Targionia, Cyathodium, Lunularia, Pallavicinia, Dumortiera, Porella, Anthoceros, Sphagnum and Bryum.

Pteridology

1. Collection, preparation and submission of five herbarium sheets of pteridophytes.
2. Study of vegetative and reproductive features of Lycopodium, Ophioglossum, Angiopteris, Osmunda, Lygodium, Ceratopteris, Pteris, Asplenium, Blechnum, Cyathea, Gleichenia,

Trichomanes, Salvinia and Azolla.
3. Study of the following fossils: Rhynia, Lepidodendron, Sphenophyllum, Calamites, Calamostachys, Zygopteris and Anachoropteris.
4. Spore germination and development of prothallus in Knop's Agar medium.

Gymnosperms

1. Identification of petrifications, compressions, impressions: Lyginopteris, Heterangium, Medullosa, Trignocarpus, Glossopteris, Caytonia, Pentaxylon and Cordaites.
2. Study of vegetative and reproductive structures of Zamia, Ginkgo, Pinus, Cryptomeria, Cupressus, Araucaria, Agathis, Podocarpus, Cephalotaxus, Ephedra and Gnetum.

Mycology

1. Critical study of the following types with the help of fresh/preserved materials by making suitable micropreparations giving emphasis on systematic position, details of vegetative and reproductive structures: Stemonitis, Saprolegnia, Phytophthora, Albugo, Mucor, Pilobolus, Saccharomyces, Xylaria, Chaetomium, Peziza, Puccinia, Auricularia, Polyporus, Ganoderma, Lycoperdon, Dictyophora, Geastrum, Cyathus, Aspergillus, Curvularia, Alternaria, Fusarium, ColIetotrichum, Parmelia, Usnea.
2. Collection and submission of common field macro fungi/lichen (5 types).

Practical records:

Submission of certified record of practicals at the time of terminal evaluation.

Field work:

2 days of field work for the *in situ* study of the types mentioned above and submission of a field report.

BOT1L02. PRACTICALS OF MICROBIOLOGY, PLANT PATHOLOGY, ANGIOSPERM ANATOMY, ANGIOSPERM EMBRYOLOGY, PALYNOLOGY AND LAB TECHNIQUES (0.5+0.5+1+0.25+0.25+0.5=3 hours)

Microbiology

1. Test for the presence of coli-form bacteria in contaminated water.
2. Preparation and sterilization of various microbial culture media and inoculation.
3. Isolation of microbes from soil: Serial dilution - pour plate/spread plate / streak plate method.
4. Staining of bacteria from curd and root nodules (negative staining, Gram staining and endospore staining).
5. Antibacterial assay- disc diffusion, agar well method.

Plant Pathology

1. Submission of five herbarium sheets of pathological specimens.
2. Study of the following diseases with reference to the symptoms, causal organisms, disease cycle and control measures:

   Bunchy top of banana, Bacterial blight of paddy, Bud rot of coconut, Powdery mildew of rubber,

tikka disease of Ground nut, Chilly - leaf spot, Ladies finger - vein clearing disease, Mango – Anthracnose, Blister blight of tea, coffee rust, Phytophthora foot rot of pepper, rhizome rot of ginger, angiospermic parasites- Dendropthoe.

3. Technique of isolation and pure culture of pathogens.

Angiosperm Anatomy

1. Study of anomalous secondary growth in roots and stems of Aristolochia, Strychnos, Amaranthaceae, Nyctaginaceae, Bignoniaceae and Agavaceae.
2. Nodal anatomy of different types.
3. Leaf anatomy: epidermal peels and TS of lamina.

Embryology

1. Study of anther development of Datura.
2. Preparation of dissected whole mounts of microsporangium.
3. Study of megaspore mother cell, megaspore and embryo sac.
4. Study of the receptivity of stigma and in situ germination of pollen.
5. Dissection of stages in the development of embryo and endosperm.
6. Pollen germination using hanging drop technique.
7. Demonstration of intra ovarian pollination.

Palynology

1. Analysis of honey for microscopic examination of pollen.
2. Calculation of percentage of viable pollen by using T and Z test.
3. Study of pollen wall by acetolysis.

Lab Techniques

1. Measurement of microscopic objects -Micrometry.
2. Camera lucida drawing - calculation of magnification
3. Double stained permanent sections - free hand section, Microtome serial sections.
4. Preparation of whole mounts, macerations and smears.
5. Submission of 10 permanent slides – which should include microtome serial sections, freehand sections, macerations, whole mounts and smears.

Practical records:

Submission of certified record of practicals at the time of terminal evaluation.

Field work:

2 days of field work for the in situ study of the types of the above areas of study and submission of a field report.

BOT2C04. CELL BIOLOGY, MOLECULAR BIOLOGY AND BIOPHYSICS (2.5 + 2.5 + 1 = 6 hours per week)

SECOND SEMESTER				
Course code	**BOT2C04**			
Name of the course	Cell Biology, Molecular Biology and Biophysics			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Total marks (Int+Ext)**
04	**CORE**	**3**	**3**	**35** (Internal 5+ External 30)

Course outcomes

1. Understand the dynamics of chromosome behaviour and its interactions.
2. Understand the central dogma of life.
3. Understand the biophysical techniques of instrumentation.
4. Discuss the significance of cell cycle and its application in cancer biology.
5. Apply the knowledge of biophysics and molecular biology in research studies.
6. Apply the knowledge of molecular evolution to decipher the phylogeny of gene families.

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand the dynamics of chromosome behaviour and its interactions	36	U	F	1	3
CO2	Understand the central dogma of life	27	U	F	1	3
CO3	Understand the biophysical techniques of instrumentation	36	U	C	2	4
CO4	Discuss the significance of cell cycle and its application in cancer biology	9	An	C	2	3
CO5	Apply the knowledge of biophysics and molecular biology in research studies	18	Ap	P	3	5
CO6	Apply the knowledge of molecular evolution to decipher the phylogeny of gene families	18	An	P	1	4

Cell Biology

Module 1 **17hr**

1. The nucleus. Interphase nucleus- Chromatin organization- nucleosomes, scaffold. Organization of eukaryotic chromosome. Heterochromatin- constitutive, facultative and condensed. Euchromatin. Satellite DNA. Chromosome banding and its significance.
2. Cell reproduction: Cell cycle. Specific events Gl, S, G2 and M phases. Significance of G0. Control of cell cycle. Significance.
3. Meiosis: types, synaptonemal complex, significance of meiosis. Genetic control and consequences of meiosis. Restriction points and check points. Behaviour of sex chromosomes in meiosis - Meiotic defects and human diseases.

Module 2 **17hr**

1. Programmed cell death: necessity, classes, signals. Genetic analysis of cell death. Proteins regulating apoptosis (caspases). Pathways leading to cell death- significance.
2. Cell signalling: Signal transduction – types (Autocrine, paracrine, endocrine). Signalling pathways, second messengers. Signaling molecules and their receptors, Receptors: Cell surface receptors – ion-channel linked receptors, G-protein coupled receptors, and Tyrosine-kinase linked receptors (RTK), Steroid hormone receptors. Regulation of signal transduction.
3. Cell interactions-communication, recognition and adhesion. General principles of cell communication. Role of cell adhesion molecules (CAM), gap junctions, extracellular matrix, desmosomes.

Module 3 **11hr**

1. Cellular differentiation and specialization. General characteristics. Molecular mechanisms of cellular differentiations, Ageing and senescence.
2. Cancer- carcinogenic agents. Phenotype of the transformed cell. Genetic basis of malignant transformation- oncogenes and tumor suppressor genes, p53 gene, virus-induced cancer, Cancer and cell cycle. Metastasis. Recent advances in cancer therapy (Brief account)

References:

1. Cooper Jeffrey M. The Cell- A Molecular Approach. ASM, Washington.
2. Karp Gerald. Cell Biology. John Wiley and Sons.
3. De robertis. Cell and Molecular Biology.
4. Pollard T.D. and Earn Shaw W.C. Cell Biology. Saunders.
5. Darnell J, Lodish H, Baltimore D. Molecular cell biology.

Advanced reading:

1. Plant two component signalling system
2. Molecular mechanism of cell death.
3. Receptors: RTK, GPCR, steroid hormone receptors

Molecular Biology

Module 4 **15hr**

1. Molecular biology of gene: Structure of DNA, Renaturation and denaturation kinetics, cot value,

Repetitive DNA, c-value paradox.

2. Replication of DNA: Replication in prokaryotes and eukaryotes. Enzymology of replication, Enzymes involved- Primosomes and replisomes. Telomerase and its function. Extrachromosomal replicons.

Module 5 **18hr**

1. Protein synthesis: Genetic code, Transcription, post-transcriptional events. Introns and their significance. Translation. Post translational events- Translational proof reading, translational inhibitors. Role of chaperons- protein folding.
2. Gene expression: regulation of gene expression- Operon concept- Gene regulation in prokaryotes (bacteria) and eukaryotes- enhancers and silencers; role of chromatin in regulating gene expression and gene silencing.

Module 6 **12hr**

1. Mutation: Molecular mechanism of mutation. Mutator and antimutator genes. DNA damage and repair- DNA repairing mechanisms.
2. Molecular evolution: The origin of genomes. Evolution of new genes. Origin of eukaryotic genomes. Evolution of multigene family. Phylogenetics- Parsimony, maximum likelihood. Application of molecular phylogenetics.

References

1. Lewin Benjamin. Genes. Oxford University press.
2. Brown T.A. Genomes. John Willey and Sons.
3. Snustad, Simmons and Jenkins. Principles of Genetics. John Willey and Sons.
4. Weaver and Hendrick. Genetics. Wm. C. Brown Publishers.
5. Hawkins J.D. Gene Structure and Expression. Cambridge University Press.
6. Pierce B.A. Genetics: A conceptual approach. Macmillan.
7. Klug W.S, Cummings M.R. Concepts of genetics. Upper Saddle River, NJ: Pearson Education.

Advanced readings:

1. DNA repair mechanisms- Direct repair, base excision repair, nucleotide excision repair, homologous recombination repair, non- homologous end joining, SOS repair.

Biophysics

Module 7 **9 hr**

1. pH and buffer solutions- hydrogen ion concentrations and pH, dissociation of acids and bases. Measurement of pH using organic indicator molecule and potentiometric method. Functions of buffersinabiologicalsystem.Useofbuffersinbiologicalandbiochemicalresearch.pHandlife. Henderson and Hasselbalch equation.
2. Chromatography: Principles of chromatography. Types of chromatography (Brief account).
3. Electrophoresis: Electrophoretic mobility, principles, PAGE, Agarose gel electrophoresis. Separation and detection of macromolecules by electrophoresis. Electrophoretic apparatus, technique and procedure.
4. Centrifugation - Theory of centrifugation. Centrifuge- Types, Methodology of centrifugation, applications.

Module 8 **9 hr**

1. Colorimetry and spectrophotometry: Beer-Lamberts law. Measurement of extinction. Calorimeters and spectrophotometers. Techniques and applications in biological and biochemical research. Comparison between colorimetry and spectrophotometry.
2. Radiobiology: Autoradiography. Principles, types. Methods and applications in biological research.
3. lmmunochemistry: lmmune response. Antigens- Antibodies. Histo-incompatibility antigens; Structure of IgG. lmmunochemical assays-RIA,ELISA.
4. Cryobiology: Freeze drying (lyophilization)-applications.

References:

1. Hoppe, W. (Ed.). Biophysics. Springer Verlag.
2. Rogers,A.W. Techniques of Autoradiography. Elsevier.
3. Roy, R.N. A Text Book of Biophysics. New Central Book Agency Pvt. Ltd, Calcutta.
4. Sasidharan, A. Selected Topics of Biophysics. Frontier Area Publishers.
5. Slayter, E.M. Optical methods in Biology. Wiley Intersciences.
6. Wong, C.H. Radiation Tracer Methodology in Biophysical Sciences. Prentice Hall.
7. Plummer, D. An introduction to Practical Biochemistry. Tata Mc Graw Hill, New Delhi.

BOT2C05. CYTOGENTICS, GENETICS, BIOSTATISTICS, PLANT BREEDING AND EVOLUTION (1+1.5+1.5+1+1= 6 hours)

SECOND SEMESTER				
Course code	**BOT2C05**			
Name of the course	Cytogenetics, Genetics, Biostatistics, Plant Breeding and Evolution			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Total marks (Int+Ext)**
05	**CORE**	**3**	**3**	**35** (Internal 5+ External 30)

Course outcomes

1. Understand the various concepts of genetics.
2. Understand statistical tools for collection, analysis, interpretation and visualization of data.
3. Understand the plant breeding techniques used in crop improvement.
4. Identify legal regulations related to IPR.
5. Demonstrate hybridization technique in different crop plants.
6. Apply statistical tools in biological experiments.

7. Analyze the structural and numerical chromosome alteration in crop improvement.
8. Solve problems in quantitative, population and molecular genetics.

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand the various concepts of genetics.	36	U	C	1	1
CO2	Understand statistical tools for collection, analysis, interpretation and visualization of data.	18	U	F	1	4
CO3	Understand the plant breeding techniques used in crop improvement	18	U	F	1	3
CO4	Identify legal regulations related to IPR	9	U	C	4	2
CO5	Demonstrate hybridization technique in different crop plants	9	U	P	1	2
CO6	Apply statistical tools in biological experiments	27	Ap	P	3	4
CO7	Analyze the structural and numerical chromosome alteration in crop improvement	18	Ap	C	6	4
CO8	Solve problems in quantitative, population and molecular genetics	9	U	P	1	3

Cytogenetics

Module1 **18 hr**

1. Cytogenetics of aneuploids, euploids and structural heterozygotes: Effect of aneuploidy on phenotype. Transmission of monosomies and trisomies and their uses. Breeding behaviour and genetics of structural heterozygotes; translocation heterozygotes; Robertsonian translocation; B-A translocation. Karyotype-concepts and its importance. Structural chromosome aberrations-types and significance in evolution. Heteroploidy, aneuploidy, monosomy, trisomy (primary, secondary, tertiary and compensating). Nullisomy. Uses of aneuploidy in cytogenetics. Euploidy- autoploidy, alloploidy and segmental allopolyploid diploidization (with specific examples). Role of aneuploidy and euploidy in evolution. Creation of alien addition and substitution lines and their breeding significance.
2. Supernumerary chromosomes: B-chromosomes.
3. Computer assisted chromosome analysis: chromosome micro-dissection and micro-cloning; flow cytometry, Physical localization of DNA sequences on chromosomes using in situ hybridization – GISH, FISH, Fiber FISH etc.
4. Cytogenetic tools used in disease diagnostics, Molecular Tools for screening and diagnosis of human diseases – Prenatal Diagnosis of Genetic Disorders and Congenital Defects.

Reference

1. Alberts B., D. Bray, J. Lewis, K. Roberts and J.D.Watson. Molecular Biology of the Cell Gart

and Publishing Inc. NewYork.
2. Atherly A.G., J.R. Girton and J.F. McDonald. The Science of Genetics. Saunders College Publishing, Fort Worth, USA.
3. Burnharm C.R. Discussions in Cytogenetics. Burgess Publishing Co., Minnesota.
4. De Robertis E.D.P. and De Robertis E.M.F. Cell and Molecular Biology ISBN, Hong Kong.
5. Dupraw E.J. DNA and Chromosomes. Holt, Rinehart and Winston lnc. NewYork.
6. Hart D., Land E.W., Jones. Genetics:Principles and Analysis. Jones & Bartlett publishers, Massachusetts, USA.
7. Khush, G.S. Cytogenetics of Aneuploids. Academic Press.
8. Karp G. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons, Inc.USA.
9. Lewin B. Gene. Oxford University Press, New York, USA.
10. Lewis R. Human Genetics: Concepts and Applications. WCB Mc Graw Hill, USA.
11. Alacinski G.M and D.Freifelder. Essentials of Molecular Biology. Jones and Bastlet Publishers lnc.,London
12. Rieger R., A. Michaelis and M.M. Green Glossary of Genetics and Cytogenetics -Classical and Molecular. Springer-Verlag, NewYork.
13. Wanson C.P., T. Merz, and J.W.Young. Cytogenetics. Prentice Hall.

Genetics

Module 2 **12 hr**

1. Mendelian principles: Dominance, segregation, independent assortment, deviation from Mendelian inheritance. Penetrance and expressivity. complementation tests Relevance of Mendelism in modern genetics.
2. Linkage and gene mapping. Three- point test cross; linkage map; interference; tetrad analysis and centromere mapping. Linkage in humans. Mapping by using somatic cell hybrids. Genetic recombination and mapping of genes in bacteria and bacteriophages.

Module 3 **8 hr**

1. Mobile genetic elements: Transposable elements in bacteria. IS elements. Tn elements. Cmp site transposon. Copia and P elements in Drosophila. Ac, DS and Mu elements in maize. Retrotransposons- Molecular characteristics and significance in development and evolution.
2. Extra nuclear inheritance: Analysis of mitochondrial and chloroplast genomes and their utility. Cytoplasmic male sterility.
3. Quantitative genetics: Polygenic inheritance, heritability and its measurements. QTL mapping.

Module 4 **7 hr**

1. Population genetics: Systems of mating. The Hardy-Weinberg principle. Estimation of gene frequencies. Factors affecting equilibrium: natural selection, mutation, migration and genetic drift.
2. Human genetics: Human pedigree analysis, Lod scores for linkage testing. Karyotype; genetic disorders.

References:

1. Snustad, Simmons and Jenkins. Principles of Genetics. John Willey and Sons.
2. Weaver and Hendrck. Genetics. Wm. C Brown Publishers.
3. Good enough. Genetics. Saunders College Publishing.
4. Stansfield. Theory and Problems of Genetics. Mc Grow Hills.
5. Strickberger. Genetics. Macmillan.
6. Burnet L. Essential Genetics. Cambridge University Press.
7. Friefelder. Microbial Genetics. Narosa Publishing House.
8. Gardner, Simmons and Snustad. Principles of Genetics. John Wiley and Sons, New York, USA.
9. Singh B.D. Fundamental of Genetics. Kalyani Publishers, New Delhi.
10. Benjamin A P. Genetics: A conceptual Approach. W.H Freeman & Company

Advanced reading:

1. Role of p53
2. Viral oncogenes

Biostatistics

Module 5 **12 hr**

1. The science of statistics and its applications in biological research.
2. Types and collection of data- Census and sampling- theory and methods.
3. Tabulation and presentation of data- diagrammatic and graphic presentation.
4. Analysis of data- central tendencies.
5. Measures of dispersion - Range, quartile deviation, mean deviation, standard deviation and standard error. Relative measures of dispersion - coefficient of variation.
6. Tests of significance- formulation and testing of hypothesis- testing the probability of committing type 1 and type 2 errors. z test, t test, chi-square test.
7. Analysis of variance- one way classification and two way classification, F test, F value calculation, F table.

Modules 6 **15 hr**

1. Correlation and Regression analysis- coefficient of correlation- significance testing. Rank correlation. Lines of regression- coefficient of regression.
2. Experimental designs- designing an experiment- CRD, RBD, LSD. Factorial experiments.
3. Probability- application of the principles of probability- theorems of probability- applications- Probability distributions- binomial, multinomial, normal and poisson distributions.
4. Statistical software's- SPSS, SPAR, MINITAB. Multivariate analysis (brief account)

References:

1. Chandal S.R.S. A Handbook of Agricultural Statistics. Achal Prakashan Mandir, Kanpur, India.
2. Das M.N. and N.C. Giri. Designs and Analysis of Experiments. Wiley Eastern Ltd.
3. Elhance and Elhance. Fundamentals of Mathematical Statistics. Kithab Mahal, New Delhi, lndia.
4. Gupta S.K and V.K. Kapoor. Fundamentals of Mathematical Statistics. Sultan Chand & Sons, New Delhi.
5. Gupta C.B. An Introduction to Statistical Methods. Vikas Publishing House Pvt. Ltd.
6. Kempthrone, O. An Introduction to Genetic statistics. John Wiley and Sons lnc. New York.

7. Mather K. and J.L. Links. Biometrical Genetics. Chapman and Hall, London.
8. Panse, V.G and P. Sukatme. Statistical Methods for Agricultural Workers. ICAR, New Delhi.
9. Rao C.A. Advanced Statistical Methods in Biometrical Research. Wiley and Sons, New York.
10. Singh P. and S.S. Narayanan. Biometrical Techniques in Plant Breeding. New Delhi.
11. Singh R.K. and Chaudhary B.D. Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi.
12. Daniel W.W. Biostatistics - A foundation for Analysis in Health Sciences.

Plant Breeding

Module 7 **18 hr**

1. Introduction and objectives.
2. Organizations involved in plant breeding.
3. Breeding systems in sexually propagated plants- Floral Biology and its significance in plant breeding. Sterility and incompatibility systems.
4. Genetic resources- centers of crop genetic diversity. In situ and exsitu conservation; cryopreservation of germplasm.
5. Conventional methods of plant breeding:
6. Domestication of wild plants- changes under domestication. Plant introduction- history, types, principles, plant introduction agencies in lndia-plant quarantine rules and regulations. Achievements.
7. Selection - selection methods in sexually and vegetatively propagated species. Selection in segregating populations. Major achievements.
8. Hybridization- history, objectives, techniques, consequences and major achievements. Heterosis breeding- genetic basis of heterosis and inbreeding depression.
9. Modern methods of plant breeding: Mutation breeding- history, methodology, applications, merits, demerits and achievements. Polyploidy breeding- methodology, applications, merits, demerits and achievements. Biotechnological approaches in plant breeding- Molecular markers and their uses- Transgenic plants- critical evaluation.
10. Breeding for special purposes: Resistance breeding- a brief account of disease resistance, pest resistance, and stress resistance- achievements. Quality breeding- objectives and achievements.
11. Biometrical techniques in Plant Breeding- analysis of variability, heritability, genetic advance and combining ability.
12. IPR- Protection of plant variety and farmers' right act.

References

1. Allard R.W. Principles of Plant Breeding. John Wiley and Sons, New Delhi.
2. Chahal G.S. and Gosal S.S. Principles and Procedure of Plant Breeding. Narosa Publishing House, New Delhi.
3. Jain H.K. and Kharkwal M.C. Plant Breeding- Mendelian to Molecular Approaches. Narosa Publishing House, New Delhi.
4. Roy D. Plant Breeding- Analysis and Exploitation of Variation. Narosa Publishing House.
5. Hayward M.D., Bosemark N.O. and Romagasa I. Plant Breeding - Principles and Prospects. Chapman & Hall.

6. Gupta S.K. Plant Breeding- Theory and Techniques. Agrobios (India), Jodhpur.
7. Khan M.A. Plant Breeding. Biotech Books, New Delhi.
8. Stoskopf N.C. Plant Breeding- Theory and Practice. Scientific Publishers (India), Jodhpur.
9. Sharma J.R. Principles and Practices of Plant Breeding. Tata Mc GrawHill.
10. Chopra V.L. Breeding Field Crops. Oxford & IBH.
11. Mohanan K.V. Essentials of Plant Breeding. PHI Ltd., New Delhi.
12. Mohanan K.V. Essentials of Plantation Science. Penta Book Publishers, Calicut, Kerala.

Advanced reading:

1. Mutation breeding: Principles, working of Gamma gardens

Evolution

Module 8 **18 hr**

1. The concept of evolution - geological time scale - Eras, Periods and Epochs
2. Origin of life - Abiogenesis, Biogenesis, Theory of Chemical and Organic Evolution- Experimental evidences of Stanley Miller and Sydney Fox.
3. Evidences of evolution. Palaentology, morphology and comparative anatomy, embryology, rudimentary organs, biogeography, physiology and biochemistry. Micro and macro-evolution and Punctuated equilibrium.
4. Theories of evolution.- Pre-Darwinian, Darwinian and Post Darwinian theories- Modern synthetic theory of evolution. Kins selection and Hamilton's rule.
5. Speciation. Species concept-Morphological, Biological and evolutionary. Modes of speciation- allopatric, sympatric and parapatric. Types of speciation- phyletic and true speciation. Mechanism of speciation - isolating mechanisms – Geographical and reproductive isolation.
6. Evolution at the molecular level: Concepts of neutral evolution, molecular divergence and molecular clocks, molecular tools in phylogeny.
7. Co-evolution: Symbiosis. Plant-animal Co-evolution; mutualism, commensalism. Protective - colouration and shape. Mimicry: Batesian and Mullerian mimicry.

References

1. Monroe W. Strickberger (1990). Evolution. Jones and Bartlett publishers.
2. Shukla R. S. and P. S. Chandel (1974). Cytogenetics, Evolution, Biostatistics and Plant Breeding. S. Chand and Company Ltd. New Delhi.
3. Mettler L. E. and Gregg T. (1969). Population Genetics and Evolution.Prentice-Hall's Foundations of Modern Biology Series
4. Dobzhanskhy Theodosius et al. (1973). Evolution. W.H Freeman & Company
5. Huxley Julian. (1974). Evolution: The modern synthesis. George Allen and Unwin
6. Lull R.S. (1957). Organic Evolution. New York, The Macmillan company
7. Stebbins G.L. (1970). Process of Organic Evolution. Prentice-Hall's Foundations of Modern Biology Series

Advanced reading:

1. Phyletic speciation & true speciation

BOT2C06. PLANT ECOLOGY, CONSERVATION BIOLOGY, PHYTOGEOGRAPHY AND FOREST BOTANY (2.5+1.5+1+1= 6 hours)

SECOND SEMESTER				
Course code	**BOT2C06**			
Name of the course	Plant Ecology, Conservation Biology, Phytogeography and Forest Botany			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Total marks (Int+Ext)**
06	**CORE**	**3**	**3**	**35** (Internal 5+ External 30)

Course outcomes

1. Understand the importance of ecosystem, biodiversity and energy flow.
2. Understand the phytogeographical distribution patterns.
3. Recognize the different forest types and products for sustainable utilization of bio-resources.
4. Identify the threatened plants and threats to global environment.
5. Identify the population characteristics and its significance.
6. Demonstrate skill for Environmental Impact Assessment.
7. Evaluate the role of different biodiversity conservation ventures at local/national and global levels.
8. Apply new strategies for *in situ* and *ex situ* conservation of biodiversity.

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand the importance of ecosystem, biodiversity and energy flow	45	U	F	1	4
CO2	Understand the phytogeographical distribution patterns	18	U	F	1	4
CO3	Recognize the different forest types and products for sustainable utilization of bio-resources	18	U	F	1	4
CO4	Identify the threatened plants and threats to global environment	9	U	C	6	4
CO5	Identify the population characteristics and its significance	9	U	C	1	4
CO6	Demonstrate skill for Environmental Impact Assessment	18	U	P	6	4

CO7	Evaluate the role of different biodiversity conservation ventures at local/national and global levels	18	E	P	1	4
CO8	Apply new strategies for in-situ and ex-situ conservation of biodiversity	9	Ap	P	5	4

Plant Ecology & Conservation Biology

Module 1 **12 hr**

1. Habitat Ecology: Salient features of terrestrial (Biomes), fresh water (Limnology), wet land and marine habitats.
2. Productivity and Energy flow: Concepts, limits and process of primary production; methods of productivity measurements: global trends in primary productivity, energy flow models.

Module 2 **12 hr**

1. Population characteristics: density, natality, mortality, distribution, biotic potential, carrying capacity, aggregation and dispersal, ecotone and edge effect. Population interactions between species - competition, parasitism, predation, commensalism, proto cooperation, mutualism, neutralism
2. The environment and its pollution- types (land, air and water). Effect on living organisms. Control with emphasis on biological methods. Environmental hazards.

Module 3 **12 hr**

1. Threats to the global environment- greenhouse effect, ozone depletion, El-Nino and La Nina effects.
2. Environment impact assessment (EIA) and assessment of environmental hazards- remote sensing.
3. Problems of conservation; causes of threat to environment- human interference, deforestation, habitat destruction, overexploitation of resources.

Module 4 **12 hr**

1. Identification of threatened plants; red list categories- extinct, endangered, vulnerable, rare and out of danger. Extinction process. Hot spots, keystone species and flagship species.
2. Strategies for conservation: *in situ* and *ex situ* conservation, biosphere reserve, national parks, wildlife sanctuaries. Gene banks, cryopreservation, seedbanks.

Module 5 **12 hr**

1. Afforestation- social forestry, agroforestry. International biological programme (lBP), Man and biosphere programme (MAB), IUCN, world environment day, wild life preservation act (1972), Indian forest (conservation) act (1980) and United Nations Environment Programme. Environment Protection Acts.

Module 6 **12 hr**

1. Environmental awareness- role of government and NGOs. Gaia hypothesis
2. Biodiversity- significance at Local, National and Global levels. Deep ecology (Paradigm shift from anthropocentric ecology to ecocentric ecology. National heritages.
3. Conservation issues of Western Ghats – Madhav Gadgil committee report.

References:

1. Negi, S.S. Hand book of National Parks and Sanctuaries in India.

2. M.P. Nair and P.K Sastry - Red data book of Indian plants.
3. Mehrotra and B.K Suri - Remote sensing for environment and forest management.
4. Negi S.S - Biosphere reserves in India.
5. Lucas and Synge - IUCN Red data book. IUCN, Stockholm
6. Dasman R.F – Environmental Conservation.
7. Odum E.P. Fundamentals of ecology
8. Odum E.P. Basic principles of ecology
9. Misra K.R. Ecology workbook.
10. Puri G.S. Indian Forest Ecology Volumes I and ll. Oxford &IBH.
11. Clarke G.L Elements of Ecology.
12. Chhatwal G.L. Encyclopedia of environmental biology.
13. Ray P.K. Pollution and Health. Willey-Eastern Ltd, New Delhi.
14. Michael P. Ecological methods for field and laboratory investigations. Tata McGraw Hill, New Delhi.
15. Kershaw K.A. Quantitative and Dynamic Plant Ecology. ELBS

Phytogeography

Module 7 **18 hr**

1. Patterns of plant distribution: continuous distribution: circumpolar, circumboreal, circumaustral, pan tropical.
2. Discontinuous distribution: Theory of land bridges, theory of continental drift, theory of glaciation.
3. Endemic distribution (neoendemic, paleoendemic), age and area hypothesis.
4. Phytochoria of world and India.
5. Remote sensing: Definition and data acquisition techniques. Application of remote sensing in vegetation classification, understanding the key environmental issues and ecosystem management.

References:

1. Ronald Good. The geography of flowering plants.
2. Bharucha F.R. A text book of plant geography of India. Oxford University Press.
3. Puri G.S. Indian Forest Ecology, Vol I, ll. Oxford, New-Delhi.
4. Jones H G, Vaugham R A. Remote sensing of vegetation. Oxford university press.

Forest Botany

Module 8 **18 hr**

1. Forest- Definitions. Study of various types of forests in the world and in India.
2. Forest products-Major and minor with special reference to Kerala. (NTFPs of plant origin-Bamboos, canes)
3. Influence of forests on environment. Consequence of deforestation and industrialization. Miyawaki method of afforestation. Sustainable utilization of bioresources.

References

1. Agarwal A.P. Forests in India. Oxford & IBH.

2. Gregorv G.R. Forest products, production, trade and consumption, quantity and value of raw materials requirements. Ford foundation, New-Delhi.
3. Puri G.S. Indian Forest Ecology Vol. l & ll. Oxford & IBH.
4. Champion G.H. and Seth S.K. A revised survey of the forest types of lndia.

Advanced reading:

1. Effect of climate change on reproductive biology & biogeography.
2. Role of biotechnology in conservation of species.

BOT2L03. PRACTICALS OF CELL BIOLOGY, MOLECULAR BIOLOGY, BIOPHYSICS, CYTOGENETICS, (0.5 +1+ 0.5+1= 3 hours)

Cell Biology

1. Study of Mitosis in onion root tip cells and determination of mitotic index
2. Pre-treatment of root tips with colchicine and study of C- mitosis
3. Study of Meiosis in *Rheo discolor* smear preparation of PMCs.
4. Chromosome banding.

Molecular Biology

1. Working out problems from molecular genetics.
2. Isolation of DNA from plant tissue
3. Agarose Gel Electrophoresis of DNA
4. Quantification of DNA by spectrophotometric method.

Biophysics

1. Preparation of buffers and measurement of pH using pH meter.
2. Determination of isoelectric pH.
3. Paper chromatography: Separation of sugars.
4. Thin layer chromatography- separation of amino acid mixtures.
5. Colorimetric and spectrophotometric elimination of proteins by Biuret / Lowry's method.
6. Estimation of amino acid by ninhydrin method (colorimetric).

Cytogenetics

1. Induction of polyploidy using colchicine; different methods of the application of colchicine.
2. Effect of induced and spontaneous polyploidy on plant phenotype, meiosis, pollen and seed fertility and fruit set.
3. Preparation of karyotype and ideogram of plant meristematic cells.
4. Cytological studies in callus tissues.
5. Study of meiosis in translocation heterozygotes (*Rheo discolor*)
6. Study of polytene chromosomes.

Practical records:

Submission of certified record of practicals at the time of terminal evaluation.

Field work:

Visit to a reputed molecular biology lab and submission of a report.

BOT2L04. PRACTICLAS OF GENETICS, BIOSTATISTICS, PLANT BREEDING, PLANTECOLOGY, CONSERVATION BIOLOGY, PHYTOGEOGRAPHY AND FORESTBOTANY (0.5+0.5+0.5+0.5+0.5+0.5=3hours)

Genetics

1. Problems from complementation tests, linkage, tetrad analysis, quantitative genetics and population genetics.

Biostatistics

1. Problems from Mean, standard deviation, of variation tests of significance and correlation analysis.
2. Use of computer programmes for statistical analysis.

Plant Breeding

1. Study of floral morphology and flower structure in crop plants- rice, cashew, pulses, Solanum, Capsicum.
2. Practice of hybridization technique in self and cross pollinated plants.
3. Biometrical techniques in Plant Breeding- analysis of variability.

Ecology and Conservation biology

1. Determination of food chains and food web in aquatic ecosystem.
2. Determination of the minimum size of the quadrat suitable for an area using species area curve method.
3. Determination of the Importance Value Index (IVI) of plant species in the community by quadrat, line and belt transect methods.
4. Comparative study of polluted and non-polluted aquatic ecosystems.
5. Visit to a meteorological station, national park or wild life sanctuary, sewage treatment unit and major construction site.
6. Estimation of dissolved oxygen content in the water sample by Winkler's method.
7. Determination of primary production in water samples by light and dark bottle method (Winkler's method).
8. Determination of dissolved carbon dioxide content in water samples.
9. Determination of frequency of plant species of an area and heterogeneity of vegetation using transect method.

Phytogeography

1. Identification of the various floristic and vegetational regions of the world and India in maps.

Forest Botany

1. Study of the major and minor forest products of Kerala and their uses.

Practical records:

Submission of certified record of practicals at the time of terminal evaluation.

Field work:

Visit to one plant breeding station and one ecologically sensitive area and submission of reports.

BOT3C07. PLANT PHYSIOLOGY, METABOLISM AND BIOCHEMISTRY

(2+ 2+ 2 = 6 hours)

THIRD SEMESTER				
Course code	**BOT3C07**			
Name of the course	Plant Physiology, Metabolism and Biochemistry			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Total marks (Int+Ext)**
07	**CORE**	**3**	**3**	**35** (Internal 5+ External 30)

Course outcomes

1. Understand the physiology of plants with reference to water relations and mineral nutrition.
2. Understand the role of hormones in plant development.
3. Describe the metabolic processes of plants.
4. Explain the different primary metabolic pathways and its regulations.
5. Demonstrate skill to estimate quantitatively the primary and secondary metabolites in plants.
6. Analyse the role of external factors in plant development and stress induction.
7. Compare the evolution of different photoreceptive pigments and photosynthetic pathways.
8. Evaluate the physiological, ecological and phylogenic importance of secondary metabolites.

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand the physiology of plants with reference to water relations and mineral nutrition	18	U	F	1	3
CO2	Understand the role of hormones in plant development	18	U	F	1	3
CO3	Describe the metabolic processes of plants	36	U	C	1	3
CO4	Explain the different primary metabolic pathways and its regulations	18	U	C	1	3
CO5	Demonstrate skill to estimate quantitatively the primary and secondary metabolites in	18	Ap	P	1	3

	plants					
CO6	Analyze the role of external factors in plant development and stress induction	9	An	C	2	3
CO7	Compare the evolution of different photoreceptive pigments and photosynthetic pathways	9	An	C	1	3
CO8	Evaluate the physiological, ecological and phylogenic importance of secondary metabolites	18	An	C	2	3

Plant Physiology

Module 1 **12 hr**

1. Water and plant cells: Properties of water, hydrogen bonding, polarity, cohesion and adhesion. The concept of water potential. Water movements in cells and tissues. Soil-plant atmosphere continuum. Transpiration, stomatal movement, modern theories of stomatal mechanism. The ascent of xylem water and the uptake of water by roots. Absorption of mineral ions- solute absorption.
2. Plants and nitrogen: The nitrogen cycle. Biological nitrogen fixation, symbiotic nitrogen fixation in leguminous plants. Biochemistry of nitrogen fixation. Export of fixed nitrogen from nodules. Genetics of nitrogen fixation. Nitrogen assimilation, assimilation of nitrate. Nitrogen nutrition - agricultural and ecological aspects. Biosynthesis of amino acids- reductive amination and transamination. GDH and GS/ GOGAT pathway.

Module 2 **12 hr**

1. Photosynthesis: Absorption and fate of light energy, absorption and action spectra. Photoreceptors-chlorophylls, carotenoids, phycobilins. Bioenergetics and the light dependent reactions of photosynthesis. Photosynthetic electron transport and photophosphorylation. The two pigment systems, Z-scheme, water oxidizing clock. The photosynthetic carbon reduction cycle, C3, C2, C4 and CAM metabolism and ecological significance.
2. Translocation and distribution of photo assimilates. Phloem transport, Sources and sinks, mechanism of translocation. Phloem loading and unloading, distribution of assimilates. Translocation of xenobiotic chemicals.

Module 3 **12 hr**

1. Patterns in plant development: Growth, differentiation, and development. Genetic control and hormonal regulation of plant development. Seed germination- physiology of hormones in plant development-auxins, gibberellins, cytokinins, abscisic acid and ethylene. Role of vitamins and nutrients
2. Photomorphogenesis: Phytochrome: chemistry and physiological effects. Mechanism of phytochrome and gene action. Cryptochromes and blue light effect.
3. Stress Physiology: Types of stress-water, temperature, salt, stresses caused by pests and pathogens and pollutants.

References

1. William G. Hopkins. Introduction to Plant Physiology. John Wiley & Sons Inc.
2. Lincoln Taiz, Eduardo Zeiger (2002). Plant physiology (II Edn). Sinaeur Associates, Inc. Publishers.
3. Frank B Salisbury, Cleon W Ross (1992). Plant Physiology (IV Edn). Wadsworth Publishing Company.

Advanced reading:

1. ABC transporters
2. Biosynthesis of growth hormones

Metabolism

Module 4 **9 hr**

1. Enzymes: General aspect, classification, Michaelis-Menton equation and its significance. Mechanism of enzyme action, co-enzymes, inhibition, regulation, allosteric enzymes, covalently modulated enzymes. Kinetics of enzyme catalysis. Isoenzymes.
2. Intermediary metabolism: Anabolism, catabolism, amphibolic pathways and anapleurotic reactions. Link between primary metabolism and secondary metabolism. Bioenergetics and thermodynamics.

Module 5 **14 hr**

1. Catabolism of hexoses: Glycolysis- two phases, overall balance sheet, regulation; fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway-multifunctional pathway (significance). Tricarboxylic acid cycle: Formation of acetate, reaction of citric acid cycle, anapleurotic reactions of citric acid cycle. Regulation of citric acid cycle. Glyoxylate cycle. Amphibolic nature of TCAcycle.
2. Carbohydrate biosynthesis: Gluconeogenesis, biosynthesis of starch, glucose and other carbohydrates. Involvement of NDP- sugars. Regulation.
3. Oxidation of fatty acids. Activation and entry of fatty acids, Beta oxidation of saturated and unsaturated fatty acids. Regulation.
4. Oxidation of amino acids and entry to TCA cycle.

Module 6 **13 hr**

1. Oxidative phosphorylation: Electron transfer reactions in mitochondria. Electron carriers, multienzyme complexes, ATP synthesis. Regulation of oxidative phosphorylation. Shuttle systems- Alternate pathways-Thermogenesis.
2. Lipid biosynthesis: Biosynthesis of fatty acids. Triacyl glycerols, phospholipids and isoprenoids. Regulation.
3. Biosynthesis of nucleotides: PRPP and its significance. Purine and pyrimidine biosynthesis. Precursors and regulation. Conversion of NMP to NTP. Biosynthesis of deoxyribonucleotides.
4. Secondary metabolism: Main pathways and their relation to primary-metabolism.

References

1. Voet D. & Voet J. G. (2004). Biochemistry. John Wiley & Sons

2. Nelson D.L. & Cox M.M. (2013). Lehninger Principles of Biochemistry. McMillian Publishers
3. Geoffrey Zubay. Biochemistry. Macmillan Publishing Company, New York.
4. Trevor Palmer. Enzymes- Biochemistry, Biotechnology and Clinical Chemistry. Norwood Publishing, Chichester.

Biochemistry

Module 7 **18 hr**

1. The molecular logic of life. The chemical unity of diverse living organisms. Weak interactions in aqueous systems and the fitness of the aqueous environment for living organisms.
2. Carbohydrates- Classification, structure and functions of simple sugars and compound carbohydrates. Sugar derivatives of biological importance.
3. Lipids- Classification- storage and structural lipids; lipids in membranes; the supramolecular architecture of membranes.
4. Nucleotides and nucleic acids. Chemistry- structure of nucleotides- Other functions of nucleotides.

Module 8 **18 hr**

1. Amino acids, peptides and proteins. Amino acids: classification based on polarity; properties. Covalent structure of proteins. Three dimensional structure of proteins. Protein- tertiary and quaternary structures. Denaturation and renaturation. Functions of protein.
2. Secondary metabolites: Secondary metabolites, their physiological roles. Significance- ecological and phylogenetic importance.

References:

1. Nelson D.L. & Cox M.M. (2013). Lehninger Principles of Biochemistry. McMillian Publishers.
2. Geoffrey Zubay. Biochemistry. Macmillen Publishing Company, NewYork.
3. Stryer, Berg & Tymoczko (2002). Biochemistry. W.H. Freeman & Company
4. S Sadasivam, A Manickam (1996). Biochemical methods (II Edn). New age international Publishers
5. Davíd T. Plummer, An Introduction to Practical Biochemistry. Tata McGrawHill.

Advanced reading:

1. Ramachandran plot
2. Dixon plot
3. Enzyme kinetics: Line weaver - Burk plot
4. Mechanism of multisubstrate reaction: Ping-pong & Bi-bi mechanism.

BOT3C08. ANGIOSPERM MORPHOLOGY, TAXONOMY AND PLANT RESOURCES (1+4+1=6hours)

THIRD SEMESTER				
Course code	**BOT3C08**			
Name of the course	Angiosperm Morphology, Taxonomy and Plant Resources			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Total marks (Int+Ext)**
08	**CORE**	**3**	**3**	**35** (Internal 5+ External 30)

Course outcomes

1. Understand the theories of origin and evolution of angiosperms, its floral parts and co-evolution of pollinators.
2. Understand the systems of classification and phylogeny of plants.
3. Understand the rules of ICN, botanical garden, character weighing, literature in plant taxonomy.
4. Identify the different plant family members through field trip and herbarium preparation.
5. Identify the modern trends in plant taxonomy and its application in research.
6. Identify and categorize different types of plant resources.
7. Analyse the current scenario of Indian taxonomy, herbaria and organizations.
8. Apply the knowledge of taxonomy to identify the plant species using floras and keys.

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand the theories of origin and evolution of angiosperms, its floral parts and co-evolution of pollinators	18	U	F	1	1
CO2	Understand the systems of classification and phylogeny of plants	18	U	C	1	1
CO3	Understand the rules of ICN, botanical garden, character weighing, literature in plant taxonomy	18	U	C	1	1
CO4	Identify the different plant family members through field trip and herbarium preparation	36	Ap	P	1	1
CO5	Identify the modern trends in plant taxonomy	18	U	C	3	1

CO6	Identify and categorize different types of plant resources	18	U	C	1	2
CO7	Analyse the current scenario of Indian taxonomy, herbaria and organizations	9	An	C	1	1
CO8	Apply the knowledge of taxonomy to identify the plant species using floras and keys	9	Ap	P	1	1

Morphology

Module 1 **18 hr**

1. A critical study of the current ideas on the origin of Angiosperms with special reference to their ancestral stock, time and place of origin.
2. The concept of primitive angiosperm flower. Origin and evolution of flower, co-evolution of flowers vis-à-vis pollinators.
3. Origin and evolution of structure and morphology of stamens, nectarines and nectar. Origin and evolution of carpels: different types- concept of foliar origin of carpels; types of ovary; evolution of placentation types- inferior ovary- foliar and axial concepts.
4. Role of floral anatomy in interpreting the origin and evolution of flower and floral parts

References:

1. Eames, E.J. Morphology of Angiosperms. Mc Graw Hills Book Co. NewYork.
2. Taylor, D.W. & Hickey L.J. Flowering plants Origin, Evolution and Phylogeny
3. Manilal, K.S. Vascularization of corolla in Compositae. J.lndian Bot. Soc.59:189-196
4. Meeuse, A.D. J. Some fundamental principles of interpretive floral morphology. International Sci. Publ. Hissar. 5. Melville, R. New theory of Angiosperm flower. Nature 188: 14-18 (1960).
5. Puri, V. Inferior ovary. Phytomorpholgy2:122 (1952).
6. Sporne, K.R. The Morphology of Angiosperms. Hutchinsons Uni. Press, London.

Taxonomy

Module 2 **14 hr**

1. Principles of Taxonomy- Scope and importance of Taxonomy; systems of classification- artificial, natural and phylogenetic systems; phenetic versus phylogenetic systems; cladistics in taxonomy.
2. Conceptual basis of classification- essentialism, nominalism, empiricism, phenetics and cladistics. phylogenetic and alternative; concept of genus; concept of family; infraspecific categories.

Module 3 **14 hr**

1. Definitions and terms: primitive and advanced; homology and analogy; parallelism and convergence; monophyly and polyphyly.
2. Taxonomic hierarchy- concept of taxa- species, genus and family- infra specific categories.

Module 4 **14 hr**

1. Plant nomenclature: history of nomenclature; polynomial and binomial systems; detailed study of salient features and major provisions of the ICN (international Code of Nomenclature for algae, fungi and plants.), modifications of ICN.

2. Effective and valid publication, rank of taxa, rule of priority and its limitations, typification, author citation, rejection of names, conserved names and names of hybrids. A brief account of International Code of Nomenclature of Cultivated Plants.

Module 5 **14 hr**

1. Concepts of character: definition, classification of characters- analytical and synthetic, qualitative and quantitative; unit and multiple, good and bad; correlation of characters; character weighting.
2. Modern trends in Taxonomy: cytotaxonomy, chemotaxonomy, biosystematics and numerical taxonomy. Molecular taxonomy- DNA barcoding in plants.

Module 6 **16 hr**

1. History and development of taxonomy in India. Classification of taxonomic literature- general indices, floras, icons, monographs, reviews-and journals; Herbarium- definition, steps involved in the development of herbarium- utility of herbarium and its maintenance- general account of regional and national herbaria with special reference to central National herbarium, Calcutta (CAL) and Madras Herbarium (MH). Botanical survey of India; Botanical gardens- types of gardens and importance of gardens in taxonomic studies- important national and international Botanical Gardens- Royal Botanical Garden, Kew; Indian Botanical Garden, Calcutta, National Botanical Garden, Lucknow, Tropical Botanic Garden, Trivandrum.

References:

1. Cronquist A. Evolution and classification of flowering plants. Thomas and Nëlson Co.
2. Cronquist. A. An integrated system of classification of flowering plants. New York. Graf A.B. Tropica. Roehrs Company Publ. NJ, USA.
3. Harborne J.B. & Turner B.L. Plant chemosystematics. A.P., London.
4. Haywood W.H. & Moore D.M. Current concepts in plant taxonomy. Rendle A.E. Classification of flowering plants.
5. Lawrance. G.H.M. Tãxonomy of vascular plants. Oxford and IBH.
6. Sneeth P.H.A. Numerical taxonomy. W.H. Freeman Co., San Francisco.
7. Sporne. K.R. The Morphology of Angiosperms. Hutchinson University Press, London.
8. Sivarajan V.V. Introduction to principles of plant taxonomy. Oxford and IBH.
9. Smith P.M. The Chemotaxonomy of plants. Edward Arnold, London. Stace, C.A. Plant Taxonomy and Biosystematics. Edward Arnord, London.
10. Takhtajan, A. L. Diversity and classification of flowering plants. Columbia University Press, New York. Woodland, D.W. Contemporary plant systematics. Prentice Hal, New Jersey.
11. Simpson M.G. Plant Systematics. Elsevier, Amsterdam.
12. Stebbins, G.L. Flowering Plants- Evolution above species level. Edward Arnord, London.

Advanced readings:

1. Synthetic approach to the systematics of angiosperms- basic concept of genome analysis - bar coding.

Plant Resources

Module 7 **12 hr**

1. A study of history, occurrence, morphology of useful part and overall chemical composition of the following:
   a. Cereals & millets: rice, wheat, maize, sorghum, finger millet, pearl millet.
   b. Pulses: Bengal gram, cluster bean, common bean, horse gram, cowpea.
   c. Sugar yielding plants: sugar cane, beetroot.
   d. Starch yielding tubers: potato, tapioca, arrow root, yam, taro.
   e. Fats & Oils: ground nut, coconut, castor, gingelly, mustard, oil palm.
   f. Beverages: tea, coffee, cocoa.
   g. Spices and Condiments: pepper, ginger, turmeric, coriander, cumin, fennel, fenu-greek, cardamom, nutmeg, cloves, cinnamon.
   h. Fibre yielding plants: cotton, jute, coir.
   i. Rubber yielding plants: pararubber.
   j. Timber yielding plants: teak, rose wood, Artocarpus, Ailanthes, Xylia.

Module 8 **6 hr**

1. A study of the following medicinãl plants with reference to the chemical and pharmacognosic properties: neem, turmeric, Adhatoda, Rauwolfia, Catharanthes, Bacopa, nux-vomica, sweet flag, Saraca, wood apple, Indian myrobalans,liquorize.

References:

1. Arora R.K. & Nayar, E,K. Wild relatives of crop plants in India. NBPGR Sci. Monograph No.7.
2. Bole, P.V. & Vaghani, Y. Field guide to common Indian trees. Oxford Uni. Press.
3. Chandel, K.P.S., Shukla, G. & Sharma, N. Biodiversity in medicinal and aromatic plants in lndia- conservation and utilization. NBPGR. New Deihi.
4. Chripeels, M.J. & Sadava, D. Plants, food and people. W. Freeman & Co. San Francisco.
5. Conway, G. The doubly green revolution: food for all in the 2lst century. Penguin Books. CS1R.
6. The useful plants of India. Publication and Information directorate, CSIR, New Delhi.
7. Kochar S.L. Economic Botany of the Tropics. Macmillon India Ltd.
8. Nair M.N.B. et al. (eds.) Sustainable management of non-wood forest products. Faculty of Forestry, Uni. Putra, Malaysia.
9. Padora R.S. and Arora R.K. Plant genetic resources and management. IPGRI Publication, South Asia office, NBPGR, Pusa Campus, New Delhi. Indian Science Academy. Plant wealth in India. Special issue of proceedings, 1997.
10. Sahni, K.C. The Book of lndian Trees. Oxford Uni. Press, Mumbai.
11. Sharma, O.P. Hill's Economic Botany. Tata Mc Graw Hill Co., New Delhi.
12. Swaminathan M.S. & Kochar, S.L.(eds.) . Plants and society. Macmillan Publication, London.
13. Thakur, R.S., Puri, H.S. & Husain, A. Major medicinal plants of lndia. Central lnstitute of Medicinal and Aromatic Plants, CSIR, Lucknow.

BOT3C09 BIOTECHNOLOGY AND BIOINFORMATICS (3+3= 6 hours)

THIRD SEMESTER				
Course code	**BOT3C09**			
Name of the course	Biotechnology and Bioinformatics			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Total marks (Int+Ext)**
09	**CORE**	**3**	**3**	**35** (Internal 5+ External 30)

Course outcomes

1. Understand the basic concepts and advanced techniques of plant tissue culture.
2. Understand the concepts and techniques involved in recombinant DNA technology.
3. Understand biological databases and emerging trends in bioinformatics.
4. Analyze the prospects, achievements and ethical issues regarding transgenics.
5. Develop skill in micropropagation and to establish commercial Tissue Culture venture.
6. Acquire knowledge in the usage of biological networks.
7. Analyze the genomes and proteomes with the aid of computational softwares.

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand the basic concepts and advanced techniques of plant tissue culture	36	U	F	1	4
CO2	Understand the concepts and techniques involved in recombinant DNA technology	36	U	C	1	4
CO3	Understand biological databases and emerging trends in bioinformatics	18	U	P	1	4
CO4	Evaluate the prospects, achievements and ethical issues regarding transgenics	9	An	C	4	4
CO5	Develop skill in micropropagation and to establish commercial tissue culture ventures	18	Ap	P	7	5
CO6	Acquire knowledge in the usage of biological networks	9	U	P	1	4
CO7	Analyse the genomes and proteomes with the aid of computational softwares	18	An	P	2	4

Biotechnology

A. Plant Tissue Culture

Module1 **10 hr**

1. Basic concepts and history.
2. General account of laboratory facilities and management, layout of a tissue culture lab, Media for in vitro culture, composition and their preparation with special reference to MS medium
3. Callus culture- selection of explants and medium- types of callus- growth profile of callus.
4. Cell culture - isolation of single cells- mechanical and enzymatic methods- measurement of growth of cells in suspension culture- viability tests.

Module 2 **17 hr**

1. Large scale cultivation of cells using bioreactors for secondary metabolite production.
2. Organogenesis- direct and indirect- factors affecting organogenesis.
3. Organ culture – apical/ axillary meristems, embryo, ovary, ovule, endosperm, anther, pollen and root cultures.
4. Applications of plant tissue culture - clonal propagation, somaclones, somatic hybrids, synthetic seeds, secondary metabolites, germplasm conservation–cryopreservation.
5. Commercial clonal propagation. Certification of TC plants. Major Tissue culture ventures in India

B. Genetic Engineering

Module3 **13 hr**

1. Molecular analysis of gene and gene products: southern, northern and western blots-restriction maps- RAPD and RFLP. FISH. PCR and its applications. DNA finger printing. DNAchips.
2. DNA sequencing: Enzymatic methods. Gilbert and Maxam method. Messing's shotgun method. Fluorescent detection and automation.
3. Recombinant DNA Technology- Enzymes, vectors, gene-cloning strategies, construction and screening of gene and cDNA Libraries. Expression of cloned genes in bacteria and mammalian cells. Prospects and achievements.

Module 4 **14 hr**

1. Transgenic plants. Gene cloning strategies in plants. Vector dependent and vector independent methods. Identification and selection of transformed plants; the reporter enzyme technology. Objectives and achievements- engineering for secondary metabolites; resistance against herbicides, pests, pathogens, stress - improved nutritional and status changes in plants. Plants as bioreactors; phytopolymers and biodegradable plastics; antisense RNA technology; transgene inactivation. Terminator and traitor technologies.
2. Cloning: objectives. Creation of transgenic animals- other developments in cloning. Human cloning. Ethics of cloning.
3. Patenting of genes and GMOs. Gene piracy. Ethics and biosafety aspects, recDNA safety; IPR, biosafety protocols.

References:

1. Gamborg O.L., G C Philips (Eds.) (2005). Plant cell, tissue and organ culture: Fundamental methods. Narosa Publishing House

2. Edwin F George, Michael A Hall, Geert-Jan De Klerk (2008). Plant Propagation by Tissue Culture: The Background (Vol I). Springer
3. D E Evans, J O D Coleman, A. Kearns (2003). Plant Cell Culture. BIOS Scientific Publishers
4. Walker J.M. and R. Rapley. Molecular Biology and Biotechnology: Panima Publishing Corporation.
5. T A Brown (1995). Gene cloning: an introduction (III Edn). Stanley Thomas (Publishers) Ltd.
6. Bernard R. Glick and Jack J. Pasternack. Molecular Biotechnology Principles and Applications of Recombinant DNA:; ASM Press Washington
7. Brown T.A. Gene Cloning and DNA Analysis Blackwell Science Pub: Primrose S.B. Molecular Biotechnology. Panima Publishing Corporation.
8. Maarten J. Chrispeels and D.E.Sadava. Plants, Genes and Agriculture. Jones and Bartlett Publishers.
9. Smita Rastogi, Neelam Pathak (2010). Genetic engineering. Oxford
10. Robert de la Pemere and Franck Seuret. Brave New Seeds: The threat of GM crops to farmers. Global lssues Series.
11. Colin Ratledge, Bjorn Kristianson (2001). Basic biotechnology. Cambridge University press
12. S. B. Primrose, R. M. Twyman (2006). Principles of gene manipulation and genomics (VII Edn). Blackwell publishing.

Bioinformatics

A. Computer application

Module 5 **8 hr**

1. Computer in Science with special reference to biology, the scope and prospects. HTTP, HTML.
2. Online publications with special reference to biology- Open Archive Initiative (www.openarchives.org) e-access debate- concepts and implications, Free Software Movement, Free Software Foundation, GNU/Linux, etc. Online archives, databases, the Public Library of Science (www.publiclibraryofscience.org). Bibliographic databases (Finding Scientific Articles)- PubMed ;Biomed; SCOPUS; Web of Science

References

Online resources freely available at lnternet sites such as

1. www. publiclibraryofscience. org
2. www.openarchives.org
3. www. pubmedcentral. gov
4. www. biomedcentral. com
5. www.nature.com/nature/debates/e-ccess/index.html
6. https://www.elsevier.com/en-in/solutions/scopus
7. https://clarivate.com/webofsciencegroup/solutions/web-of-science/

B. Bioinformatics

Module 6 **24 hr**

1. An Introduction to bioinformatics. Scope and relevance of bioinformatics
2. Biological Data bases: Online databases and search tools, data organization, NCBI. Biological

data bases, structural data bases, DNA and RNA sequence data bases. Nucleic acid sequence databases: GenBank , EMBL, DDBJ; Protein sequence databases: PIR, TrEMBL, SWISS-PROT; Composite protein databases: NRDB, OWL. Secondary databases: PROSITE, PRINTS, BLOCKS, IDENTIFY. Protein structure database: SCOP, CATH, Protein Data Bank

3. Alignment: Sequence comparison, Pair wise sequence alignment, Global alignment: Use of ALIGN, Local alignment: Use of BLAST, FASTA. Amino acid substitution matrices PAM and BLOSUM, Multiple sequence alignment: Use of ClustalW.
4. Phylogenetic analysis: Use of PHYLIP, MEGA

Module 7 **15 hr**

1. Genomics: Assembly of contiguous DNA sequence; whole genome shot gun approach, clone contig approach; chromosome walking and jumping, clone finger printing. Approaches used in sequencing: *Haemophilus influenzae* genome and human genome. Important findings of the completed genome projects: Human genome project, Rice genome project, Arabidopsis genome project, *E. coli* genome project.
2. Proteomics: Molecular structure viewing tool – Rasmol; Protein structure prediction – Secondary Structure prediction (Chou Fasman method), Tertiary structure prediction (Homology modeling). Proteome, Proteome analysis through 2D PAGE, MALDI-TOF

Module 8 **7 hr**

1. Emerging areas of Bioinformatics: transcriptomics, metabolomics, comparative genomics, pharmacogenomics and drug design, DNA editing

References

1. Attwood T.K. and D.J. Arry-smith. lntroduction to Bioinformatics. Pearson Education.
2. Sundararajan S. and R. Balaji, lntroduction to Bioinformatics. Himalaya Publishing House.
3. S. B. Primrose, R. M. Twyman (2006). Principles of gene manipulation and genomics (VII Edn). Blackwell publishing.
4. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2004). Genetics: From genes to genomes (II Edn). McGraw Hill.
5. David W Mount (2001). Bioinformatics: Sequence and genome analysis. CBS publishers & distributors.
6. Jeremy W Dale, Malcolm von Schantz (2002). From genes to genomes. John Wiley & Sons Ltd.
7. Paul G Higgs, Teresa K Attwood (2005). Bioinformatics and molecular evolution. Blackwell publishing.
8. Zhumur Ghosh, Bibekan and Mallik (2008). Bioinformatics: principles and applications. Oxford University press.
9. Sensen C.W. (2002). Genomics and Bioinformatics. Wiley – VCH.
10. Jeremy R (2015). Bioinformatics: An Introduction. Springer Publishing Co.
11. Choudhuri S (2014). Bioinformatics for Beginners (I Edn). Academic Press

BOT3L05. PRACTICALS OF PLANT PHYSIOLOGY, METABOLISM, BIOCHEMISTRY, ANGIOSPERM MORPHOLOGY AND TAXONOMY (0.5+0.5+0.5+0.5+1=3 hours)

Plant Physiology

1. Preparations of normal, molar, ppm, mg/ml solutions
2. Determination of water potential by tissue weight change method.
3. Estimation of total chlorophyll and study of absorption pattern of chlorophyll solution
4. Separation of photosynthetic pigments by paper chromatography and calculating the Rf value
5. Separation of photosynthetic pigments by TLC and calculating the Rf value.
6. Separation and collection of leaf pigments by silica gel column chromatography.
7. Demonstration of Hill reaction.
8. Effects of light intensity on photosynthesis by Wilmot's bubbler.
9. Analyses of proline in abiotic stress.
10. Testing of seed viability by NBT test.
11. Extraction and estimation of leg haemoglobin from root nodules.

Metabolism

1. Preparation of buffers-Citrate and Phosphate-various strengths.
2. Determination of peroxidase activity in plant tissues affected by biotic/abiotic stresses.
3. Determination of enzyme/protein sub units by SDS PAGE.
4. Isolation and estimation of amylase from germinating seeds.
5. Flavanoid assay

Biochemistry

1. Qualitative tests for monosaccharides, reducing and non-reducing oligosaccharides, starch, amino acids and protein and lipids.
2. Quantitative estimation of reducing sugars and starch.
3. Estimation of total phenolics in plant tissue.
4. Quantitative estimation of protein by Biuret/Lowry method.
5. Quantitative estimation of DNA and RNA (colorimetric/spectrophotometric)

Morphology

1. Preparation of cleared whole mounts of floral parts to show vasculature.
2. Examination of the following with the help of dissections and hand sections: Transmitting tissues/canals in style and stigma; Different types of ovaries; Different types of placentation, vasculature of androecium and gynoecium in special types of flowers.

Taxonomy

1. Familiarization with local flora and construction of keys – use of floras in identification up to species.
2. Study of diagnostic features of the families studied in the theory paper with special reference to their economic aspects.
3. Study of the following families with special reference to morphology of modified parts,

economic importance, interrelationships and evolutionary trends: Magnoliaceae, Ranunculaceae, Menispermaceae, Nymphaeace, Polygalaceae, Caryoplyllaceae, Clusiaceae, Sterculiacéae, Meliaceae, Sapindaceae, Vitaceae, Rosaceae, Melastomaceae, Rhizophoraceae, Aizoaceae, Rubiaceae, Sapotaceae, Gentianaceae, Boraginaceae, Convolvulaceae, Scrophulariaceae, Pedaliaceae, Verbenaceae, Nyctaginaceae, Euphorbiaceae, Urticaceae, Casuarinaceae, Orchidaceae, Zingiberaceae, Amaryllidaceae, Commelinaceae, Araceae, Cyperaceae and Poaceae.

4. Dissection of at least two members of each family in the laboratory, making suitable sketches, describing them in technical terms and identifying them constructing appropriate floral diagrams.
5. Field study of three days under the guidance and supervision of teachers at an ecologically different locality and submission of a field study report certified by the teacher concerned. The report should contain ecology of flora of the area studied.
6. Collection of plant specimens following the standard means of plant collection for preparation of herbarium. Each student shall submit a minimum of 25 such herbarium specimens with QR code along with the field book for the Practical examination.
7. Workout nomenclatural problems regarding Priority and Author citations. Problems in Barcoding.

BOT3L06. PRACTICALS OF PLANT RESOURCES, BIOTECHNOLOGY AND BIOINFORMATICS

Plant Resources

1. Morphological study of the source plants mentioned in the theory syllabus and identification of the plants and plant products.

Biotechnology

A. Tissue Culture

1. Preparation of the stock solutions of MS medium.
2. Preparation of MS medium from stock solutions.
3. Isolation, preparation, sterilization and inoculation of different explants like shoot tip, node, anther, embryo and cambium.
4. Procedure of callus induction
5. Estimation of cell growth in callus culture by fresh wt. and dry wt.
6. Induction of multiple shoots using axillary and apical meristems as explants.
7. Plantlet regeneration from callus.
8. Quantification of metabolites in callus cultures.
9. Preparation of a commercial TC planting material production plan for a crop species
10. Synthetic seed production

B. Genetic Engineering

1. lsolation of plant genomic DNA.
2. Tools used in genetic engineering
3. Designing a primer for a well characterized *E.coli* gene.
4. Working out problems in genetic engineering

Bioinformatics-

1. Preparation of scientific presentations using MS-PowerPoint.
2. Use of statistical package-SPSS
3. Use of web browsers and search engines.
4. Retrieving data from various databases mentioned in the syllabus
5. Visit to Bioinformatics websites: NCBI, SWISS PROT, PIR,PDB.
6. Use of biological and bioinformatic websites Agris, Agricola, BIOSIS, CABWeb.
7. Local alignment using BLAST and FASTA
8. Multiple sequence alignment using Clustal W
9. Phylogenetic analysis using MEGA

Practical records:

Submission of certified record of practicals at the time of terminal evaluation.

Submission of 10 plant products directly collected by the student from the field with a note on the source plant and plant part.

BOT4E01**: To be selected by the Board of studies from the list appended** BOT4E02**: To be selected by the Board of studies from the list appended**

List of Electives for M.Sc. Botany CBCSS Programme:

A. Elective I

1. Advanced Angiosperm Taxonomy
2. Environmental Biology and Biodiversity Conservation
3. Plant Tissue Culture
4. Plant Physiology
5. Plant Cell and Molecular Biology
6. Genetics and Crop Improvement

B. Elective II

1. Molecular Plant Taxonomy
2. Pathology of Plantation crops and Spices
3. Genetic Engineering
4. Genomics and Proteomics
5. Genetic Engineering and Bioinformatics
6. Biotechnology in Crop Improvement

The board of studies selected the following Electives

BOT4E01- Environmental Biology and Biodiversity Conservation (6 hours)

FOURTH SEMESTER				
Course code	**BOT4E01**			
Name of the course	Environmental Biology and Biodiversity Conservation			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Total marks (Int+Ext)**
10	**ELECTIVE**	**3**	**3**	**35** (Internal 5+ External 30)

Course outcomes

1. Understand population and community ecology and major global environmental challenges.
2. Understand global initiative and regional initiatives for environment protection.
3. Discuss the important environmental protection laws in India and Indian environmental activists.
4. Discuss the impact of climate change on ecosystem and role of people movements for biodiversity conservation.
5. Explain the different biodiversity information resources, meta-databases and virtual libraries.
6. Analyze biodiversity in terms of wild and agro biodiversity and its conservation practices.
7. Evaluate different types of habitats with reference to Kerala.
8. Apply conservation strategies in global perspective for the use and restoration of threatened ecosystem.

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand population and community ecology and major global environmental challenges	27	U	F	1	4
CO2	Discuss global initiative and regional initiatives for environment protection	18	U	C	6	4
CO3	Discuss the important environmental protection laws in India and Indian environmental activists.	9	U	C	1	4
CO4	Discuss the impact of climate change on ecosystem and role of people movements of biodiversity conservation	18	An	C	5	4

CO5	Explain the different biodiversity information resources, metadatabases and virtual libraries	18	An	C	2	4
CO6	Analyse biodiversity in terms of wild and agro biodiversity and its conservation practices	18	An	C	5	4
CO7	Evaluate different types of habitats with reference to Kerala	18	An	C	1	4
CO8	Apply conservation strategies in global perspective for the use and restoration of threatened ecosystem	18	Ap	P	6	4

Module 1 **20 hr**

1. Population ecology: Properties (concepts of rate, intrinsic rate of natural increase, carrying capacity, population fluctuations and cyclic oscillations, density independent and density dependent mechanisms of population regulation, patterns of dispersion, Allee principle of aggregation and refuging, home range and territoriality, energy partitioning and optimization, r and K selection.
2. Community ecology: Types of interaction between two species, coevolution, evolution of cooperation, group selection, interspecific competition and coexistence, positive and negative interactions, concepts of habitat, ecological niche and guild.

Module 2 **5 hr**

1. Human population: Expansion and its causes, rich and poor nations, consequences, dynamics, Cairo conference1994.

Module 3 **20 hr**

1. Major global environmental challenges: Acid rain, Ozone depletion, climate disruption, deforestation, land degradation and desertification, freshwater degradation and shortage, marine fisheries decline, loss of biological diversity and excess nitrogen.
2. Global initiatives: Stockholm conference (1972), Rio (1992), Ramsar convention (1971), Kyoto (1997), Johannesburg (2002), Stockholm (2011).COP15 (15th Conference of the parties under the UN framework convention on climate change) and Paris protocol.
3. Environmental Law- International and National: The Environment Protection Act & Rules 1986; Water (Prevention & Control of Pollution) Act 1974; Biodiversity Act (2002). Air (protection and control of pollution) act, 1981; Wildlife (protection) Act, 1972; Forest (conservation) Act, 1980

Module 4 **11hr**

1. Thoughts on ecology: Contributions of Buddha, Rabindranatha Tagore, Mahatma Gandhi, Rachel Carson, Gro Herlem Brundtland, Edward O Wilson, Aldo Leopald, Salim Ali, Sunder Lal Bahuguna, Madhav Gadgil, Anil Agarwal, Medha Patkar and Vandana Siva.

Module 5 **20 hr**

1. Biodiversity: a) Genetic diversity, agrobiodiversity and cultivated taxa, causes of decline, value of wild species, conservation practices- traditional (upavana vinoda, sacred groves, sthala vrikshas) and modern (*in situ* and *ex situ*). b) Biodiversity information management and communication- libraries, databases (taxonomic database working groups for plant sciences, data bases on biodiversity); distribution of biodiversity information, meta-databases, virtual libraries.

Module 6 **10 hr**

1. Ecosystem capital- use and restoration: Global perspective on biological systems; conservation, preservation and restoration. Biomes and ecosystems under pressure (forest biomes, ocean ecosystems).
2. Habitat studies: Wetlands (Ramsar sites), mangroves and forest types of Kerala.

Module 7 **12 hr**

1. Brief study of the following: Cybernetics, ecological foot print, sustainable development, deep ecology, Gaia hypothesis, conservation ethics, peoples' movements for biodiversity conservation- Chipko, Save Silent Valley Movement, Jungle Bachao Andolan. Role of NGOs- WWF, NEERI, Thanal and educational institutions in biodiversity conservation, trade related IPR. Ecotourism - positive and negative impacts - ecotourism centers in Kerala - Thenmala and Thattekkad WLS

Module 8 **9 hr**

1. Climate change and its impacts- brief study.
2. Disaster management- basic aspects.

References

1. Champion H.G. and Seth S.K. A Revised Classification of Forest Types of India. Govt. of India, New Delhi.
2. Gadgil Madhav. Ecological Journeys. Permanent Black, Delhi.
3. Jaiswal P.C. Soil Plant and Water Analysis. Kalyani Publishers, Ludhiana.
4. Krishnamurthy K.V. An Advanced Text Book on Biodiversity Principles and Practice. Oxford IBH. Misra R. Ecology Workbook. Oxford IBH.
5. Odum E.P. and Barrett G.W. Fundamentals of Ecology. Thomson Books, Bangalore. Palmer J.A. Fifty Thinkers on the Environment. Routledge, London.
6. Puri G.S. Indian Forest Ecology. Oxford IBH.
7. Pushpangadan P. and Nair K.S.S. Biodiversity and Tropical Forests- The Kerala Scenario. STEC, Thiruvananthapuram.
8. Sarngdharacharyar. (Translated by Vishnu B.). Vruksha Ayurvedam Janapriya Pusthakasala, Kottayam.
9. Sivadasan M. and Mohanan K.V. Biodiversity and Ecology: Concepts and Facts. Department of Botany, University of Calicut, Kerala.
10. Speth Gustave James and Haas M. Peter. Global Environmental Governance. Pearson Longman, New Delhi.

11. Vijayalakshmi K. and Shyam Sundar K.M. Vrkshayurveda- An Introduction Indian Plan Science. Lok Swasthya Parampara Samvardhan Samithi, Madras.
12. Wright T. Richard. Environmental Science- Towards a Sustainable Future. Prentice Hall Learning Pvt. Ltd., New Delhi.

BOT4E02- Genetic Engineering (6 hours)

FOURTH SEMESTER				
Course code	**BOT4E02**			
Name of the course	Biotechnology and Bioinformatics			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Total marks (Int+Ext)**
11	**ELECTIVE**	**3**	**3**	**35** (Internal 5+ External 30)

Course outcomes

1. Understand the general procedure of gene cloning.
2. Understand gene therapy strategies and its application in medical field.
3. Understand different molecular markers and its application.
4. Discuss various techniques employed in the creation of transgenic crops and the ethical issues involved.
5. Acquire basic skills in techniques of genetic engineering.
6. Evaluate the merits and demerits of different tools used in r-DNA technology.
7. Evaluate the importance of bio-nanotechnology in medicine and bioremediation and its bio safety concerns.

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Understand the general procedure of gene cloning	36	U	F	1	4
CO2	Understand gene therapy strategies and its application in medical field	18	U	C	2	4
CO3	Understand different molecular markers and its application	9	U	C	1	4
CO4	Discuss various techniques employed in	18	An	C	4	4

	the creation of transgenic crops and the ethical issues involved.					
CO5	Acquire basic skills in techniques of genetic engineering	36	An	P	3	4
CO6	Evaluate the merits and demerits of different tools used in r-DNA technology	9	An	C	1	4
CO7	Evaluate the merits and demerits of different tools used in r-DNA technology	18	An	C	4	1

Module1 **10 hr**

1. Purification and Separation of DNA using gel electrophoresis: techniques for visualization and reading sequences
2. Blotting techniques: southern, northern, western, southwestern and northwestern blotting techniques.

Module 2 **10 hr**

1. Polymerase Chain Reaction - History, methodology of PCR. Variations from Basic PCR- reverse transcriptase PCR, inverse PCR, nested PCR, Anchored PCR Quantitative real time PCR - applications of PCR.

Module 3 **12 hr**

1. DNA sequencing- chemical and enzymatic methods. Messing's shot gun method, DNA sequencer, NGS technology (brief account)-pyrosequencing, Nanopore sequencing; Importance of DNA sequencing.
2. DNA profiling- methodology & applications.

Module 4 **12 hr**

1. Molecular markers- RAMPO, SSCP, RFLP, RAPD, AFLP, EST markers, SNP markers. Repetitive DNA, Microsatellite (SSR and ISSR) and Minisatellite.

Module 5 **20 hr**

1. Enzymes used in genetic engineering: Restriction enzymes, DNA polymerases, RNA Polymerases, Taq polymerase, Reverse Transcriptase, Ligases, Phosphatase, polynucleotide kinase, single strand specific nucleases
2. Cloning vectors : Plasmid and bacteriophage based vectors, Ti plasmid based vectors, Special vectors such as shuttle vectors, expression vectors, dominant selectable vectors, amplifiable vectors, integrating vectors, single-stranded plasmid vectors, artificial mini chromosomes, broad host range vectors, P-elements, Retrotransposons used in rDNA technology,
3. Tools of rDNA technology, methods of creating rDNA molecules, Modification of restriction fragments - Linkers, Adaptors

Module 6 **16 hr**

1. Gene transfer techniques in plants- Agrobacterium mediated transfer, gene gun method, electroporation, microinjection, microcell fusion technique, metaphase chromosome transfer
2. Selection and screening of recombinant clones: Insertional inactivation of marker genes, visual screening (blue white) methods, plaque phenotype. Complementation or suppression of a mutation. Indirect screening techniques: Immunological techniques, nucleic acid hybridization, colony and dotblot hybridization.

Module 7 **18 hr**

1. Genetic engineering for crop improvement – transgenic plants., transgenic tomatoes, control of ripening by antisense technology, insect resistance (Bt. protein), golden rice, herbicide resistance, biodiesel, designer flowers, plants as bioreactors. Prospects of engineering RUBISCO and nitrogen fixation.
2. Cloning of genes and production of vaccines, drugs and growth hormones.
3. Hazards and impact of GMO: Biosafety Considerations: Biological risks, ethical issues, legal issues.

Module 8 **10 hr**

1. Gene therapy- Introduction, Somatic and germ line gene therapy, Gene replacement and gene addition Transgenic animal models, Vehicles for gene transfer-viral and non-viral vectors: Cancer gene therapy
2. Nanotechnology and its applications in genetic engineering. Preparation and Characterization of Bionanomaterials; Biocompatability, Nanoparticles' Cytotoxicity, Nanobiosensors; Nanoparticles in Biological Labeling and Cellular Imaging, use of nanotechnologies and materials impact on biodiversity, resource conservation, ecosystems. Nanoparticle in Drug delivery; Nanobiotechnology - brief account, Medical Applications of Nanobiotechnology.

References

1. Hartl D.L. and Jones E.W. Genetics- Analysis of genes and genome. Jones and Bartlett Publishers. Nicholl Desmond S.T. An Introduction to Genetic Engineering. Cambridge Pub.
2. Brown T.A. Gene Cloning and DNA Analysis. Blackwell Science Pub. Dubey R.C. A Text Book of Biotechnology. Chand Pub.
3. Singh B.D. Biotechnology. Kalyani Publishers.
4. Walker and Rapley. Molecular Biology and Biotechnology. Panima Pub.
5. Chrispeels M.J. and Sadava D.E. Plants, Genes and Agriculture.
6. Lewin B. Genes. Oxford University Press.
7. Mason A.C. Principles of Gene Manipulation and Genomics.
8. Rissler J. and Mellon M. The Ecological Risks of Engineered Crops. MIT Press, Cambridge.
9. Avice, John C. The Hope, Hype and Reality ofGenetic Engineering.
10. McYYan R.P. Genetics and Genetic Engineering. Saras Publications.
11. Narayana L.M. Molecular Biology and Genetic Engineering.
12. Khadpekar N.R. The Age of Nanotechnology. ICFAI University Press, Hyderabad.
13. Nalwa H.R. Encyclopedia of Nanoscienceand Technology.

BOT3L07. PRACTICALS OF ENVIRONMENTAL BIOLOGY & BIODIVERSITY CONSERVATION AND GENETIC ENGINEERING (3 + 3 = 6 hours)

Environmental Biology and Biodiversity

1. Studies on the following and submission of reports: Waste water treatment plant, local environmental peculiarities (such as hillocks and forest patches), wet land ecosystem, alien invasive plants, degraded ecosystem, different forest types, effluent treatment system).
2. Physical and chemical analysis of soil and water: Particle size analysis of soil, estimation of

particle density using relative density or volumetric flask; Air capacity analysis of soil by field method; Soil pH analysis of soil using pH meter. Water analysis for pH using pH meter, estimation of BOD by Winkler's method (dark and light bottles).

3. Study of community structure: Charting and mapping of vegetation, Raunkiaer's lifeforms, biological spectrum, profile diagram (soil).
4. Study of ecological succession: Different types of ecological successions.
5. Visit to an ecological sensitive area and submission of a report.

Genetic Engineering

1. Working out problems in genetic engineering.
2. Isolation of plant DNA and its quantification by spectrophotometer.
3. Isolation of plasmid DNA from E. coli.
4. Gel electrophoresis- gel preparation, casting and staining.
5. Visualization of DNA by agarose gel electrophoresis and gel reading.
6. RAPD analysis of three closely related bacterial strains.
7. Visit to a genetic engineering lab and submission of a report.

BOT4P01 DISSERTATION

FOURTH SEMESTER				
Course code	**BOT4P01**			
Name of the course	DISSERTATION			
Course No	**Course Category Core/Compli/ Elective**	**Number of Credits**	**Number of hours of Lectures/week**	**Total marks (Int+Ext)**
12	**CORE**	**3**	**3**	**35** (Internal 5+ External 30)

Course outcomes

1. Recognize the knowledge gaps in botanical research.
2. Examine relevant literature and write a literature review of the chosen field.
3. Apply theoretical frameworks to the chosen area of study.
4. Demonstrate the ability to collate and critically interpret data.
5. Demonstrate the skill to write research report and scientific publications.
6. Develop an ability to effectively communicate knowledge in a scientific manner.
7. Propose recommendations based on research findings.

CO	CO Statement	Hrs	Cognitive Level (CL)	Knowledge Category (KC)	PO	PSO
CO1	Recognize the knowledge gaps in botanical research	9	U	C	7	5
CO2	Examine relevant literature and write a literature review of the chosen field	18	Ap	P	1	5
CO3	Apply theoretical frameworks to the chosen area of study	36	Ap	P	2	5
CO4	Demonstrate the ability to collate and critically interpret data	36	Ap	P	3	5
CO5	Demonstrate the skill to write research report and scientific publications	18	Ap	P	4	5
CO6	Develop an ability to effectively communicate knowledge in a scientific manner	18	Ap	P	5	5
CO7	Propose recommendations based on research findings	9	C	P	7	5

- Project/research work shall be carried out under the supervision of a teacher in the concerned department.
- A student may be permitted to work in an industrial/research organization on the recommendation of the supervisor.
- There shall be an internal and external assessment for the dissertation.

PATTERN OF QUESTION PAPER (MSc BOTANY)
SEMESTER: 1

CODE: BOT1C01: PHYCOLOGY, BRYOLOGY, PTERIDOLOGY& GYMNOSPERMS

Contact Hours per Week : 6
Number of Credits : 9
Number of Contact Hours : 72
Course Evaluation : External 30 Weightage + Internal 5 Weightage
Duration of Exam : 3hrs

Module Blue Print For Question Paper Setting / Scrutiny									
Maximum Score: 30 Weightage									
Question Paper			Syllabus						
Sections or Parts	W/g	Question Numbers	MODULE:I	MODULE:II	MODULE:III	MODULE:IV	MODULE:V	MODULE:VI	MODULE:VII	MODULE:VIII
			Hour:13	Hour:14	Hour:18	Hour:12	Hour:12	Hour:12	Hour:12	Hour:15
			score:8	score:7	score:7	score:5	score:7	score:6	score:7	score:8
Expected Marks >>>>										
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weightage			55							

FIRST SEMESTER M.Sc. (CSS) DEGREE EXAMINATION
BOT1C01:PHYCOLOGY, BRYOLOGY, PTERIDOLOGY & GYMNOSPERMS

Time:3hrs **Max. weightage: 30**

I Give short answers to any four of the following: (4×2=8 weightage)

1. Describe diatomaceous earth
2. Distinguish between haplontic and diplontic life cycle
3. General account of fossil bryophytes and their affinities
4. Differentiate between apospory and apogamy
5. Explain polyploidy in pteridophytes
6. Explain ovuliferous scale of coniferales and its significance
7. Briefly explain Chamberlain's system of classification

II Answer any four of the following in paragraph: (4×3=12 weightage)

8. General account of energy source and pigments
9. Briefly explain conjugation in conjugales
10. Explain stelar evolution in pteridophyte
11. Give an account of Indian pteridologists and their contribution
12. Explain the features of pteridospermales
13. Outline the interrelationships of cordaitales
14. Economic importance of pteridophytes

III Write essay on any two of the following: (2×5=10 weightage)

15. Describe thallus organisation and evolutionary trends in chlorophyceae
16. Explain origin and evolution of gametophyte and sporophyte in bryophytes
17. Explain origin and evolution of sporangium in pteridophytes
18. Comment on geological history and origin of gymnosperms

PATTERN OF QUESTION PAPER (MSc BOTANY)
SEMESTER: 1

CODE: BOT1C02: MYCOLOGY & LICHENOLOGY, MICROBIOLOGY AND PLANT PATHOLOGY

Contact Hours per Week :6
Number of Credits : 9
Number of Contact Hours : 72
Course Evaluation : External 30 Weightage + Internal 5 Weightage
Duration of Exam : 3hrs

Module Blue Print For Question Paper Setting / Scrutiny										
Maximum Score: 30 Weightage										
Question Paper			Syllabus							
Sections or Parts	W/g	Question Numbers	MODULE:I	MODULE:II	MODULE:III	MODULE:IV	MODULE:V	MODULE:VI	MODULE:VII	MODULE:VIII
			Hour:15	Hour:15	Hour:15	Hour:9	Hour:16	Hour:20	Hour:12	Hour:6
			score:10	score:8	score:7	score:5	score:7	score:8	score:7	score:3
Expected Marks >>>>										
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weightage>>>>			55							

FIRST SEMESTER M.Sc. (CSS) DEGREE EXAMINATION
BOT01C02: MYCOLOGY & LICHENOLOGY, MICROBIOLOGY & PLANT PATHOLOGY

Time: 3 hrs **Max. Weightage: 30**

I Give short answers to any four of the following: (4×2=8 weightage)

1. Explain VAM with its significance.
2. Comment on parasexuality.
3. Enumerate the ecological & economic importance of lichens.
4. Explain the salient features of Cyanobacteria.
5. Differentiate between Archaebacteria and Eubacteria.
6. Explain the bacterial cell wall.
7. Describe on Iatrogenic diseases.

II Answer any four of the following in paragraph: (4×3=12 weightage)

8. General account on Basidiomycota with examples.
9. Give a general account and systematic of lichen thallus.
10. Explain about fungal nutrition.
11. What are the subviral agents? Explain their characteristics.
12. Write a note on Bacterial genetics.
13. Write a note on biofertilizers.
14. Write a short note on plant disease management.

III Write essay on any two of the following: (2×5=10 weightage)

15. Explain the Alexopoulos system of classification and comment on phylogeny of fungi.
16. Give details on fungal decomposition of organic matter.
17. Give a detailed account on microbiology of fermented food.
18. Explain about various defense mechanisms in plants.

PATTERN OF QUESTION PAPER (MSc BOTANY)
SEMESTER: 1

CODE: BOT1C03: ANGIOSPERM ANATOMY, ANGIOSPERM EMBRYOLOGY, PALYNOLOGY AND LAB TECHNIQUE

Contact Hours per Week :6
Number of Credits : 9
Number of Contact Hours : 72
Course Evaluation : External 30 Weightage + Internal 5 Weightage
Duration of Exam : 3hrs

Module Blue Print For Question Paper Setting / Scrutiny										
Maximum Score: 30 Weightage										
Question Paper			Syllabus							
Sections or Parts	W/g	Question Numbers	MODULE:I	MODULE:II	MODULE:III	MODULE:IV	MODULE:V	MODULE:VI	MODULE:VII	MODULE:VIII
			Hour:12	Hour:12	Hour:12	Hour:8	Hour:20	Hour:8	Hour:18	Hour:18
			score:8	score:7	score:5	score:5	score:9	score:6	score:7	score:8
Expected Marks >>>>										
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Weightage>>>>			55							

FIRST SEMESTER M.Sc. (CSS) DEGREE EXAMINATIONS
BOT01 CT03: ANGIOSPERM ANATOMY, ANGIOSPERM EMBRYOLOGY, PALYNOLOGY AND LAB TECHNIQUES

Time: 3 hrs **Max. Weightage: 30**

I Give short answers to any four of the following: (4×2=8 weightage)

1. Give a brief account on sieve tube differentiation.
2. Explain the secondary growth in leaf trace.
3. Comment on taxonomical relation of angiosperm anatomy.
4. Role of tapetum in pollen development.
5. Describe the role of synergids in fertilization.
6. Explain the significance of pollen - pistil interaction.
7. What are the significance of mellitopalynology?

II Answer any four of the following in paragraph: (4×3=12 weightage)

8. Role of cambium in wound healing and grafting.
9. Explain the anomalous secondary growth in Dicots.
10. Comment on wood anatomy.
11. Write a note on polyembryony and its significance.
12. Comment on apomixes with special emphasis to its genetics.
13. Explain heterospory and male gametophyte development.
14. Give a short note on Fuelgen reaction.

III Write essay on any two of the following: (2×5=10 weightage)

15. Elucidate the ultra-structure of cell wall.
16. An Essay on about endosperm and development of haustoria.
17. Comment on recent advances in palynological studies.
18. Explain the different types of microtomes.

PATTERN OF QUESTION PAPER (MSc BOTANY)
SEMESTER: 2

CODE: BOT2C04: CELL BIOLOGY, MOLECULAR BIOLOGY AND BIOPHYSICS.

Contact Hours per Week :6
Number of Credits : 9
Number of Contact Hours : 72
Course Evaluation : External 30 Weightage + Internal 5 Weightage
Duration of Exam : 3hrs

Module Blue Print For Question Paper Setting / Scrutiny									
Maximum Score: 30 Weightage									
Question Paper			Syllabus						
Sections or Parts	W/g	Question Numbers	MODULE:I	MODULE:II	MODULE:III	MODULE:IV	MODULE:V	MODULE:VI	MODULE:VII	MODULE:VIII
			Hour:17	Hour:17	Hour:11	Hour:15	Hour:18	Hour:12	Hour:9	Hour:9
			score:8	score:7	score:5	score:10	score:10	score:5	score:5	score:5
Expected Marks >>>>										
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Weightage>>>>			55							

SECOND SEMESTER M.Sc. (CSS) DEGREE EXAMINATION BOT2C04. CELL BIOLOGY, MOLECULAR BIOLOGY AND BIOPHYSICS

Time: 3 hrs **Max. Weightage: 30**

I Give short answers to any four of the following: (4×2=8 weightage)

1. What is Heterochromatin?
2. Explain Signaling molecules and their receptors.
3. Molecular mechanism of cellular differentiation.
4. Define Telomerase and its function.
5. Briefly describe Genetic code.
6. Write a note on Molecular mechanism of mutation.
7. A Note on Principles and types of Autoradiography.

II Answer any four of the following in paragraph: (4×3=12 weightage)

8. Write on Meiosis types and significance.
9. Describe cell cycle, its control and significance.
10. Comment on Genetic basis of malignant transformation.
11. Describe Structure of DNA.
12. Briefly explain Regulation of gene expression in prokaryotes and eukaryotes.
13. Write a note on DNA damage and repairing mechanisms.
14. Explain Principles and types of ELISA.

III Write essay on any two of the following: (2×5=10 weightage)

15. Enumerate Apoptosis and its significance.
16. Describe DNA replication in prokaryotes .Give enzymes of replication.
17. Broadly explain protein synthesis.
18. Write an essay on Centrifugation-theory of centrifugation, types, methodology and its applications.

PATTERN OF QUESTION PAPER (MSc BOTANY)
SEMESTER: 2

CODE: BOT2C05: CYTOGENETICS, GENETICS, BIOSTATISTICS, PLANT BREEDING AND EVOLUTION.

Contact Hours per Week :6
Number of Credits : 9
Number of Contact Hours : 72
Course Evaluation : External 30 Weightage + Internal 5 Weightage
Duration of Exam : 3hrs

Module Blue Print For Question Paper Setting / Scrutiny										
Maximum Score: 30 Weightage										
Question Paper			Syllabus							
Sections or Parts	W/g	Question Numbers	MODULE:I	MODULE:II	MODULE:III	MODULE:IV	MODULE:V	MODULE:VI	MODULE:VII	MODULE:VIII
			Hour:18	Hour:12	Hour:8	Hour:7	Hour:12	Hour:15	Hour:18	Hour:18
			score:5	score:7	score:5	score:3	score:7	Score:8	Score:10	score:10
Expected Marks >>>>										
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Weightage>>>>			55							

SECOND SEMESTER M.Sc. (CSS) DEGREE EXAMINATION
BOT2C05 CYTOGENETICS, GENETICS, BIOSTATISTICS, PLANT BREEDING AND EVOLUTION

Time: 3 hrs **Max. Weightage: 30**

I Give short answers to any four of the following: (4×2=8 weightage)

1. Define B-Chromosomes
2. Describe Tetrad analysis
3. Briefly describe Relevance of Mendelism in modern genetics.
4. Note on Coefficient of variation
5. Explain Experimental designs
6. write a note on IPR
7. Explain Micro and macro evolution

II Answer any four of the following in paragraph: (4×3=12 weightage)

8. Differentiate the role of aneuploidy and euploidy in evolution.
9. Briefly explain Genetic recombination and mapping of genes in bacteria and bacteriophages.
10. Give a note on Human pedigree analysis.
11. Comment on Statistical softwares
12. What is Probability distributions
13. Write a note on Plant introduction agencies in India
14. Explain Evolution at the molecular level

III Write essay on any two of the following: (2×5=10 weightage)

15. Write an essay on mobile genetic elements with examples
16. Enumerate Test of significance with Special reference to Z-test and Chi -square test
17. Describe Resistance breeding and give a brief account on disease, pest, and stress resistance with achievements
18. Explain Plant-Animal co-evolution

PATTERN OF QUESTION PAPER (MSc BOTANY)
SEMESTER: 2

CODE: BOT2C06: PLANT ECOLOGY, CONSERVATION BIOLOGY, PHYTOGEOGRAPHY AND FOREST BOTANY

Contact Hours per Week :6
Number of Credits : 9
Number of Contact Hours : 72
Course Evaluation : External 30 Weightage + Internal 5 Weightage
Duration of Exam : 3hrs

Module Blue Print For Question Paper Setting / Scrutiny										
Maximum Score: 30 Weightage										
Question Paper			Syllabus							
Sections or Parts	W/g	Question Numbers	MODULE:I	MODULE:II	MODULE:III	MODULE:IV	MODULE:V	MODULE:VI	MODULE:VII	MODULE:VIII
			Hour:12	Hour:12	Hour:12	Hour:12	Hour:12	Hour:12	Hour:18	Hour:18
			score:5	score:5	score:7	score:5	score:8	Score:5	Score:10	score:10
Expected Marks >>>>										
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Weightage>>>>			55							

SECOND SEMESTER M.Sc. (CSS) DEGREE EXAMINATION
BOT2C06 PLANT ECOLOGY, CONSERVATION BIOLOGY, PHYTOGEOGRAPHY & FOREST BOTANY

Time: 3 hrs **Max. Weightage: 30**

I Give short answers to any four of the following: (4×2=8 weightage)

1. Explain Energy Flow Model.
2. What is Carrying Capacity?
3. Write Notes on EIA.
4. Describe Flagship species.
5. Name any 4 National heritages.
6. Briefly describe Circum austral distribution.
7. Write a note on Evergreen Forest.

II Answer any four of the following in paragraph: (4×3=12 weightage)

8. Explain the methods of productivity measurements.
9. Comment on different population interactions.
10. Differentiate between in-situ and ex-situ conservation with Examples.
11. Describe MAB and IBP.
12. Write a note on Role of NGOs.
13. Explain Theory of continental drift.
14. Write on major and minor forest products

III Write essay on any two of the following: (2×5=10 weightage)

15. Write an essay on Threats to global environment.
16. Enumerate Environment Protection Acts.
17. Describe Phytochoria of World.
18. Explain various types of Forest in India.

PATTERN OF QUESTION PAPER (MSc BOTANY)
SEMESTER: 3

CODE: BOT3C07: PLANT PHYSIOLOGY, METASBOLISM AND BIOCHEMISTRY

Contact Hours per Week :6
Number of Credits : 9
Number of Contact Hours : 72
Course Evaluation : External 30 Weightage + Internal 5 Weightage
Duration of Exam : 3hrs

Module Blue Print For Question Paper Setting / Scrutiny										
Maximum Score: 30 Weightage										
Question Paper			Syllabus							
Sections or Parts	W/g	Question Numbers	MODULE:I	MODULE:II	MODULE:III	MODULE:IV	MODULE:V	MODULE:VI	MODULE:VII	MODULE:VIII
			Hour:12	Hour:12	Hour:12	Hour:9	Hour:14	Hour:13	Hour:18	Hour:18
			score:7	score:8	score:7	score:3	score:7	Score:5	Score:8	score:10
Expected Marks >>>>										
A	2	1	2							
		2			2					
		3			2					
		4					2			
		5						2		
		6							2	
		7								2
B	3	8		3						
		9			3					
		1(				3				
		1						3		
		1							3	
		1							3	
		1								3
C	5	1	5							
		1(		5						
		1					5			
		1								5
Weightage>>>>			55							

THIRD SEMESTER M.Sc. (CSS) DEGREE EXAMINATION
BOT3C07 PLANT PHYSIOLOGY, METABOLISM AND BIOCHEMISTRY

Time: 3 hrs **Max. Weightage: 30**

I Give short answers to any four of the following: (4×2=8 weightage)

1. Explain GS/GOGAT Pathway.
2. Short notes on Cryptochrome and their action.
3. Discuss the Role of vitamins in plant growth.
4. Point out involvement of NDP sugars.
5. Explain regulation of oxidative phosphorylation.
6. Short notes on Functions of nucleotides.
7. Differentiate between denaturation and renaturation of protein.

II Answer any four of the following in paragraph: (4×3=12 weightage)

8. Explain translocation of xenobiotics.
9. Discuss the genetic control of plant development.
10. Give the importance of amphibolic pathway and anapleurotic reactions.
11. Write notes on Shuttle systems.
12. Explain Classification of carbohydrates.
13. Write an account on lipids in membranes and supramolecular architecture.
14. Write notes on functions of proteins

III Write essay on any two of the following: (2×5=10 weightage)

15. Write an essay on absorption of mineral ions.
16. Differentiate between C3 and C4 cycle and explain their ecological significance.
17. Explain TCA Cycle and its regulation.
18. Discuss the Structure of proteins.

PATTERN OF QUESTION PAPER (MSc BOTANY)
SEMESTER: 3

CODE: BOT3C08: ANGIOSPERM MORPHOLOGY, TAXONOMY AND PLANT RESOURCES

Contact Hours per Week :6
Number of Credits : 9
Number of Contact Hours : 72
Course Evaluation : External 30 Weightage + Internal 5 Weightage
Duration of Exam : 3hrs

Module Blue Print For Question Paper Setting / Scrutiny										
Maximum Score: 30 Weightage										
Question Paper			Syllabus							
Sections or Parts	W/g	Question Numbers	MODULE:I	MODULE:II	MODULE:III	MODULE:IV	MODULE:V	MODULE:VI	MODULE:VII	MODULE:VIII
			Hour:18	Hour:14	Hour:14	Hour:14	Hour:14	Hour:16	Hour:12	Hour:6
			score:13	score:5	score:5	score:7	score:5	Score:8	Score:7	score:5
Expected Marks >>>>										
A	2	1	2							
		2		2						
		3			2					
		4				2				
		5					2			
		6							2	
		7							2	
B	3	8	3							
		9	3							
		1(		3						
		1			3					
		1					3			
		1						3		
		1							3	
C	5	1	5							
		1(				5				
		1						5		
		1								5
Weightage>>>>			55							

THIRD SEMESTER M.Sc. (CSS) DEGREE EXAMINATION
BOT3C08: ANGIOSPERM MORPHOLOGY, TAXONOMY AND PLANT RESOURCES

Time: 3 hrs **Max. Weightage: 30**

I Give short answers to any four of the following: (4×2=8 weightage)

1. Explain Foliar and axial concept of placentation
2. Differentiate Phenetic and Phylogenetic system in classification
3. Define homology and analogy
4. Briefly describe Rule of priority and limitations
5. Short note on Correlation of characters
6. Any two fibre yielding plant, scientific name, family and useful part
7. Any two timber yielding plant scientific name, family

II Answer any four of the following in paragraph: (4×3=12 weightage)

8. Explain The concept of primitive angiosperm flower
9. Describe Origin and evolution of nectarines and nectar
10. Comment on Conceptual basis of classification
11. Write a note on Taxonomic hierarchy
12. Write an account on Molecular taxonomy and DNA barcoding in plants
13. Explain the Classification of taxonomic literature
14. Give a note on Binomial and Morphology of pulses

III Write essay on any two of the following: (2×5=10 weightage)

15. Write an essay on Role of floral anatomy in interpreting the origin and evolution of flower and floral part
16. Explain Salient features and major provision of the ICN
17. Write an essay on National and international Botanical Gardens
18. Enumerate Medicinal plants and their Pharmacognosic property

PATTERN OF QUESTION PAPER (MSc BOTANY)
SEMESTER: 3

CODE: BOT3C09: BIOTECHNOLOGY AND BIOINFORMATICS

Contact Hours per Week :6
Number of Credits : 9
Number of Contact Hours : 72
Course Evaluation : External 30 Weightage + Internal 5 Weightage
Duration of Exam : 3hrs

Module Blue Print For Question Paper Setting / Scrutiny										
Maximum Score: 30 Weightage										
Question Paper			Syllabus							
Sections or Parts	W/g	Question Numbers	MODULE:I	MODULE:II	MODULE:III	MODULE:IV	MODULE:V	MODULE:VI	MODULE:VII	MODULE:VIII
			Hour:10	Hour:17	Hour:13	Hour:14	Hour:8	Hour:24	Hour:15	Hour:7
			score:5	score:5	score:7	score:10	score:2	Score:13	Score:8	score:5
Expected Marks >>>>										
A	2	1	2							
		2		2						
		3			2					
		4				2				
		5					2			
		6						2		
		7							2	
B	3	8	3							
		9		3						
		1(				3				
		1						3		
		1							3	
		1						3		
		1							3	
C	5	1			5					
		1(				5				
		1						5		
		1								5
Weightage>>>>			55							

THIRD SEMESTER M.Sc. (CSS) DEGREE EXAMINATION
BOT3C09- BIOTECHNOLOGY AND BIOINFORMATICS

Time: 3 hrs **Max. Weightage: 30**

I Give short answers to any four of the following: (4×2=8 weightage)

1. Explain Culture media
2. What is Organogenesis and explain factors affecting it
3. Differentiate RAPD and RFLP
4. Briefly describe Antisense RNA technology
5. Note on Free software foundation
6. Describe Protein structure databases
7. Comment on Human genome project

II Answer any four of the following in paragraph: (4×3=12 weightage)

8. Briefly explain cell culture
9. Write a note on Applications of plant tissue culture
10. Explain Human cloning and also write about ethics of cloning
11. Comment on Multiple sequence alignment
12. Describe Protein structure prediction
13. Give a note on Nucleic acid sequence databases
14. Short note on Chromosome walking and jumping

III Write essay on any two of the following: (2×5=10 weightage)

15. Write an essay on Tools used in rDNA technology
16. Give a note on Patenting of genes and GMOs
17. Enumerate Scope and relevance of bioinformatics
18. Explain Emerging areas of Bioinformatics

PATTERN OF QUESTION PAPER (MSc BOTANY)
SEMESTER: 4

CODE: BOT4E01- ELECTIVE 1 (ENVIRONMENTAL BIOLOGY AND BIODIVERSITY CONSERVATION)

Contact Hours per Week :6
Number of Credits : 9
Number of Contact Hours : 72
Course Evaluation : External 30 Weightage + Internal 5 Weightage
Duration of Exam : 3hrs

Module Blue Print For Question Paper Setting / Scrutiny										
Maximum Score: 30 Weightage										
Question Paper			Syllabus							
Sections or Parts	W/g	Question Numbers	MODULE:I	MODULE:II	MODULE:III	MODULE:IV	MODULE:V	MODULE:VI	MODULE:VII	MODULE:VIII
			Hour:10	Hour:10	Hour:12	Hour:12	Hour:20	Hour:16	Hour:18	Hour:10
			score:8	score:2	score:10	score:5	score:7	Score:10	Score:10	score:3
Expected Marks >>>>										
A	2	1					2			
		2		2						
		3			2					
		4				2				
		5					2			
		6						2		
		7							2	
B	3	8	3							
		9			3					
		10				3				
		11					3			
		12						3		
		13							3	
		14								3
C	5	15	5							
		16			5					
		17						5		
		18							5	
Weightage>>>>			55							

FOURTH SEMESTER M.Sc. (CSS) DEGREE EXAMINATION
BOT4E01 ELECTIVE 1 (ENVIRONMENTAL BIOLOGY AND BIODIVERSITY CONSERVATION)

Time: 3 hrs **Max. Weightage: 30**

I Give short answers to any four of the following: (4×2=8 weightage)

1. Discuss about Cairo conference (1994).
2. Mention about Kyoto protocol.
3. Enumerate the contributions of Rachel Carson and Edward O Wilson.
4. Describe agrobiodiversity.
5. Comment on virtual libraries.
6. Comment on forest biome.
7. Mention about deep ecology.

II Answer any four of the following in paragraph: (4×3=12 weightage)

8. Explain about r and K selection.
9. Describe the national environment protection acts.
10. Mention about the contributions of Indian ecologists.
11. Discuss the conservation practices employed in Biodiversity.
12. Comment on wetlands and forest types of Kerala.
13. Explain the role of NGOs and educational institutions in biodiversity conservation.
14. Describe the basic aspects of disaster management.

III Write essay on any two of the following: (2×5=10 weightage)

15. Discuss about the types of interactions among species.
16. Explain the major global environmental challenges.
17. Describe about ecosystem capital, its use and restoration.
18. Discuss about ecotourism with special reference to Kerala.

PATTERN OF QUESTION PAPER (MSc BOTANY)
SEMESTER: 4

CODE: BOT4E02. ELECTIVE 2 (GENETIC ENGINEERING)

Contact Hours per Week :6
Number of Credits : 9
Number of Contact Hours : 72
Course Evaluation : External 30 Weightage + Internal 5 Weightage
Duration of Exam : 3hrs

Module Blue Print For Question Paper Setting / Scrutiny										
Maximum Score: 30 Weightage										
Question Paper			Syllabus							
Sections or Parts	W/g	Question Numbers	MODULE:I	MODULE:II	MODULE:III	MODULE:IV	MODULE:V	MODULE:VI	MODULE:VII	MODULE:VIII
			Hour:10	Hour:10	Hour:12	Hour:12	Hour:20	Hour:16	Hour:18	Hour:10
			score:3	score:5	score:7	score:5	score:10	Score:10	Score:10	score:5
Expected Marks >>>>										
		1		2						
		2			2					
		3				2				
		4					2			
		5						2		
		6							2	
A	2	7								2
		8	3							
		9		3						
	3	1(				3				
B		1					3			
		1						3		
		1							3	
		1								3
		1			5					
C	5	1(					5			
		1						5		
		1							5	
Weightage>>>>			55							

FOURTH SEMESTER M.Sc. (CSS) DEGREE EXAMINATION
BOT4E02. ELECTIVE 2 (GENETIC ENGINEERING)

Time: 3 hrs **Max. Weightage: 30**

I Give short answers to any four of the following: (4×2=8 weightage)

1. Explain PCR and its methodology.
2. Comment on DNA profiling.
3. Write notes on RAMPO and SSCP.
4. Discuss about linkers and adaptors.
5. What is colony and dot blot hybridization?
6. Comment on production of vaccines and drugs using genetic engineering.
7. Explain gene therapy.

II Answer any four of the following in paragraph: (4×3=12 weightage)

8. Describe the different blotting techniques.
9. Mention about the types involved in variations of PCR.
10. Describe in detail RFLP, RAPD and AFLP.
11. Describe the enzymes used in genetic engineering.
12. Explain the selection and screening of recombinant clones.
13. What is GMO? Comment on its hazards, impact and related ethical issues.
14. Comment on nano-biotechnology and its medical applications.

III Write essay on any two of the following: (2×5=10 weightage)

15. Describe DNA sequencing and the different methods employed in sequencing.
16. Explain the different cloning vectors used in recombinant DNA technology.
17. Describe the different gene transfer techniques employed in plants.
18. Describe the application of genetic engineering in crop improvement.

AUDIT COURSE

Audit Courses (To be completed within the first three semesters by the students- Evaluation is 100% internal based on Examination /Test (40%) + Seminar / Presentation (30%) + Written assignment (30%) **and the marklists are to be forwarded to the university by the end of the third semester)**				
ACIAEC	Ability Enhancement Course: Scientific Documentation and Report writing	100%	0%	4
AC2PCC	Professional Competency Course: Intellectual Property Rights	100%	0%	4

ACIAEC: Ability Enhancement Course: Scientific Documentation and Report writing

1. Collection of scientific literature from secondary and primary sources.
2. Preparation of literature reviews and review papers- structure and components
3. Preparation of research papers- structure and components
4. Scientific conduct, ethics, authorship issues, plagiarism, citation and acknowledgement. Importance of language and
5. Effective communication.
6. Presenting a paper in a scientific seminar- oral and poster presentation
7. Preparation of oral presentations
8. Preparation of scientific posters

AC2PCC: Professional Competency Course: Intellectual Property Rights

1. Introduction to intellectual property right (IPR) - Concept and kinds. Economic importance. IPR in India and world. IPR and WTO (TRIPS, WIPO).

2. Patents- Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents- Working of patents. Infringement.

3. Copyrights- Introduction. Works protected under copyright law. Transfer of Copyright. Infringement. Trademarks- Objectives, Types, Rights. Protection of goodwill. Infringement.

4. Geographical Indications- Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian position.

5. Protection of Traditional Knowledge- Objective, Concept, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy, Alternative ways, Protectability, Traditional knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.

6. Protection of Plant Varieties- Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

7. Biotechnology and Intellectual Property Rights- Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions