File Ref.No.2911/GA - IV - J1/2013/CU

UNIVERSITY OF CALICUT

Abstract

General and Academic - Faculty of Science- Scheme and Syllabus of MSc Botany Programme for affiliated colleges w.e.f 2020 Admission onwards -Incorporating Outcome Based Education- Implemented - Subject to ratification by Academic Council -Orders Issued

G & A - IV - J

U.O.No. 5578/2021/Admn Dated, Calicut University.P.O, 26.05.2021

Read:-1. U.O.No. 8867/2019/Admn, Dated 05.07.2019
2. E-mail dated 12.04.2021 from the Chairperson, Board of Studies in Botany PG.
3. Remarks of the Dean, Faculty of Science, Dated 21.05.2021.
4. Orders of the Vice-chancellor in the file of even no, Dated 24.05.2021.

ORDER

1. The scheme and syllabus of M.Sc Botany Programme for affiliated colleges under CBCSS PG Regulations 2019, w.e.f 2019 admission onwards has been implemented in the University, vide paper read (1) above.
2. Vide paper read (2) above, the Chairman, Board of Studies in Botany (PG), forwarded the scheme and syllabus of M.Sc Botany programme incorporating Outcome Based Education (OBE), in accordance with CBCSS PG Regulations 2019, with effect from 2020 Admission onwards, after circulating among the members of the Board, as per Clause (34) of Chapter 3 of Calicut University First Statutes (CUFS)1976.
3. The scheme and syllabus of M.Sc Botany Programme, incorporating Outcome Based Education (OBE) in the existing syllabus has been approved by the Dean, Faculty of Science, vide paper read (3) above and by the Vice Chancellor, subject to ratification by the Academic Council, vide paper read (4) above.
4. The scheme and syllabus of M.Sc Botany Programme, incorporating Outcome Based Education (OBE) in the existing syllabus, in accordance with CBCSS PG Regulations 2019, is therefore implemented, with effect from 2020 Admission onwards, subject to ratification by the Academic Council.
5. Orders are issued accordingly.
6. U.O.No. 8867/2019/Admn Dated, 05.07.2019 stands modified to this extent. (modified syllabus appended).

Ajitha P.P

Joint Registrar

To

The Principals of Affiliated Colleges

Copy to: PS to VC/PA to PVC/PA to R/PA to CE/JCEI/JCE V/SF/DF/FC

Forwarded / By Order

Section Officer

UNIVERSITY OF CALICUT

SYLLABUS

For

M.Sc. Botany

(CBCSS PG 2019)

Under Choice Based Credit Semester System

(w.e.f. 2020 Admission)

Board of Studies in Botany PG

University of Calicut

UNIVERSITY OF CALICUT				
M.Sc. Programme in Botany (CBCSS) (from 2020 admissions onwards)				
Programme, structure of courses and distribution of credits				
Course	Title	Credits		
		Internal	External	Total credits
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, Angiosperm Embryology, Palynology and Lab Techniques	20%	80%	5
BOT1L01	Practicals of Phycology, Bryology, Pteridology, Gymnosperms, Mycology andLichenology	20%	80%	2.5
BOT1L02	Practicals of Microbiology, Plant Pathology, Angiosperm Anatomy, Angiosperm 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 andCytogenetics	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, Angiosperm Taxonomy and Plant Resources	20%	80%	5
BOT3C09	Biotechnology and Bioinformatics	20%	80%	5
BOT3L05	Practicals of Plant Physiology, Metabolism, Biochemistry, Angiosperm Morphology andAngiosperm Taxonomy	20%	80%	2.5
BOT3L06	Practicals of Plant Resources, Biotechnology and Bioinformatics	20%	80%	2.5
Semester IV				
BOT4E01	Elective I	20%	80%	5
BOT4E02	Elective II	20%	80%	5
BOT4L07	Practicals of Electives	20%	80%	2
BOT4D01	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	100%	0%	4
AC2PCC	Professional Competency Course	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				

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 /

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 progrmmes. 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 University during the Third Semester as per the notification of theUniversity.

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:

SI.No	Component	Percentage |Weightage
1	Examination/Test	40%
2	Seminars/Presentation	20%
3	Assignment	20%
4	Attendance	20%

(b) Practical :

1	LabSkill	40%
2	Records	30%
3	PracticalTest	30%

(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 thecourse

teacher. All the records of Continuous Assessment (CA) must be kept in the college and must be made available for verification by university, if asked for.)

EXTERNAL / END SEMESTER EVALUATION (ESE)

The semester-end examinations in theory courses shall be conducted by the University with question papers set by external experts. The evaluation of the answer scripts shall be done by examiners based on a well-defined scheme of valuation. 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 University. Students shall have the right to apply for revaluation or scrutiny as per rules within the time permitted for it. 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 one external examiner and one internal examiner 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 away 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. Practicals

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 examination 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
1	Relevance of the topic	10	3
2	Methodology & Analysis	40	12
3	Discussion	10	3
4	Viva Voce (on the project)	40	12
	Total	100	30

COMPREHENSIVE VIVA-VOCE

There shall be an External Comprehensive Viva-Voce at the end of the IVth Semester. The External Viva Voce shall be conducted by one External Examiner appointed by the University 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 astudent 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.

AIMS AND OBJECTIVES OF THE PROGRAMME

1. The fundamental objective of the curriculum is to impart effective education at the Postgraduate level, exposing them to recent trends and developments in the subject.
2. Clear, comprehensive and advanced mastery in the field of Botany.
3. Creating scientific temper is another major objective of this curriculum. Incorporating research components along with deep study in the subject enables students to develop independent creative thinking.
4. Understand the scope and significance of the discipline.
5. Understand the advanced areas of biological sciences with special reference to Botany and its applied branches.
6. Imbibe love and curiosity towards nature through the living plants.
7. Ability to suggest innovative programs to care for nature and life for sustainable development.
8. In order to make students open-minded and curious, we try our best to enhance and develop a scientific attitude.
9. We make the students fit for the society by enabling them to work hard.
10. Make the students exposed to the diverse life forms.
11. The curriculum is meant to inspire creativity and combine passion with critical thinking skills in students who one day will be the citizens working to convert the world to more sustainable systems.
12. Make them skilled in practical work, experiments, laboratory equipment and to interpret correctly on biological materials and data.
13. Develop interest in Biological research.
14. Develop a thirst to preserve the natural resources and environment.
15. Develop the ability for the application of acquired knowledge in various fields of life so as to make our country self-sufficient
16. Another major thrust given here is to develop an environmental concern in all activities of the students.
17. Appreciate and apply ethical principles to biological science research and studies.

PROGRAMME OUTCOMES

1. **Critical Thinking with Scientific Temper**: Frame students' thinking and actions in such way to check out the degree to which the assumptions are accurateand valid with a research mind, and looking at their ideas and decisions (intellectual, organizational, and personal)from different perspectives.

2. **Research aptitude:** Enhanced observations kindle research aptitude which ultimately lead to additions to the existing knowledge base
3. **Effective Scientific Communication**: Read, write, listen and disseminate plant science with research knowledge, in person and through scientific platforms and journals.

4. **Problem Solving**: Understand and solve the problems with reference to Nature and society to meet the specified needs using the knowledge, skills and attitudes acquired.

5. **Effective Citizenship**: Demonstrate empathetic environmental and social concern for equity centered global development, and develop the ability to act with an informed awareness of issues and participate incivic life through volunteering.

5. **Environment and Sustainability**: Understand the issues of environmental contexts and sustainable development at global level.

6. **Independent and Life-long Learning**: Acquire the ability to engage in independent learning through research and lifelong learning in the broadest context of socio-technological changes

PROGRAMME SPECIFIC OUTCOMES (PSOs)

- After completing the PG course in Botany, the students will be able to acquire competency in the area of plant biology.
- Will be competent in differentiating the diverse groups of plants and microbes
- Will be well versatile in understanding the importance of nature and natural ecosystems along with sustainable utilization of natural resources for the betterment of humankind.
- Will have a sound understanding in the cultivation process of crop plants, its diseases and managing the diseases.
- Will be trained in acquiring the problem solving skills in environmental monitoring and pollution control measures
- Understand the importance of biodiversity conservation
- Gain knowledge in understanding the importance of research, its methodology, use of library & digital resources
- The use of sophisticated equipments and to demonstrate analytical ability to tackle the scientific research problems and also to maintain a high level of botanical research.
- Acquire the ability to understand life processes at cellular as well as molecular level
- Acquire core competency in distinguishing the internal structure of various groups of plants and knows the concept, process, physiology of plant development.

DETAILED SYLLABUS

BOT1 C01. PHYCOLOGY, BRYOLOGY, PTERIDOLOGY AND GYMNOSPERMS (1.5+1+2+1.5 = 6 hours per week)

Phycology

1. Classification of Algae-comparative Survey of important systems-Fritsch-Smith-Round.Criteria for algal classification-Phylogenetic considerations.
2. Biological importance ofPlanktons.
3. Algal cytology-Basic ideas of cell features-Electron microscopic studies of algal cell, cell wall,flagella, chloroplast, pyrenoid, eyespot- their importance in classification.
4. Reproduction-Different types of life cycles in algae.
5. General account of energy sources and pigments inalgae.
6. Economicimportanceofalgae-Rollofalgaeinsoilfertility,algaeinindustry-Biologica limportance of phyto planktons and waterblooms.
7. General account of thallus structure, cell ultra-structure, reproduction, relationships andevolutionary trends in the following'groups: Chlorophyta, Xanthophyta, Bacillariophyta, Phaeophyta,Rhodophyta.

References:
1. Fritsch, F.E. The structure and Reproduction ofAlgae.
2. Smith, G.M. Manual ofPhycology
3. Round, F.E, The Biology ofAlgae.
4. Pold and Wyane. Introduction ofAlgae.

Bryology

1. General characters and systems of classifications of Bryophytes
2. General account of the anatomy, reproduction, life history and phylogeny of Sphaerocarpales, Marchantiales, Jungermanniales, Calobryales, Anthocerotales, Sphagnales, Andreales, Funariales and Polytrichales
3. Origin and evolution of Bryophytes- gametophytic andsporophytic.
4. A general account of fossil Bryophytes and theiraffinities.
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.l&II. ChronicaBotanica
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. Mannual of Bryology. Ashor& Co.,Amsterdam.
7. Shaw, J. and Goffinet, B. Bryophyte Biology. Cambridge University Press.
8. Manju C. Nair, K.P. Rajesh and MadhusoodananP.V.Bryophytes of Wayanad in Western Ghats.
Malabar Natural History Society,Kozhikode.

Pteridology

1. General characters and life history of Pteridophytes.
2. Cytology of Pteridophytes- Chromosome number andpolyploidy.
3. Structure and evolution of stele inPteridophytes.
4. Origin and evolution of Sporangium.
5. Heterospory and seed habit.
6. Development and evolutionary trends in the Gametophytes of Pteridophytes.
7. Apogamy, Apospory and Parthenogenesis.
8. Classification of Pteridophytes: Holttum,Pichi-Sermolli.
9. Comparative morphology, ecology and phylogeny of the following:
a) Psilopsida :Rhyniales, Psilophytales and Psilotales
b) Lycopsida: Lycopodiales andlsoetales
c) Sphenopsida: Hyeniales, Pseudobomiales, Sphenophyllales, Calamitales and Equisetales.
d) Filicopsida: General account: Primofilicales, Ophioglossales, Marattiales, Osmundales, Schizaeales, Cyatheales, Gleicheniales, Marsileales and Salviniales.
10. Economic importance of Pteridophytes-Medícinal, Horticulture, Biofertilizer,weeds.
11. General account of the contribution of Indian pteridologists.
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Refercnces
1. Bierhost, D.W. Morphology of Vascular Plants. Mac Miilan Co., NewYork.
2. Dyer, A.C. The Experimenial Biology of Ferns. Academic Press,London.
3. Jermy, A.C. (Ed.): The phylogeny and Classification ofFerns.
4. Kramer, K.U. and Green, P.S. The Families and Genera of Vascular Plants. Narosa, NewDelhi.
5. Nampy, S. and Madhusoodanan, P.V. Fern Flora of South India-Taxonomic Revision of Polypodioid Ferns. Daya Publishing House, NewDelhi.
6. Abdul Hameed C., Rajesh K.P. and MadhusoodananP.V. Filmy Ferns of South India. Penta Book Publishers & Distributors, Calicut.
7. Azeez K., VenugopalakrishnaKurupV. and P.V. Madhusoodanan. Spleenworts (Aspleniaceae) of South lndia. Malabar Natural History Society,Calicut.
8. VenugopalakrishnaKurupV., Azeez K. and P.V. Madhusoodanan. Primitive Ferns of South India. 'V'Publishers, Kottayam.

Gymnosperms

1. Geological time scale and correlated predominant Gymnospermflora.
Classification of Gymnosperms- Chamberlain'ssystem.
2. Geologicalhorizons.Distribution,morphology,anatomy,reproductionandinterrelationshipofthe 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
3. Phylogenetic relationship ofGymnosperms.
4. Economic importance ofGymnosperms

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.Macmíllan.
4. Bower, F.O. Primitive Plants.Macmillan.
5. Chamberlain, C.J. Gymnosperms- Structure and Evölution. Univ. of Chicago Press.
6. Foster,A.S.&E.M.Gifford.Comparativemorphologyofvascularplants.Freeman.
7. Maheshwari, P &V. Vasil. Gnetum. CSIR, NewDelhi.
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 Fossilplants.

Course Outcomes:

1. Provideknowledge on the occurrence and evolution of plant groups like Algae, Bryophytes, Pteridophytes and Gymnosperms.
2. Develop understanding on the classification, nomenclature, diversity and distribution in these plant groupswith uptodate research knowledge.
3. Develop understanding on the range of variation in their structural and life cycle patterns, cellular organization and ecological / economic importance as separate plant groups.
4. Develop hands-on approaches to study algae, Bryophyte, Pteridophyte and Gymnosperm populations and their growth forms in the surrounding environment.

- Understand and distinguish the diverse group of algae
- Infer the economic value of different types of algae
- Outline the ecological significance of algae
- Build the skills for collection, identification and artificial culture of algae.
- Interpret different groups of Bryophytes and Pteridophytes
- Analyze the different theories regarding the origin of both Bryophytes and Pteridophytes and develop ideas regarding their evolution.
- Compare the structural evolution of gametophytes and sporophytes in both Bryophytes and Pteridophytes.
- Clarify organization of different types of steles, sori and sporangial characters in an evolutionary perspective
- Validate the ecological and economical roles played by both Bryophytes and Pteridophytes.
- Understand the classification of Gymnopserms
- Make use of the economic value of Gymnosperms
- Acquire the skills for field identification of Gymnosperms

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

Mycology

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.
2. Classification of fungi by Ainsworth &Bisby (1983), Alexopoulos et al. (1996)- Phylogeny of fungi- Characters used inclassification.
3. General account of Myxomycota, Mastigomycota, Zygomycota, Ascomycota, Basidiomycota and mitosporic fungi. Different kinds of spores and theirdispersal.
4. Fungi as saprophytes: details of the fungal decomposition of organic matter, coprophilous fungi, lignin degrading fungi, role of fungi in degradation ofpesticides.
5. Fungi as symbionts: Mycorrhiza – ectotrophic, orchidaceous and Ericoid mycorrhiza, Vesicular Arbuscular Mycorrhiza - their distribution and significance. Endophytes.
6. Lichenology: General account and systematics of lichens, thallus structure, reproductive bodies, ecological significance and economic importance of lichens.

References:
1. Alerxopoulos C.J., Mims, C.W. & Blackwell, M. lntroductory Mycology. 4th edition. John Wiley & Sonslnc.
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. EdwardAmolds.
4. Cariile, M. J. & Watkinson S.C. The Fungi. AcademicPress.
5. Deacon, J.W. Introduction to Modem Mycology.Blackwell.
6. Dubey, H.C. Anlntroduction 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 ScientifìcPublishers.
9. Mehrotra,R.S.&Aneja,K.R.AnlntroductióntoMycology.NewAgeInternationalPublishers.
10. Landecker, Elizabeth Moore. Fundamentals of Fungi. 4th Ed. PrenticeHall.
11. Nair, M.C. & Balakrishnan, S. Beneficial fungi and their utilization. Scientific Publishers, Jodhpur.
12. Nash, T.H. Lichen Biology. Cambridge UniversityPress.
13. Webster, John .lntroduction to Fungi. cambridge University Press.

Microbiology

1. Introduction - main groups of microorganisms and their characteristics -prions, viroids, viruses, bacteria, mycoplasmas andactinomycetes.
2. Bacteria - classification based on Bergey's Manuel. Archaeoacteria and Eubacteria. Morphology, ultra-structure,. nutrition,genetics
3. Plasmids and their characterization.
4. Cyanobacteria- salient features, morphology, ultrastructure, classification and economicimportance.
5. Viruses- General account of plant and animal viruses, bacteriophages and their classification. lsolation, purificatíon, infection, replication and transmisiion of plant virüses. Detailed study of TMV and T4Phage.6. Microbial ecology- microbiology of rhizosphere and phylloplane. Sewage disposal, bioremediation and.water purification. Detection of microbes in air and water.
7. Agricultural microbiology - management of agricultural soils, biofertilizers,biopesticides.
8. 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 cellprotein.
9. Industrial Microbiology - Production of alcohol, vinegar, antibiotics, vitamins, steroids, vaccines, organic acids, aminoacids.

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

Plant Pathology

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. Latrogenic diseases. Seedpathology.
2. Details of different symptoms of plantdiseases.
3. Process of infection- mechanical, physiological and enzymatic action. Penetration and entry of pathogens in to hosttissue.
4. Host- parasite interaction. Enzymes and toxins in pathogenesis. Defense mechanisms in plants (structural and biochemical).
5. Details of different ways of spread and transmission of plant diseases- wind and water-mediated, seed borne and vector borne.
6. Plant disease management- exclusion, eradication and protection. Different pesticides and fungicides and their application. Biocides in plant protection.
7. 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, Mahali of Arecanut, Powdery mildew of rubber, Abnormal leaf fall of rubber, tikka disease of Ground nut, Late blight of potato, Blister blight of tea, wheat rust, coffee rust, grey leaf spot of coconut, Phytophthora foot rot of pepper, rhizome rot of ginger and turmeric, angiospermic parasites-Viscum, Dendropthoe.

References

Agrios, G.N. Plant pathology. 4th Ed., Academic Press.
Bilgrami, K.H. & Dube, H C. A Text Book of Modem Plant Pathology. Vikas Publishers, New Delhi.
Chaube, H.S. & Ramji Singh . |ntroductory Plant Pathology. lnternational Book Distributing Co., Lucknow.
Gareth-Jones, D. Plant Pathology: Principles and Practice. Open University Press.
Horsfall J.G. & Cowling E. B. (Ed.). Plant Disease:An Advanced Treatise. Academic Press.
Lucas, J. A.. Plant Pathology and Plant pathogens. Blackwell.
Manners, J.G. Principles of Plant Pathology. Cambridge Univ Press.
Mehrotra, R.S. Plant Pathology. Tata Mc Graw Hill.
Pandey, B. P. Plant Pathology -pathogen and plant disease. S. Chand & Co.
Pathak, V.N., Khatri, N.K. & Pathak, M. Fundamentals of Plant Pathology. Agro-bios India.
Rangaswami, G. Diseases of Crop Plants of lndia. Prentice Hall lndia.

Tarr,S.A.J.ThePrinciplesofPlantPatholgy.WinchesterPress.
Wheeler, H. Plant Pathogenesis. SpringerVerlag.
Wood, R.K.S. Physiological Plant Pathology. Blackwell

Course outcomes

1. Develop understanding of the major groups of organisms like fungi, lichens and microorganisms, their occurrence, distribution and systematic classification.
2. Acquaint with the basic understanding of plant diseases, causative organisms, mode of action and measures for their control
3. Acquire practical knowledge onfungi, lichens, micro-organisms, plant pathogens and mode of their growth in specific habitats.
4. Develop understanding on the ecological and economic significance of the above groups of organisms.

    a. Understand the diversity of fungi.
    b. Classify fungi based on different classification system and recognize recent trends in classification of fungi
    c. Distinguish fungal group with their characteristic features
    d. Understands the interaction of fungi with other living organisms.
    e. Understands economic importance of different fungal groups
    f. Identify the different types of fungi with reason.
    g. Develop the understanding of the concept of microbial nutrition
    h. Classify viruses based on their characteristics and structure
    i. Examine the general characteristics of bacteria and their reproduction
    j. Enhance their awareness and appreciation of human friendly viruses, bacteria and their economic value
    k. Understand the basic principles of plant pathology and plant protection
    l. Identify the different plant diseases and their quarantine measure.
    m. Familiarize with the basic skills and techniques related to mycology and plant pathology

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

Angiosperm Anatomy

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 secondarywall.
2. Node-nodalpattems:Unilacunar,trilacunar,multilacunarandsplitlateral..Phylogeneticconsiderations. Leaf trace and branch trace- origin, departure; effect on stele and pith. Secondary growth in leaftraces.
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).
4. 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. Controle 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 waterconduction.
5. 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, sweetpotato).
6. Seedling anatomy: Concepts: anatomy of cotyledons, hypocotyl, seedling root, mesocotyldifferentiation
7. Leaf anatomy: Unifacial, bifacial and centric leaf (onion); structure of epidermis, stomatal types; foriarsclerieds; oil cells; crystalidioblasts.
8. Anatomy in relation totaxonomy.
9. Wood anatomy- generalaccount.

References

1. Easu, K. Plant Anatomy - Wiley EasternLimited.

2. Fahn, A. Plant Anatomy. PergamonPress.
3. Cutter, E.G. & Edward, E. Plant Anatomy : Experiment and Interpretations Part I andII.
4. Mauseth, J.D. Plant Anatomy - The Nenjamin Cumming PublishingCo.
5. Forester, A.S. Practical Plant Anatomy. D. Van Nostrand Companylnc.
6. Roberts, L.W. Cytodifferentiation in Plants - Cambridge University Press,Cambridge.

Angiosperm Embryology

1. Introduction to angiosperm embryology - structure of dithecous and monothecousanther.
2. Microsporogenesis: Structure and function of wall layers, role of tapetum in pollendevelopment
3. Male gametophyte: Pollen mitosis, division of generative cells,heterospory.
4. Megasporogenesis: Megaspore triad, dyad,coenomegaspore.
5. Embryo sac- different types- ultra-structure of components- synergid and antipodal. Theories of the morphological nature of embryo sac
6. 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 andfertilization.
7. Fertilization: Role of synergids - filiform apparatus, heterospermy and triplefusion.
8. Structure and development of typical dicot and monocot embryos- structure and function ofsuspensor.
9. Endosperm: classification and type- ruminate endosperm- mosaic endosperm- endosperm haustoria- physiology and cytology ofendosperm.
10. Polyembryony - classification – practicalvalue.
11. Apomixis - general account, genetics of apomixis.
12. Parthenocarpy -seedless fruits
13. Experimental embryology-embryo culture, anther culture, ovuleculture.
14. Embryology in relation totaxonomy.

References:

1. BoumanF. Ovule initiation, ovule development and seed coat astructure in angiosperms. Today and TomarrowPublishers, NewDelhi.
2. Bhojwani S.S. and Bhatnagar S.S. The embryology of Angiosperms. Vikas Publication, NewDelhi.
3. Davis C.L. Systematic embryology of Angiosperms. JohnWiley.
4. Eames A.J. Morphology of Angiosperms. Mc GrawHill.
5. Johanson D. Plant Embryology. Waltham,Massachusetts.
6. John B.D. (Ed.). Embryology of Angiosperms. SpringerVerlag.
7. MaheswariP. An introduction to the Embryology of Angiosperms. Mc GrawHill.
8. Raghavan V. Experimental embryogenesis in plants. AcademicPress.
9. Wardlaw C.W. Embryogenesis in Plants. Methusen,London.

Palynology

1. Introduction- contributions of Erdtman and P K KNair.
2. Development and structure of pollen wall. Pollen morphology and its application. Pollenevolution
3. Aero-palynology- methods of aerospore survey andanalysis
4. Melittopalynology- nutritional and medical value of honey- unifloral and multifloralhoney.
5. Recent advances in palynological studies- forensic-pollen allergy-oilexploration-paleopalynology.
6. Palynology in relation to taxonomy- eurypalynous and stenopalynoustaxa.

References:

1. Sripad N. Agashe. Palynology and itsApplication.
2. Kahinath Bhattacharya et. al. A Text Book ofPalynology.

Laboratory Techniques

1. Study of the following instruments - their uses andprinciples:
a. Microscope: microscopic measurements - camera lucida,micrometry.
b. Microtomes- Sledge, Rocking,Rotary.
2. Killing, fixing and staining of planttissues:
a. Important reagents and chemicals used in the preparation of fixatives and theirproperties.
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 briefdescription.
d. Stains - classification, composition and specific uses - safranin, crystal violet, cotton blue, fast green, Orange - G, hematoxylin,carmine.
e. Brief account of vitalstaining.

f. Staining techniques - Doublestaining.
i. Saffranin - Fastgreen
ii. Crystal violet – OrangeG
iii. Methods of embedding plant materials in paraffin wax - TBA method; embedding for Electronmicroscopy.
iv. Sectioning of embedded paraffin wax materials using RotaryMicrotome.
v. Double stainíng of microtome serial sections embedding in paraffin wax - Saffranin - fast green; Crystal violet - Orange G /Erythrosin.
vi. Whole mounts - generalaccount
vii. Maceration,smears
viii. Histochemical tests –
(1) PAS Test - insolublepolysaccharides.
(2) Sudan black-lipids
(3) Fuelgen reaction - NucleicAcids.

References:
1. Peter Gray. Hand book of Basic microtechnique. Mcgraw – Hill.
2. John E. Sass. Botanical Microtechnique, Oxford & IBH PublishingCo.
3. John R. Baker. Principles of Biological Microtechnique–
4. A guide book to microscopical methods. A. V. Grimstone and R.J. Saker, Cambridge Univ.press.
5. K.V. Krishnamurthy. Methods in PlantHistochemistry.

Course Outcomes:

1. Develop understanding of thestructural composition and functional organization in major land plants
2. Acquire knowledge on the reproduction and developmental processes associate with major land plants
3. Understand the significance of pollen studies in developmental process and the recent developments in palynology
4. Practical knowledge on cell and tissue organization, developmental stages and process associated with the reproduction in major land plants.
    a. Retrieve different types of tissues, non-living inclusions in plant cells.
    b. Interpret structure, function and roles of vascular cambium and cork cambium.
    c. Categorize different types of Anomalous secondary growth and their anatomical peculiarities and adaptational significance.
    d. Illustrate significance and properties of wood &fibres used commercially.
    e. Analyze leaf initiation, types of stomata and trichomes and appraise anatomical peculiarities in C3, C4 and CAM plants.
    f. Compare Nodal anatomy , Floral anatomy and their evolutionary significance
    g. Illustrate the organogenesis in plants
    h. Acquire the basic concepts of developmental biology
    i. Summarize the embryogenesis in plants
    j. Familiarizes with biological instrumentation and plant micro technique

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. Morphorogical 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 ofpteridophytes.
2. Study of vegetative and reproductive features of Lycopodium, Ophioglossum, Angiopteris, Osmunda, Lygodium, Ceratopteris, Pteris, Asplenium, Blechnum, Cyathea, Gleichenia, Trichomanes, Salvinia andAzolla.
3. Study of the following fossils: Rhynia, Lepidodendron, Sphenophyllum, Calamites, Calamostachys, Zygopteris andAnachoropteris.
4. Spore germination and development of prothallus in Knop's Agarmedium.

Gymnosperms

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

Mycology

1. Critical study of the following types with the help of fesh/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.

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.

Course Outcomes:

1. provide practical knowledge on the collection and identification of members of Algae, Fungi and Lichens
2. Provide practical knowledge on the collection of plant groups like Bryophytes, Pteridophytes, Gymnosperms and assessment of their morphological and anatomical features through laboratory exercises.

BOT1L02. PRACTICALS OF MICROBIOLOGY, PLANT PATHOLOGY, ANGIOSPERM TAXONOMY, 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 coliform bacteria in contaminatedwater.
2. lsolation of Eubacteria and Cyanobacteria from soil by dilution platemethod.
3. lsolation of pure bacterial culture by streak platemethod.
4. Staining of bacteria (negative staining, Gram staining and sporestaining).
5. Demonstration of bacterial motility by hanging drop method.
6. Morphological studies on Scytonema, Aphanocapsa, Spirulina, Oscillatoria,Anabaena.

Plant Pathology

1. Submission of five herbarium sheets of pathologicalspecimens.
2. Detailed lab study of the followingdiseases:

Bunchy top of banana, Bacterial blight of paddy, Bud rot of coconut, Mahali of Arecanut, Powdery mildew of rubber, Abnormal leaf fall of rubber, tikka disease of Ground nut, Late blight of potato, Blister blight of tea, wheat rust, coffee rust, grey leaf spot of coconut, Phytophthora foot rot of pepper, rhizome rot of ginger and turmeric, angiospermic parasites- Viscum and Dendropthoe.

3. Technique of isolation and pure culture ofpathogens.

Angiosperm Anatomy

1. Study of anomalous secondary growth in roots and stems of Aristolochia, Strychnos, Amaranthaceae, Nyctaginaceae, Bignoniaceae andAgavaceae.
2. Nodal anatomy of differenttypes.
3. Leaf anatomy: epidermal peels and TS oflamina.

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

Palynology
1. Anaiysis of honey for microscopic examination ofpollen.
2. Calculation of percentage of viable pollen by using T Ztest.
3.Study of pollen wall byacetolysis.

Lab Techniques
1. Measurement of microscopic objects -Micrometry.
2. Camera lucida drawing - calculation ofmagnification
3. Double stained permanent sections - free hand section, Microtome serialsections.
4. Preparation of whole mounts, macerations andsmears.
5. Submission of 10 permanent slides - which should include microtome
serial sections, free hand sections, macerations, whole mounts andsmears.

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.

Course Outcomes:

1. Provide practical knowledge on the collection, culturing and identification of microorganisms (general and pathogenic) from specific habitats and evaluation of their growth performances.
2. Acquire hands-on experience on the tissue organization in major land plants.
3. Acquire practical knowledge in the reproductive structures of major land plants and the developmental processes associated with them.

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

Cell Biology
1. The nucleus. Interphase nucleus- Chromatin organization- nucleosomes, scaffold. Organization of eukaryotic chromosome. Heterochromatln- constitutive, facultative and condensed. Euchromatin. Satellite DNA. Chromosome banding and itssignificance.
2. Cell reproduction: Cell cycle. Specific events G1, S, G2 and M phases. Significance of G_0. Control of cell cycle. Significance. Gene expression during cell cycle. Mitotic Inducers.
3. Meiosis: types, synaptinemal complex, significance of meiosis. Genetic control and consequences of meiosis. Restriction points and check points. Cell cycle regulation of meiotic events- behaviour of sex chromosomes in meiosis- suppression of DNA replication between Meiosis I and II. Meiotic defects and humandiseases.
4. Programmed cell death- necessity, classes, signals. Genetic analysis of cell death. Proteins regulating apoptosis. Pathways leading to cell death- significance. Aging- cellular and extracellular. Cellsignaling.
5. Cell interactions-communication, recognition and adhesion.Application.
6.Cellular differentiation and specialization. General characteristics, intrinsic interactions- Nucleo-cytoplasmic. Extrinsic interactions. Molecular mechanisms of cellulardifferentiations.
7. Cancer- carcinogenic agents. Phenotype of the transformed cell. Genetic basis of malignant transformation- oncogenes. Tumour suppressor genes. Cancer and cell cycle. Metastasis. Interaction of cancer cells with normal cells.

References:
1. Cooper Jeffrey M. The Cell- A Molecular Approach. ASM,Washington.
2. Karp Gerald. Cell Biology. JohnWiley andSons.

3. Derobertis. Cell and MolecularBiology.
4. Sadava R.
5. Pollard T.D. and Earn Shaw W.C. Cell Biology.Saunders.

Molecular Biology

1. Molecular biology of gene: Structure of DNA: Repetitive DNA; c-value paradox.
2. Replication of DNA: Enzymology of replication. Replication in prokaryotes and eukaryotes. Primosomes and replisomes. Telomerase and itsfunction.
3. Gene expression: regulation of gene expression- Operon concept- Gene regulation in prokaryotes and eukaryotes- enhancers and silencers.
4. Protein synthesis: Transcription, post-transcriptional events. Infrons and their significance. Translation. Post translational events. Role of chaperons.
5. Mutation: Spontaneous and induced. Physical and chemical mutagens. Molecular mechanism of mutation. Mutation and cancer. Mutator and antimutatór genes. DNA repairingméchanisms.
6. Molecular evolution: The origin of genomes. Evolution of new genes. Origin of eukaryotic genomes. Phylogenetics. Application of molecularphylogenetics.

References

1. Lewin Benjamin. Genes. Oxford Universitypress.
2. Brown TA. Genomes. John Willey andSons.
3. Snustad, Simmons and Jenkins. Principles of Genetics. John Willey andSons.
4. Weaver and Hendrick. Genetics. Wm. C. BrownPublishers.
5. Hawkins J.D. Gene Structure and Expression. Cambridge UniversityPress.

Biophysics

1. pH and buffer solutions- hydrogen ion concentrations and pH, dissociation of acids and bases. Measurement of pH using organic indicator molecule and potentometric method. Functions of buffers in a biological system. Use of buffers in biological and biochemical research. pH and life. Henderson and Hasselbalchequation.
2. Chromatography: Principles of chromatography. Types of chromatography (Briefaccount).
3. Electrophoresis: Electrophoretic mobility, principles, PAGE, Agarose gel electrophoresis. Separation and detection of macromolecules by electrophoresis. Electrophoretic apparatus, technique andprocedure.
4. Centrifugation - Theory of centrifugation. Centrifuge- Types, Methodology of centrifugation,applications.
5. 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.
6 Radioblology: Autoradiography. principies, types. Methods and applications in biological research.
7. lmmunochemistry: lmmune response. Antigens- Antibodies. Histo-incompatibility antigens; Structure of IgG. lmmunochemical assays-RIA,ELISA.
8. Cryobiology: Freeze drying (lyophilization)-applications.

References:

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

Course Outcomes:

1. Develop the understanding on cells, their structural and functional organization and the systematic process of growth and development.
2. Provide insight on various sub cellular materials in the molecular level and the processes associated with them, resulting in various metabolic activities.
3. Develop understanding and skills on various Biophysical methods used in cellular studies and the processes associated with them.

- Get an idea of intracellular components and cell communication
- Understand the life cycle of cell

- Infer various aspects of cytoskelton
- Analyze the chromosome organization in eukaryotes
- Familiarize the DNA replication, repair and recombination
- Understand the basic concepts of mechanism of gene expression
- Familiarize the control of gene expression
- Familiarizes with biological instrumentation
- Understand the better use of microscopes in biology

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

Cytogenetics

1. Cytogenetics of aneuplolds, euploids and structural heterozygotes: Effect of aneuploidy on phenotype. Transmission of monosomics and trisomics 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, monosoly, trisomy (primary, secondary, tertiary and compensating). Nullisomy. Uses of aneuploidy in cytogenetics. Euploidy- autoploidy, alloploidy and segmental alopolyploic diploidization. Role of aneuploidy and euploidy in evolution.
2. Molecular cytogenetics: Multigenic families and their evolution; in situ hybridization- concept. Computer assisted chromosome analysis, chromosome micro-dissection and micro-cloning; flowcytometry.
3. Polytene and lampbrush chromosomes- cytogeneticimportance.
4. Supernumerary chromosomes:B-chromosomes.

References

1. Alberts B., D. Bray, J. Lewis, K. Roberts and J.D.Watson. Molecular Biology of the Cell Gartand Publishing Inc. NewYork.
2. AtherlyA.G.,J.R.GirtonandJ.F.McDonald.TheScienceofGenetics.SaundersCollegePublishing, Fort Worth, USA.
3. Burnharm C.R. Discussions in Cytogenetics. Burgess Publishing Co.,Minnesota.
4. De RobertisE.D.P. and De RobertisE.M.F. Cell and Molecular Biology ISBN, HongKong.
5. Dupraw E.J. DNA and Chromosomes. Holt, Rinehart and Winston lnc. NewYork.
6. Hart D.L and E.W. Jones. Genetics: Principles andAnalysis. Jones & Bartlett publishers, Massachusetts, USA.
7. Khush, G.S. Cytogenetics of Aneuploids. AcademicPress.
8. Karp G. Celland 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. MalacinskiG.MandD.Freifelder.EssentialsofMolecularBiology.JonesandBastletPublisherslnc.,London
12. Rieger R., A.Michaelis and M.M.Green Glossary of Genetics and Cytogenetics -Classical and Molecular. Springer-Verlag, NewYork.
13. Swanson C.P., T. Merz, and J.W.Young. Cytogenetics. PrenticeHall.

Genetics

1. Relevance of Mendelism in modern genetics. A critical evaluation of Mendelism on the basis of modern concept ofgenes.
2 Linkage and gene mapping. Three- point test cross; linkage map; interference; tetrad analysis and centromere mapping. Linkage in humans. Pedigree analysis. Genetic recombination and mapping of genes in bacteria and bacteriophages.
3. Mobile genetic elements: Transposable elements in bacteria. lS elements. Tn elements. Cmp site transposon. Cepia and P elements in Drosophila. Ac, DS and Mu elements in maize. Retrotransposons- Molecular characteristics and significance in development and evolution.
4. Extranuclear inheritance: Analysis of mitochondrial and chloroplast genomes and their utility. Cytoplasmic male sterility.
5. Quantitative genetics: Polygenic inheritance, heritability and its measurements. QTLmapping.
6. Populationgenetics:Systemsofmating.TheHardy-Weinbergprinciple.Estimationofgenefrequencies.
Factors affecting equilibrium: natural selection, mutation, migration and geneticdrift.
7. Human genetics: Human pedigree analysis, Lod score for linkage testing. Karyotype; geneticdisorders.

References:

Snustad, Simmons and Jenkins. Principles of Genetics. John Willey and Sons.
Weaver and Hendrck. Genetics. Wm. C Brown Publishers.

Goodenough. Genetics. Saunders College Publishing.
Stansfield. Theory and Problems of Genetics. Mc Grow Hills.
Strlckberger. Genetics. Macmillan.
Burnet L.Essential Genetics. Cambridge University Press.
Friefelder. Microbial Genetics. Narosa Publishing House.
Gardner, Simmons and Snustad. Principles of Genetics.John Wiley and Sons, New York, USA.
Singh B.D. Fundamental of Genetics. Kalyani Publishers, New Delhi.

Biostatistics

1. The science of statistics and its applications in biologicalresearch.
2. Types and collection of data- Census and sampling- theory andmethods.
3. Tabulation and presentation of data- diagrammatic and graphicpresentation.
4. Analysis of data- centraltendencies.
5. Measures of dispersion - Range, quartìle deviation, mean deviation, standard deviation and standard error. Relative measures of dispersion - coefficient ofvariation.
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, Ftable.
8. Correlation and Regression analysis- coefficient of correlation- significance testing. Rank correlation. Lines of regression- coefficient ofregression.
9. Experimental designs- designing an experiment- CRD, RBD, LSD. Factorialexperiments.
10. Probability- application of the principles of probability- theorems of probability- applications- Probability distributions- binomial, multinomial, normal and poissondistributions.
11. Statistical softwares- SPSS, SPAR,MINITAB.

References:

1. Chandal S.R.S. A Handbook of Agricultural Statistics.AchalPrakashan Mandir, Kanpur, India.
2. Das M.N. and N.C. Giri. Designs and Analysis of Experiments. Wiley EasternLtd.
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, NewDelhi.
5. Gupta C.B. An Introduction to Statistical Methods. Vikas Publishing House Pvt.Ltd.
6. Kempthrone,O.Anntroduction to Genetic statistics. John Wiley and Sons lnc. NewYork.
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, NewDelhi.
9. Rao C.A. Advanced Statistical Methods in Biometrical Research. Wiley and Sons, NewYork.
10. Singh P. and S.S. Narayanan. Biometrical Techniques in Plant Breeding. Kalyani Publishers, NewDelhi.
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 HealthSciences.

Plant Breeding

1. Introduction and objectives.
2. Organizations involved in plantbreeding.
3. Breeding systems in sexually propagated plants- Floral Biology and its significance in plant breeding. Sterility and incompatibilitysystems.
4. Genetic resources- centers of crop genetic diversity. In situ and ex situ conservation; cryopreservation of germplasm.
5. Conventional methods of plantbreeding:

Domestication of wild plats- changes under domestication.
Plant introduction- history, types, principles, plant introduction agencies in lndia- rules and regulations. Major achievements.

Selection- selection methods in sexually and vegetatively propagated species. Selection in segregating populations. Major achievements.
Hybridization- history, objectives, techniques, consequences and major achievements.
Heterosis breeding- genetic basis of heterosis and inbreeding depression.

6. Modern methods of plantbreeding:

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.

7. Breeding for special purposes: Resistance breeding- a brief account of disease resistance, pest resistance,stress

resistance- achievements. Quality breeding- objectives andachievements.
8. Biometrical techniques in Plant Breeding- analysis of variability, heritability, genetic advance and combining ability.
9. IPR- Protection of plant variety and farmers' rightact.

References
1. Allard R.W. Principles of Plant Breeding. John Wiley and Sons, NewDelhi.
2. Chahal G.S. and Gosal S.S. Principles and Procedure of Plant Breeding. Narosa Publishing House, NewDelhi.
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 PublishingHouse.
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., NewDelhi.
12. Mohanan K.V. Essentials of Plantation Science. Penta Book Publishers, Calicut,Kerala.

Evolution
1. The concept of evolution- evidences of evolution- geological time scale andevolution.
2. Origin of life- theories and experimental evidences.- chemical evolution and biologicalevolution.
3. Evidences ofevolution.
4. Theories of evolution.- Pre-Darwinian, Darwinian and Post Darwinian theories.- Modern synthetic theory of evolution.
5. Reproductive isolation and the origin of species.
6. Evolution at the molecularlevel.

Course outcomes

1. Acquaint with cells and chromosomes, their structural and functional attributes, diversity and resultant manifestation on organisms.
2. Develop understanding of Mendelian Principles of Genetics.
3. Impart knowledge on human genome.
4. Provide an insight on the nature and type of data collection and its management.
5. Develop skills in data analysis using varied statistical software

- Understand the history of genetics
- Familiarize the concepts of linkage and genetic mapping
- Outline the basic concepts of quantitative genetics
- Understand the genetics behind cancer
- Familiarize the basic concepts of population genetics
- Understand the basic statistical methods for biological research
- Understand the basic concepts of plant breeding
- Familiarize the mechanism of hybridization in plants
- Outline the methods of breeding resistance in plants
- Familiarize the modern plant breeding methods.
- Infer the various theories of evolution
- Understand the process of evolution of plants

BOT2C06. PLANT ECOLOGY, CONSERVATION BIOLOGY, PHYTOGEOGRAPHY AND FOREST BOTANY (2.5+1.5+1+1= 6 hours)
Plant Ecology & Conservation Biology
1. Habitat Ecology: Salient features of terrestrial (Biomes), fresh water (Limnology), wet land and marinehabitats.
2. Productivity and Energy flow: Concepts, limits and process of primary production; methods of productivity measurements: global trends in primary productivity, energy flowmodels.
3. Population characteristics: density, natality, mortality, distribution, biotic potential, carrying capacity, aggregation and dispersal, ecotone and edgeeffect.

4. The environment and its pollution- types (land, air and water). Effect on living organisms. Control with emphasis on biological methods. Environmentalhazards.
5. Threats to the global environment- green house effect, ozone depletion, El-Nino and La Ninaeffects.
6. Environment impact assessment (EIA) and assessment of environmental hazards- remotesensing.
7. Problems of conservation; causes of threat to environment- human interference, deforestation, habitatdestruction, overexploitation ofresources.
8. identification of threatened plants; red list categories- extinct, endangered, vulnerable, rare and out of danger. Extinction process. Hot spots, keystone species and flagshipspecies.
9. Strategies for conservation: in situ and ex situ conservation, biosphere reserve, national parks, wildlife sanctuaries. Gene banks, cryopreservation, seedbanks.
10. Afforestation- social forestry, agroforestry. International biological programme (lBP), Man and biosphere programme (MAB), IUCN, world environment day, wild life preservation act (1972), Indian forést (conservation) act (1980) and United Nations Environment Programme. Environment ProtectionActs.
11. Environmental awareness- role of government and NGOs.-Gaiahypothesis
12. Biodiversity- significance at Local, National and Global levels. Deep ecology (Paradigm shift from anthropocentric ecology to ecocentric ecology. Nationalheritages.

References:
1. Negi, S.S. Hand book of National Parks and Sanctuaries inIndia.
2. M.P. Nair and P.K Sastry - Red data book of Indianplants.
3. Mehrotra and B.K Suri - Remote sensing for environment and forestmanagement.
4. Negi S.S - Biosphere reserves inIndia.
5. Lucas and Synge - IUCN Red data book. IUCN,Stockholm
6. Dasman R.F - EnvironmentalConservation.
7. OdumE.P. Fundamentals ofecology
8. OdumE.P. Basic principles ofecology
9. Misra K.R. Ecologyworkbook.
10. Puri G.S. - Indian Forest Ecology Volumes I and ll. Oxford &IBH.
11. Clarke G.L - Elements ofEcology.
12. Chhatwal G.L. Encyclopedia of environmental biology.
13. Ray P.K. - Pollution and Health. Willey-Eastern Ltd, NewDelhi.
14. MichaeLP.- Ecological methods for field and laboratory investigations.Tata McGraw Hill, NewDelhi.
15. Kershaw K.A. Quantitative and Dynamic Plant Ecology.ELBS.

Phytogeography
l. Patterns of plant distribution: continuous distribution: circumpolar, circumboreal, circum austral, pan tropical.
2. Discontinuous distribution: Theory of land bridges, theory of continental drift, theory ofglaciation.
3. Endemic distribution (neoendemic, paleoendemic), age and areahypothesis.
4. Phytochoria of world andIndia.

References:
1. Ronald Good. The geography of flowering plants.Lcngmans.
2. BharuchaF.R. A text book of plant geography of India. Oxford UniversityPress.
3. Puri G.S. Indian Forest Ecology, Vol I, ll. Oxford,New-Delhi.

Forest Botany
1. Forest- Definitions. Study of various types of forests in the world and inIndia.
2. Forest products-Major and.minor with special reference toKerala.
3. Influence of forests on environment. Consequence of deforestation and industrialization- 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 rawmaterials 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 oflndia.

Course outcomes

1. Familiarity with various types of ecosystems and the ecological principles operating in each ecosystem.
2. Evaluate the threats associated with various ecosystems and an understanding of various management strategies

for their conservation.
3. Understand the nature and pattern of distribution of plant communities and the reasons underlying it.
4. Understand the nature and type of forests; their ecological as well as economic contribution and strategies for their management

- Have an idea about the major ecosystem of the world
- Understand the population ecology and community ecology system in the world
- Get meticulous knowledge in ecological succession and phytogeography
- Get knowledge in environmental pollution, global environmental problems, their mitigation and remedies and to acquire knowledge about the importance of biodiversity conservation
- Understand the concept of conservation of nature and natural resources
- To understand the importance of plants in environmental quality
- Understand the importance of forest and forest products

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

Cell Biology

1. Study of Mitosis in root tipcells.
2. Pre-treatment of root típs with colchicine /hydroxy quinoline /paradichlorobenzene and studyof chromosomes in Chlorophytum,/Zea mays/ Crotalaria/Cyanotis.
3. Isolation of plastids andmitochondria.
4. Chromosome banding

Molecular Biology

1. Working out problems from moleculargenetics.
2. lsolation of nucleic acid and identification of histones bySDS-PAGE.
3. lsolation of plant DNA and its quantification by spectrophotometric/ calorimetricmethod.
4. lmmunological techniques: ELISA and WesternBIot.

Biophysics

1. Preparation of buffers and measurement of pH using pHmeter.
2. Determination of isoelectricpH.
3. Paper chromatography: Separation ofsugars.
4. Thin layer chromatography- separation of amino acidmixtures.
5. Calorimetric and spectrophotometric elimination of proteins by Biuret / Lowry'smethod.
6. Estimation of amino acid by ninhydrin method(colorimetric).

Cytogenetics

1. lnduction of polyploidy using colchicine; different methods of the application ofcolchicine.
2. Effect of induced and spontaneous polyploidy on plant phenotype, meiosis, pollen and seed fertility and fruitset.
3. Preparation of karyotype and ideogram of plant meristematiccells.
4. Cytological studies in callustissues.
5. Study of meiosis in translocation heterozygotes (Rheodiscolor)
6. Study of polytenechromosomes.

Preparation of lab record and submission for valuation.
Visit to a reputed molecular biology lab and submission of a report.

Course outcomes

1. Demonstration of practical skills in the isolation of cell organelles and demonstration of cellular processes
2. Demonstration of practical skills in the isolation of genetic materials from cellular systems and to familiarize recent methods fortheir characterization.
3. Develop abilities in the conduct of various experiments related to the physical and chemical separation of biochemical components.
4. Demonstration of practical skills in the area of Cytogenetics and its logical reasoning.
5. Develop skills in analyzing experiments related to the course materials, their interpretation and reporting.

BOT2L04. PRACTICALS OF GENETICS, BIOSTATISTICS, PLANT BREEDING, PLANT ECOLOGY, CONSERVATION BIOLOGY, PHYTOGEOGRAPHY AND FOREST BOTANY (0.5+0.5+0.5+0.5+0.5+0.5=3 hours)

Genetics

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

Biostatistics

1. Problems from Mean, standard deviation, Coefficient of variation, tests of significance and correlationanalysis.
2. Use of computer programmes for statisticalanalysis.

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 mentioned in(1).
3. Biometrical techniques in Plant Breeding- analysis ofvariability.

Ecology and Conservation biology

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

Phytogerography

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.

Preparation and submission of lab record

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

Course outcomes

1. Develop skills in the statistical analysis of data, both manually and using statistical software.
2. Demonstration of practical skills in plant breeding and hybridization.
3. Develop abilities in the conduct of various experiments related to ecosystems evaluation and characterization.
4. Develop skills and abilities in assessing species composition and biotic interactions associated with heterogeneous ecosystems.
5. Demonstration of skills in the identification of phytogeographic areas, with special reference to forest biome.
6. Develop skills in evaluating the mandate of various organizations and their programmes in the priority areas specified in the course.

BOT3C07. PLANT PHYSIOLOGY, METABOLISM AND BIOCHEMISTRY (2+ 2+ 2 = 6 hours)

Plant Physiology

1. Water and plant cells: Properties of water, hydrogen bonding, polaritv, 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 up take 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/ GOGATpathway.

3. 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 transportandphotophosphorylation.Thetwopigmentsystems,Z-scheme,wateroxidizingclock.Thephotosynthetic

carbon reduction cycle, C3, C2,C4 and CAM metabolism and ecologicalsignificance.
4. Tanslocation and distribution of photo assimilates. Phloem transport, Sources and sinks, mechanism of translocation. Phloem loading and unloading, distribution of assimilates. Translocation of xenobioticchemicals.
5. Patterns in plant development: Growth, differentiation, and development . Genetic control and hormonal regulation of development. Seed germination- physiology of hormones in plant development- auxins, gibberellins, cytokinins, absciscic acid and ethylene. Role of vitamins andnutrients.
6. Photomorphogenesis: Phytochrome: chemistry and physiological effects. Mechanism ofphytochrome and gene action. Cryptochromes and blue lighteffect.
7. Stress Physiology: Types of stress- water, temperature, salt, stresses caused by pests and pathogens andpollutants.

References
William G. Hopkins. Introduction to Plant Physiology. John Wiley & Sons Inc.
Lincoln Taiz and Eduardo Zeiger. Benjamin/Cumming Publishing Company lnc. New York.

Metabolism
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 andthermodynamics.
3. 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.
4. Oxidation of fatty acids. Activation and entry of fatty acids, Beta oxidation of saturated and unsaturated fatty acids.Regulation.
5. Oxidation of amino acids and entry to TCAcycle.
6. Oxidative phosphorylation: Electron transfer reactions in mitiochondria. Electron carriers, multienzyme complexes, ATP synthesis. Regulation of oxidative phosphorylation. Shuttle systems- Alternatepathways -Thermogenesis.
7. Carbohydrate biosynthesis: Gluconeogenesis, biosynthesis of starch, glucose and othercarbohydrates. Involvement of NDP- sugars. Regulation.
8. Lipid biosynthesis: Biosynthesis of fatty acids. Triacylglycerols, phospholipids and isoprenoids.Regulation.
9. Biosynthesis of nucleotides: PRPP and its significance. Purine and pyrimidine biosynthesis. Precursors and regulation. Conversion of NMP to NTP. Biosynthesis ofdeoxyribonucleotides.
10. Secondary metabolism: Main pathways and their relation toprimary-metabolism.

References
Lehnìnger. Principles of Biochemistry, Macmillan, U.K.
Geoffrey Zubay. Biochemistry. Macmillan Publishing Company, New York.
Trevor Palmer. Enzymes- Biochemistry, Biotechnology and Clinical Chemistry. Norwood Publishing, Chichester.

Biochemistry
1. The molecular logic oflife.
2. The chemical unity of diverse livingorganisms.
3. Weak interactions in aqueous systems and the fitness of the aqueous environment for living organisms. 4. Biomolecules: a- Carbohydrates- Classification, structure and functions of simple sugars and compound carbohydrates. Sugar derivatives of biological importance. b- Lipids. Classification- storage and structural lipids; lipids in membranes; the supramolecular architecture of membranes. c- 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. d- Nucleotides and nucleic acids. Chemistry- structure ofnucleotides-
Other functions of nucleotides.
5. Secondary metabolites: Secondary metabolites, their physiological roles. Significance- ecological and phylogenetic importance.

References:
1. Lehninger. Principles of Biochemistry, Macmillon,U.K.
2. Geoffrey Zubay. Biochemistry. Macmillen Publishing company,Newyork.
3. Sadasivam and Manickam. Biochemical Methods. New Age International Publishers. NewDelhi.

4. DavídT. Plummer, An Introduction to Practical Biochemistry. Tata McGrowHill.

Course outcomes

1. Understand various physiological processes associate with plant systems.
2. Understand various metabolic processes linked to biological systems.
3. Acquire knowledge on the properties of biomolecules (primary and secondary) and to understand the biochemistry of their action.

- Get an idea about the plant water relations
- Understand the transport of ions, solutes and other macromolecules
- Infer various aspects of photosynthesis.
- Understand respiratory metabolism in plants
- Analyze the nitrogen metabolism in plants.
- Familiarize the affects different types of stresses in plants
- Outline the basic knowledge in sensory photobiology
- Examine the various plant growth regulators
- Understand the structure and function of biomolecules
- Familiarize different types of secondary metabolites

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

Angiosperm Morphology

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

References:

1. Eames, E.J. Morphology of Angiosperms. Mc Graw Hills Book Co. NewYork.
2. Bamard, C. The interpretation of Angiosperm flower. Aust. J. Sci.24:64-72.(1961).
3. Manilal, K.S. Vascularization of corolla in Compositae. J.lndian Bot. Soc.59:189-196
4. Meeuse,A.D.J.SomefundamentalprinciplesofinterpretivefloralmorphologyLntemationalSci.Publ.Hissar. 5. Melville, R. New theory of Angiosperm flower. Nature 188: 14-18.(1960).
6. Puri, V. Inferior ovary. Phytomorpholgy2:122.(1952).
7. Sporne, K.R. The Morphology of Angiosperms. Hutchinsons Uni. Press,London.

Angiosperm Taxonomy

1. Principles of Taxonomy- Scope and importance of Taxonomy; systems of classification- artificial, natural and phylogeneticsystems;pheneticversusphylogeneticsystems;cladisticsintaxonomy;APGsystemofclassification.
2. Conceptual basis of classification- essentialism, nominalism, empiricism, phenotics and cladistics. phylogenetic and alternative; concept of genus; concept of family; infraspecificcategories.
3. Definitions and terms: primitive and advanced; homology and analogy; parallelism and convergence; monophyly andpolyphyly.
4. Taxonomic hierarchy- concept of taxa- species, genus and family- infra specificcategories.
5. Plant nomenclature: history of nomenclature; polynomial and binomial systems; detailedstudy of salient features and major provisions of the International Code of Botanical Nomenclature. Effective and valid publication, rank of taxa, rule of priority and its limitations, typification, author citation, rejection of names and names of hybrids. A brief account of International Code of Nomenclature of CultivatedPlants.
6. Concepts of chàracter: definition, classification of characters- analytical and synthetic, qualitative and quantitative; unit and multiple, good and bad; correlation of characters; characterweighting.
7. ModerntrendsinTaxonomy:cytotaxonomy,chemotaxonomy,biosystematicsandnumerical taxonomy. Molecular taxonomy- DNA bar coding inplants.
8. 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:

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

Plant Resources

1. A study of history, occurrence, morphology of useful part and overall chemical composition of thefollowing:
a. Cereals & millets: rice, wheat, maize, sorghum, finger millet, pearlmillet.
b. Pulses: Bengal gram, cluster bean, common bean, horse gram, cowpea.
c. Sugar yielding plants: sugar cane, beet root.
d. Starch yielding tubers: potato, tapioca, arrow root, yam,taro.
e. Fats & Oils: ground nut, coconut, castor, gingelly, mustard, oilpalm.
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.
2. 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:

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

Course outcomes

1. Acquaint with the structure and organizationof various plant organsand a detailed analysis on their origin and evolution.
2. Understand various principles and practices of Plant Systematics.
3. Acquire knowledge on the recent development in plant systematics and the institutions involved in it.
4. develop understanding on the history, occurrence, and botanical characteristics of various plant resources of commercial importance.

- Recognize concepts of taxonomic hierarchy and phylogeny of angiosperms.
- Illustrate sources of taxonomic characters in solving taxonomic disputes.
- Recall the principles, rules and recommendations of ICN in plant taxonomy
- Conceptualize the plant classification system proposed by different taxonomists
- Develop critical understanding of the different tools in taxonomy
- Develop critical evaluation of taxonomic keys
- Recognize the importance of digital resources of taxonomy and virtual herbarium
- Enhance their observation capacity by dissecting different floral structures and to improve their taxonomic illustrations and floral imaging
- Critically evaluate the interrelationships and evolutionary trends of angiosperm families
- Understand the economic importance of plants and its commercial applications

BOT3C09. BIOTECHNOLOGY AND BIOINFORMATICS (3+3= 6 hours)
Biotechnology
A. Plant TissueCulture
1. Basic concepts andhistory.
2. General account of laboratory facilities and management.
3. Media for in vitro culture, composition and theirpreparation.
4. Callus culture- selection of explants and medium- types of callus- growth profile ofcallus.
5. Cell culture - isolation of single cells- mechanical and enzymatic methods- measurement of growth of cells in suspension culture- viability tests.
6. Large scale cultivation of cells using bioreactors for secondary metaboliteproduction.
7. Organogenesis- direct and indirect- factors affectingorganogenesis.
8. Organ culture – apical/ axillary meristems, embryo, ovary, ovule, endosperm, anther, pollen and rootcultures.
9. Applications of plant tissue culture - clonal propagation, somaclones, somatic hybrids, synthetic seeds, secondary metabolites, germplasm conservation –cryopreservation.

B. GeneticEngineering
1. Molecular analysis of gene and gene products: southern, northern and western blots-restriction maps- RAPD and RFLP. Chromosome walking and jumping. FISH. PCR and its applications. DNA finger printing. DNA chips.
2. DNA sequencing: Enzymatic methods. Gilbert and Maxam method. Messing's shot gun method. Fluorescent detection and automation. The Human GenomeProject.
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 andachievements.
4. Transgenic plants. Gene cloning strategies in plants. Vector dependent and vectorindependent methods. Identification and selection of transformed plants; the reporter enzymetechnology. Objectivesandachievements-engineeringforsecondarymetabolites;resistanceagainstherbicides,pests,pathogens, stress - improved nutritional änd status changes in plants. Plants as bioreactors; phytopolymers and biodegradable plastics; antisense RNA technology; transgene inactivation. Terminator and traitortechnologies.
5. Cloning: objectives. Creation of transgenic animals- other developments in cloning. Human cloning. Ethics of cloning.
6. PatentingofgenesandGMOs.Genepiracy.Ethicsandbiosafetyaspects,recDNAsafety;IPR,biosafety protocols.

References:
Walker J.M. and R. Rapley. Molecular Biology and Biotechnology: Panima Publishing Corporation.
Bernard R. Glick and Jack J. Pasternack. Molecular Biotechnology Principles and Applications of Recombinant DNA:; ASM Press Washington

Brown T.A. Gene Cloning and DNA Analysis Blackwell Science Pub:

Primrose S.B. Molecular Biotechnology. Panima Publishing Corporation.
Maarten J. Chrispeels and D.E.Sadava. Plants, Genes and Agriculture. Jones and Bartlett Publishers.
Robert de la Pemere and Franck Seuret. Brave New Seeds: The threat of GM crops to farmers. Global lssues Series.

Bioinformatics

A. Computerapplication.

1. .Computer in Science with special reference to biology, the scope andprospects.
2. lnformation super highway (lnternet)- Information net works: lnternet, World Wide Web. Web browsers, HTTP, HTML and URLs. Biologicalnetworks.
3. Online publications with special reference to biology, -electronic journals, books,downloading and uploading.)- Open Archive Initiative (www.openarchives.org), biomedcentral, pubmedcentral, freedom of scientific information access, 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).

References

Online resources freely available at lnternet sites such as
www.publiclibraryofscience. org www.openarchives.org
www.pubmedcentral. gov
www.biomedcentral. com
www.nature.com/nature/debates/e-ccess/index.html

B. Bioinformatics

1. lntroduction: lmportance andscope.
2. BiologicalDatabases

a. Nucleic acid databases: EMBL, GenBank- structure of GenBank entries. Specialized genomic resources, UniGene.
b. Proteinsequencedatabases:PIR,SWISS-PROT,TrEMBL.
Composite protein databases: NRDB,OWL.
Secondary databases: PROSITE, PRINTS, BLOCKS, IDENTIFY.
Structure classification databases- SCOP, CATH.

3. Databasesearching

a. Sequence database searching. EST searches. Different approaches to EST analysis. Merck/lMAGE, lncyte, TIGR. EST analytical tools. Sequence similarity, sequence assembly and sequenceclustering.
b. Pair wise alignment technique: Comparison of sequences and sub-sequences. Ldentity and similarity. Substitution matrices, BLOSUM, DOTPLOT andBLAST.
c. Multiplè alignment technique: Objective, Manual, simultaneous and progressive methods. Databases of multiple alignments. PSI-BLAST,CLUSTAL-W.

4. Protein structurePrediction:

a. Secondary structure prediction. Chou-Fasman, JPred.
b. Tertiary structure prediction: Comparative modelling -Modeller,RasMol.

5. Emerging areas of Bioinformatics: DNA Microarrays, functional genomics, comparative genomics, pharmacogenomics, chemoinformatics, Medicalinformatics.

References

1. Attwood T.K. and D.J. Arry-smith. lntroduction to Bioinformatics. PearsonEducation.
2. Sundararajan S. and R. Balaji, lntroduction to Bioinformatics. Himalaya PublishingHouse.

Course outcomes

1. Understand the basic principles and practices and develop skills in the advanced areas of plant tissue culture.
2. Acquire knowledge on the recent techniques and developments in Genetic Engineering and the legal procedures underlying genetic manipulation.
3. Acquaint with the principles and applications of Bioinformatics and to acquire skills in the use of computer aided Bioinformatics tools.

- Get a thorough knowledge in plant tissue culture
- Familiar with genetic engineering and advanced tools

- Get knowledge in genomic and proteomics
- Get basic knowledge in bioinformatics
- The students will be able to familiarize with social issues in biotechnology

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

Plant Physiology

1. Determination of water potential by tissue weight change method.
2. Extraction of leaf pigments and preparation of absorption spectra of chlorophylls andcarotenoids.
3. Demonstration of Hillreaction.
4. Separation of leaf pigments by paper chromatography and columnchromatography.
5. Effects of light intensity on photosynthesis by Wilmot'sbubbler.
6. Determination of sugars and amino acids in germinating seed byTLC.
7. Extraction of seed proteins based onsolubility.
8. Biochemical analyses of leakages from seeds duringgermination.
9. Analyses of proline in water stressedplants.
10. Testing of seed viability by NBTtest.
11. Changes in the reserve proteins duringgermination.

Metabolism

1. Extraction of enzyme: Anyenzyme.
2. Effect of substrate on enzyme and determination of its Kmvalue.
3. pH dependent activity profile ofenzymes.
4. Ammonium sulphate precipitation ofenzymes.
5. Desalting of proteins by gel filtration using Sophadex G25/ dialysis
6. Separation of isoenzymes by native PAGE.
7. Determination of enzyme / protein sub units by SDSPAGE.
8. Metabolism of germinating seeds - changes in metabolisablecarbohydrates.

Biochemistry

1. Qualitative tests for monosaccharides, reducing and non reducing oligosaccharides, starch, amino acids and protein.
2. Quantitative estimation of reducing sugars andstarch.
3. Qualitative tests for lipids. Emulsification, saponification, acrolein test, Boundouin'stest.
4. Quantitative estimation of aminoacids.
5. Quantitative estimation of protein by Biuret / Branford's /Lowry et almethod.
6. QuantitativeestimationofDNAandRNA(colorimetric/spectrophotometric)
7. Quantitative estimation of totalphenolics.

Angiosperm Morphology

1. Preparation of cleared whole mounts of floral parts to showvasculature.
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 offlowers.

Angiosperm Taxonomy

1. Familiarization with local flora and construction of keys – use of floras in identification up tospecies.
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, Rosaceae, Melastomaceae, Rhizophoraceae, Aizoaceae, Rubiaceae, Sapotaceae, Gentianaceae, Boraginaceae, Convolvulaceae, Scrophulariaceae, Pedaliaceae, Verbenaceae, Nyctaginaceae, Euphorbiaceae, Urticaceae, Casuarinaceae, Orchidaceae, Zingiberaceae, Amaryllidaceae, Commelinaceae, Araceae, Cyperaceae andPoaceae.
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 floraldiagrams.
4. 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 areastudied.

5. 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 Practicalexamination.
6. Problems in BarCoding

Course outcomes:

1. Develop skills in conducting / demonstrating experiments related to various physiological processes in plants.
2. Demonstration of practical skills in the area of separation of biomolecules and their assays.
3. Develop abilities to test various biochemical components in plants using standard protocols.
4. Develop skills and abilities in assessing plant organs and to comment on their developmental processes.
5. Demonstration of skills in the collection, preservation and systematic elucidation of plant specimens to their respective families using conventional and modern methods.

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 and sterilization of culturemedia.
2. Culturing of Carrot/Tobacco/Datura.
3. Estimation of cell growth in callus culture by fresh wt. and drywt.
4. Induction of multiple shoots using axillary and apical meristems asexplants.
5. Plantlet regeneration fromcallus.
6. Identification of secondary metabolites incultures.

Biotechnology- B. Genetic Engineering
lsolation of DNA.

Bioinformatics-
A. ComputerApplication
1. Acquiring basic computer operation and internet browsing skills in Windows and Linuxplatforms.
2. Acquiring basic word processing/ data entry skills using popular (both commercial and open source) packages such as MS-Word, K-Word, Open Word,PageMaker.
3, Acquire graphic processing skills using popular packages such as PhotoShop, Corel Draw, Chem Draw.
4. Preparation of scientific presentations using packages such asMS-PowerPoint.
5. Use of statistical packages such as SPSS, Biostat, Origin,MS-Excel.

B. Bioinformatics
1. Acquisition of basic skills in Internet browsing
2. Use of web browsers and search engines.
3. Use of biological and bioinformatic websites Agris, Agricola, BIOSI S,CABWeb.
4. Visit to Bioinformatics websites: NCBI, SWISS PROT, PIR,PDB.
Submission of lab record
Submission of 10 plant products directly collected by the student from the field with a note on the source plant and plant part.

Course outcomes

1. Develop skills in the identification of plant specimens having commercial / economic value.
2. Develop skills and abilities in undertaking tissue culture protocols.
3. Develop skills and abilities in the separation of genetic materials from plant specimens.
4. Acquire skills in the use of computers for conventional applications and also for computational purposes using statistical software.
5. Demonstration of skills in using computer software relating to Bioinformatics purposes.

E01: To be selected by the centre from the list appended as Elective I
E02: To be selected by the centre from the list appended as Elective II
L07: Practicals of Electives.

(The centres are advised to select relevant and related electives so that the centres can be developed to centres of excellence in the specialization area.)

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

A. Elective I

1. Advanced AngiospermTaxonomy
2. Environmental Biology and Biodiversity Conservation
3. Plant TissueCulture
4. PlantPhysiology
5. Plant Cell and MolecularBiology
6. Genetics and Crop Improvement

B. ElectiveII

1. Molecular PlantTaxonomy
2. Pathology of Plantation crops andSpices
3. Genetic Engineering
4. Genomics andProteomics
5. Genetic Engineering andBioinformatics
6. Biotechnology in Crop Improvement

BOT4E01-1. Advanced Angiosperm Taxonomy

1. Need and importance of taxonomy. Aspects of tyaxonomy (identification, nomenclature, classification, systematics, molecular systematics, phases of taxonomy (exploration, consolidation, experiment or biosystematics, encyclopedic orholotaxonomy).
2. Plant identification: Methods, taxonomic keys- dichotomous (indented, bracketed),polyclave.
3. Plant nomenclature; ICBN- BRIEF HISTORY, St. Louis Code (outyline, principles, rules and recommendations, provisions for the governance of thecode).
4. History and systems of plantclassification:

a. Ancient Greeks, Middle ages, Herbalists, Pre and Post Linnaean. Evolutionary and Phylogeneticsystems

b. Types of classification; systems developed by Bessy, Engler, Hutchinson,Cronquist.

5. Botanical garden: role, special types. Major botanical gardens of the world andIndia.
6. Taxonomy as a synthetic subject: taxonomy in relation to morphology, cytology, palynology, phytochemistry and serology.
7. Numerical taxonomy: Principles, steps for the construction of taxonomic groups. Merits anddemerits.
8. Brief study of the following: phonetic method, phyletic method. Floral imaging (digitalphotography).
9. Phylogeny of angiosperms: Evolutionary trends; transitional- combinationaltheory.
10. Electronic herbarium and digital database preparation(DELTA).
11. Geographical distribution of plant families, endemic families, dispersal ofplants.
12. Contributions of van Rheede, J D Hooker, WillamRoxburgh, Nathaniel Wallich, Richard Henry Beddome, E K Janaki Ammal, K M Mathew, Cecil J Saldanha, V VSivarajan.
13. Study of the following families in detail giving importance to morphology of the modified parts, economic importance, interrelationships and evolutionary trends: Magnoliaceae, Cruciferae, Caryophyllaceae, Dipterocarpaceae, Tiliaceae, Malphigiaceae, Celastraceae, Rhamnaceae, Moringaceae, Droseraceae, Rhizophoraceae, Begoniaceae, Plumbaginaceae, Ebenaceae, Oleaceae, Lentibulariaceae, Bignoniaceae, Polygonaceae,Aristolochiaceae,Piperaceae,Loranthaceae,Dioscoriaceae,Pandanaceae,Typhaceae,Eriocaulaceae.

Practicals

1. Preparation of checklist of a particulararea.
2. Phenology of at least 10species.
3. Programming DELTA of at least 20 species withimages.
4. Study of at least two plants each of the above listedfamilies.
5. Preparation of key to at least 10 species of any families studied in PG corecourse.
6. Preparation of 25 herbarium sheets of plants of the above families with QRcode.
7. Study tour to a forest or any other special ecosystem in South India and submission of tourreport.

References

Singh Gurcharan. Plant Systematics. Oxford IBH.
Mondal A.K. Advanced Plant Taxonomy. Central Book Agency, Kolkatta.
Sivarajan V.V. and Robinson. Introduction to the Principles of Plant Taxonomy. Oxford IBH.

Greuter W. et. al. International Code of Botanical Nomenclature. St. Louis Code. Koeltz Scientific Books, Konigstein.
Jain S.K. and Rao R.R. A hand book of Field and Herbarium Methods. Today & Tomorrow Publications, New Delhi.
Cronquist A. Evolution and Classification of Flowering Plants. New York Botanic Gardens, Bronx, New York.
David P.H. and Heywood P.H. Principles of Angiosperm Taxonomy. Oliver & Boys, London.
Good R. The Geography of Flowering Plants. Longman, London.
Hutchinson J. Genera of Flowering Plants. Cambridge University Press, London.
Mayr E. This is Biology. University Press, Hyderabad.
Naik V.N. Taxonomy of Angiosperms. Tata Mc Graw Hill, New Delhi.
Mabberley D.J. The Plant Book. Cambridge University Press,London.

Course outcomes

1. Develop advanced understanding on the history, importance, methods, and recent advancements in the area of Plant Taxonomy.
2. Systematic elucidation of the characteristics of selected families cited in the syllabus with ecological / economic significance and interrelationships.
3. Develop skills in the collection, processing and systematic elucidation of plant specimens, following standard procedures.
4. Develop skills and abilities in undertaking tissue culture protocols
5. Acquire skills in floristic expeditions of areas having ecological significance

BOT4E01-2. Environmental Biology and BiodiversityConservation

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 Kselection.

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 andguild.

3. Human population: Expansion and its causes, rich and poor nations, consequences, dynamics, Cairo conference 1994.

4. 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 excessnitrogen.

5. Global initiatives: Stockholm conference (1972), Rio (1992), Ramsar convention (1971), Kyoto (1997), Johannesburg (2002), Stockholm(2011).

6. Environmental Law- International and National: The Environment Protection Act & Rules 1986; Water (Prevention & Control of Pollution) Act 1974; Biodiversity Act(2002).

7. Thoughts on ecology: Contributions of Buddha, RabindranathaTagore, Mahatma Gandhi, Rachel Carson, Gro Herlem Brundtland, Vandana Siva, Edward O Wilson, AldoLeopald.

8. Biodiversity: a). Genetic diversity, agrobiodiversity and cultivated taxa, causes of decline, value of wild species, conservation practices- traditional (*upavanavinoda*, sacred groves, *sthalavrikshas*) 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, metadatabases, virtual libraries.

9. Ecosystem capital- use and restoration: Global perspective on biological systems; conservation, preservation and restoration. Biomes and ecosystems under pressure (forest biomes, oceanecosystems).

10. Habitat studies: Wetlands (Ramsar sites), mangroves and forest types of Kerala.

11. Brief study of the following: Cybernetics, ecological foot print, sustainable development, deep ecology, Gaia hypothesis, conservation ethics, peoples' movements for biodiversity conservation, role of NGOs and educational institutions in biodiversity conservation, trade related IPR,ecotourism.

12. Climate change and its impacts- brief study.

13. Disaster management- basicaspects.

Practicals

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 lightbottles).
3. Study of community structure: Charting and mapping of vegetation, Raunkiaer's life forms, biological spectrum, profile diagram(soil).
4. Study of ecological succession: Different types of ecologicalsuccessions.
5. Visit to an ecological sensitive area and submission of areport.

References

Champion H.G. and Seth S.K. A Revised Classification of Forest Types of India. Govt. of India, New Delhi.
Gadgil Madhav. Ecological Journeys. Permanent Black, Delhi.
Jaiswal P.C. Soil Plant and Water Analysis. Kalyani Publishers, Ludhiana.
Krishnamurthy K.V. An Advanced Text Book on Biodiversity Principles and Practice. Oxford IBH.
Misra R. Ecology Workbook. Oxford IBH.
Odum E.P. and Barrett G.W. Fundamentals of Ecology. Thomson Books, Bangalore.
Palmer J.A. Fifty Thinkers on the Environment. Routledge, London.
Puri G.S. Indian Forest Ecology. Oxford IBH.
Pushpangadan P. and Nair K.S.S. Biodiversity and Tropical Forests- The Kerala Scenario. STEC, Thiruvananthapuram.
Sarngdharacharyar. (Translated by Vishnu B.). *Vrukshaayurvedam*JanapriyaPusthakasala, Kottayam.
Sivadasan M. and Mohanan K.V. Biodiversity and Ecology: Concepts and Facts. Department of Botany, University of Calicut, Kerala.
Speth Gustave James and Haas M. Peter. Global Environmental Governance. Pearson Longman, New Delhi.
Vijayalakshmi K. and Shyam Sundar K.M. Vrkshayurveda- An Introduction Indian Plan Science. Lok Swasthya Parampara Samvardhan Samithi, Madras.
Wright T. Richard. Environmental Science- Towards a Sustainable Future. Prentice Hall Learning Pvt. Ltd., New Delhi.

Course outcomes

1. Develop advanced understanding of various concepts and principles in Ecology and Environmental Biology
2. Provide insights onexisting Environmental Challenges and analyze their future impacts due to increasing anthropogenic interferences.
3. Enable students to acquire knowledge and analyze unique habitats with regard to their environmental settings, processes and threats.
4. Develop hands-on skills to study environmental samples like soil and water and thereby its qualitative elucidation.

BOT4E01-3. Plant Tissue Culture

1. Tissue culture- plant tissue culture- techniques and significances of embryo, endosperm and haploid plant culture. Techniques and significances of cell and protoplastculture.
2. Tissue culture as a biotechnological tool- clonal propagation, somatic embryogenesis, synseed production and exploitation of somaclonal variations.
3. Culture media- liquid, semisolid, raft- MS, WPM, White's, Nitsch & Nitsch, SH- a comparative study. Media for special purposes- modifications, additives- antioxidants, organic supplements,adsorbants.
4. Hormones- role of hormones in phytomorphogenesis*in vitro* and *in vivo*- mode of action of hormones-synergistic action.
5. Commercial clonal propagation- requirements, management- production planning- man power- contamination- endophytes as contaminants in tissue cultures- in process qualitycontrol.
6. Hardening of TC plants- primary and secondary- green house- poly house- shade house- pots. Media for hardening- management of TCplants.
7. Bioreactor technology for plant micropropagation- photoautotrophicmicropropagation.
8. Secondary metabolite production- objectives andachievements.
9. Commercial tissue culture production of trees: Eucalyptus, Teak, Bamboo; crops: Banana, Potato, Papaya; flower crops: Orchids, Anthurium,Gingers.
10. Virus indexing of tissue cultured plants- ELISA, PCR based indexing- methodology andimportance.
11. Value addition in TC plants- inoculation of VAM and otherendophytes.
12. Certification of TCplants.
13. Farmer's acceptance of TC plants- lab to landawareness.
14. Costing- cost benefit analysis- cost reduction measures and low costalternatives.
15. Marketing of TCplants.
16. Major tissue culture ventures in India and abroad- successstories.

Practicals

1. Media preparation- culture initiation- clonal multiplication- rooting- hardening and filed transfer in the case of one plantspecies.
2. Callus induction and organogenesis in the case of one plantspecies.
3. Synseed production in the case of one plantspecies.
4. Suspension culture and its microscopic examination for morphological features and viability in the case of one plantspecies.
5. Preparation of commercial TC planting material production plan for a cropspecies.
6. Visit to a TC lab and submission of areport.
7. Preparation of a project report for a commercial TCunit.

References

Bajaj Y.P.S. (Ed.). High Tech Micropropagation. Springer.
Biotech Consortium India Ltd. Summary Report on Market Survey on Tissue Cultured Plants.
DBT, Govt. of India. National Certification System for Tisuue Culture Raised Plants.
Dutta G.S. and Ibaraki Y. (Ed.). Plant Tissue Culture Engineering. Springer.
George E.F., Hall M.A. and Klerk Geert –Jan De. Plant Propagation by Tissue Culture. Springer.
George E.F. and Sherrington P.D. Plant Propagation by Tissue Culture. Exegetics Limited.
IAEA. Low-cost Options for Tissue Culture Technology in Developing Countries.
Jain S.M. and Ishii K. (Ed.). Micropropagation of Woody Trees and Fruits. Kluwer Academic Publishers.
Greisen Kay S. Commercial Propagation of Orchids in Tissue Culture: Seed- Flasking Methods.
Dirr, Michael A. and Heuser Jr., Charles W. The Reference Manual of Woody Plant Propagation- From Seed to Tissue Culture.
Neumann K.H., Kumar A. and Imani J. Plant Cell and Tissue Culture- A Tool in Biotechnology: Basics and Application. Springer.
Razdan M.K. Plant Tissue Culture. Science Publishers Inc., U.S.A.
Trigiano, Robert N. and Gray Dennis J. (Eds.) Plant Tissue Culture, Development and Biotechnology. CRC Press.
Ziv M., 2000. Bioreactor technology for plant micropropagation. Horticultural Reviews 24: 1-30.

Course outcomes

1. Develop advanced understanding of various concepts, principles, techniques and practices in Tissue Culture.
2. Provide technical insights onthe production of tissue culture plants having higher commercial value.
3. Enable students to acquire knowledge on various analytical procedures and certification processes in the production and marketing of tissue culture plants.
4. Develop hands-on skills in the area of production of tissue culture plants using standard protocols.

BOT4E01-4. Plant Physiology

1. Water and plant cells: Water in plant's life; properties. Diffusion and facilitated diffusion. Absorption and short distance transport, pressure driven bulk flow and long distance transport. Osmosis driven by water potential gradient. Water absorption by roots via apoplastic, symplastic and transmembrane pathways. Role of aquaporins. Water movement through xylem. Mechanism and theories of transport. Cavitation and embolism. Soil-plant-atmosphere continuum. Physiology of stomatal function- blue lighteffect.

2. Plants and inorganic nutrition: Nutrient elements- classification based on biochemical functions. Physiological roles. Nutrient uptake: interaction between roots and microbes. Ion uptake by roots: diffusion, facilitated diffusion and apparent free space. Apoplastic and symplastic pathways. Membrane potential. Passive and active transport. Transport proteins: carriers- Michaelis-Menten kinetics. Channels: Voltage dependent K+ channels, voltage gated channels, Calcium channels, vacuolar malate channels. ATPase ctivity and electrogenic pumps. Patch clamp studies. Application of Nernst equation. Active transport and electrochemical potentialgradients.

3. Assimilation of mineral nutrients: Nitrogen and bio geocycle nitrate assimilation, reduction, biological nitrogen fixation. Symbiosis: Nitrogenase activity, assimilation of ammonia, pathways and enzymes. Transport of amides and ureides. Sulphur assimilation: Bio geocycle, reduction of sulphates. Importance of Phosphorus, Iron, Magnesium, Calcium and Potassium assimilation. Energetics of nutrient assimilation. Molecular physiology of micronutrientacquisition.

4. Photosynthesis: Light absorption and energy conversion. Electron transport system in chloroplast membranes. ATP synthesis in chloroplast. Photosynthetic carbon reduction, carbon oxidation and photorespiratory cycles. C4 and CAM metabolism. Physiological and environmental consideration of photosynthesis. Distribution of photoassimilates- export. Starch and sucrose synthesis. Allocation and partitioning: Phloem loading and unloading. Concept of osmotically generated pressure flow. Importance of plasmodesmata in symplastictransport.

5. Respiration: Glycolytic reactions. Pyruvate entry in to mitochondria and citric acid cycle. Electron transfer system and ATP synthesis. Transporters involved in exchange of substrates and products. ATP synthesis, unique electron transport enzymes of plant mitochondria. Interaction between mitochondrial and other cellular components. Metabolites and specific transporters. Lipidmetabolism.

6. Growth, differentiation and development: Analysis of plant growth: production of cells, growth velocity profile. Cytological and biochemical events. Differentiation: secondary cell wall formation, multinet growth hypothesis of cell wall. Development: initiation and regulation of development, genes involved in the control of development, role of protein kinases. Types of development: flowering- floral induction, evocation and morphogenesis. Floral organ identity genes. Biochemical signaling: Theories of flowering. Control of flowering- phytochrome, cryptochrome and biological clock. Factors affecting flowering: Photoperiodism and thermoperiodism.

7. Fruit development and ripening: physiology of ripening- cell wall architecture and softening, enzymes involved in biochemicalchanges.

8. Seed development: deposition of reserves during seed development, desiccation of seeds- hormones involved- desiccation tolerance. Classification of seeds. Seeddormancy.

9. Germination physiology: Imbibition, germination and reserve mobilization- metabolism of carbohydrates, lipids, proteins and phytins. Physiology of seeddormancy.

10. Plant growth regulators: auxins, gibberellins and cytokinins- biosynthesis, physiological roles. Ethylene- biosynthesis, mode of action, physiological roles, commercial importance. Abscisic acid- biosynthesis and metabolism, physiiological effects, role in dormancy and senescence. Hormonal balanceconcept.

11. Photoreceptors: Phytochromes- photochemical and biochemical properties; functions. Mechanism of of phytochrome regulated differentiation. Signal transduction.Cryptochromes.

12. Senescence and programmed cell death: Apotosis and necrosis. Programmed cell death in relation to reproductive development and stress response. Metabolism duringsenescence.

13. Stress physiology: Water deficit and drought resistance. Heat stress and heat shock, chilling and frost. Salinity stress. Stresses due to oxygen deficiency and heavy metalpollution.

Practicals

1. Determination of moisture content of plant materials.
2. Separation of plant pigments by paper chromatography and thin layer chromatography and study of their absorptionspectra.
3. Quantitative estimation of chlorophyll usingspectrophotometry.
4. Study of amylase activity and effect of gibberellic acid in germinating cerealseeds.
5. Estimation of protein by dye bindingmethod.
6. Proline estimation under various levels of abioticstresses.
7. Estimation of phenol content in plant tissues as affected by bioticstresses.
8. Study of the effect of plant hormones on seedlinggrowth.
9. Visit to a research station with facilities in the subject area and submission of areport.

References:

Anderson J.W.and BoardallJ. Molecular Activation of Plant Cells- An Introduction to Plant Biochemistry. Blackwell ScientificPublishers.
Beck C.B. An Introduction to Plant Structure and Development. Cambridge University Press.
Bowley J.D. and Black E. Seeds: Physiology of Development and Germination. Plenum Publishing Corporation.
Bidwell R.G.S. Plant Physiology. Macmillan Publishing Corporation.
Buchanan B.B., Gruissem W. and Johns R.L. Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
Devlin R.M. ndWithan F.H. Plant Physiology. CBS Publishers & Distributers.
Hopkins W.G. Introduction to Plant Physiology. John Wiley & Sons Inc.
Mayer and PoljakoffMayber. The Germination of Seeds. Pergamon Press.
Moore T.C. Research Experience in Plant Physiology- A Laboratory Manual. Springer Verlag.
Noggle G.R. and Fritz G.J. Introductory Plant Physiology. Prentice Hall of India Pvt. Ltd.
Salisbury F.B. and Ross C.W. Plant Physiology. Wordsworth Publishing Corporation.
Steward F.C. Plant Physiology- A Treatise. Vol. I to X. Academic Press.
Stumpf P.K. and Conn E.E. The Biochemistry of Plants: A comprehensive Treatise. Academic Press.
Taiz L. and Zeiger E. Plant Physiology. The Benjamin Cummings Publishing Corporation Inc.
Wilkins M.B. Advances in Plant Physiology. Longman Scientific & Technical.

Course outcomes

1. Develop advanced understanding on various physiological processes associated with plants including water

absorption, nutrition, photosynthesis, respiration, growth and differentiation, and reproduction.
2. Develop hands-on skills in analyzing the physiological processes associated with plants.
3. Acquire hands on experience in the separation / extraction of metabolites and their analyses

BOT4E01-5. Plant Cell and Molecular Biology

1. Structure and organization of cell and cell organelles- generalaccount.
2. Organization and expression of plant genes.
3. Light regulation of plant geneexpression.
3. Phytochrome control of plantdevelopment.
4. Molecular genetics of photosynthesis.
5. Photochemical reaction centres: structure andorganization.
6. Mitochondrial genome and malesterility.
7. Genetics of nitrogen fixation; Bacterial and cyanobacterial nitrogen **f**ixation; symbiotic nitrogenfixation
8. Storage proteins and theirgenes.
9. Molecular aspects of incompatibility.
10. Transposons inplants.
11. Adaptation of plants tostress.
12. Biochemistry of endogenousrhythm.
13. Plant hormones: Currentstatus.
14. Lectins and cell-cell recognition problems.
15 Plant cell culture and regeneration with special reference to legumes and cereals.
16. Protoplasts and somatic cell hybridization.
17 Plant cell mutants and somaclonal variation.
18. Genetic engineering of plant cells (i) Engineering of plant genes of photosynthesis (ii) ConferringHerbicide Resistance (iii) Nitrogen fixation (iv) Storage proteins (v)Vitamins.
19. Techniques in Plant Molecular Biology: Buffers, Cell fractionation; Centrifugation (preparative and analytical ultracentrifugation); Chromatography; Electrophoresis; Spectrophotometry (UV and visible, Dualwavelength spectrophotometry); Radioisotope techniques; Transmission and scanning electron microscopy; Cell and protoplast culture; DNA isolation from nuclei, chloroplasts, andmitochondria.

Practicals

1. Buffers, CellFractionation
2. Preparative and analyticalcentrifugation
3. Chromatography -- paper and thinlayer
4. Electrophoresis
5. Spectrophotometry (UV and Visible, Dual WavelengthSpectrophotometry)
6. Cell and Protoplast Culture
7. Plant CellTransformation
8. DNA Isolation- planttissues.
9. Visit to a research centre in the subject area and submission of areport.

References

Harry Smith. Phytochrome and Photomorphogenesis-An Introduction to the Photocontrol of Plant Development. Nature Publishing Company.
Pusztai A. Plant Lectins. Cambridge University Press.
Jenkins M.A. and Wood A .J. Genes for Plant Abiotic Stress. Wiley and Blackwell.
Jenkins M.A. and Wood A .J. (Eds). Plant Desiccation Tolerance. Wiley and Blackwell.
Alberts B., Johnson A., Lewis J. Molecular Biology of the Cell. NCBI.
Arteca R. Plant Growth Substances: Principles and Applications. Chapman and Hall.
Willard, Merrit, Dean and Seattle. Instrumental Methods of Analysis. CBS Publishers.

Course outcomes

1. Develop advanced understanding of plant cell and cell organelles.
2. Develop advance understanding of various processes associated with the cells in a molecular basis.
3. Provide insights onvarious techniques used in plant molecular biology.
4. Develop skills in various processes and techniques in cell and molecular biology.

BOT4E01-6. Genetics and Crop Improvement

1. General account of origin, variability, floral biology, propagation, breeding techniques, crop management and

major R&D bottle necks in the case of the following crops: rice, wheet, maize, jowar, tea, coffee, rubber, cardamom, coconut, arecanut, oil palm, cocoa, cashew, pepper, ginger, turmeric,vanilla.
2. Detailed account of crop research institutes under CGIAR, ICAR and CommodityBoards.
3. Crop genetic resources- conservation and utilization. Centres of origin of cultivated plants- primary and secondary centres of diversity. Gene banks- international and national networks of genebanks.
4. Systems of reproduction and mating systems in cropplants.
5. Conventional methods of plant breeding- plant domestication, introduction, selection andhybridization.
6. Modern methods of plant breeding- mutation breeding, polyploidy breeding, distant hybridization and biotechnologicalapproaches.
7. Resistance breeding- breeding for biotic and abiotic stressresistance.
8. Genetics ofphotosynthesis.
9. Genetics of nitrogenfixation.
10. Patenting of life forms- IPR, farmers' rights and plant breeders'rights.
11. Production of improved seeds- seed certification- procedure for varietyrelease.
12. Farming systems- intensive, organic and integrated- sustainableagriculture.
13. Genetically modified crops- major achievements- merits and demerits-biosafety.

Practicals

1. Morphological and floral studies of majorcrops.
2. identification of crop species/ subspecies/ varieties of the abovecrops.
3. Identification of the major pests and diseases of the above crop plants and submission ofspecimens.
4. Study of chemical composition and use of major pesticides, weedicides, fungicides and other plant protection formulations.
5. Visit to two major plant breeding stations of South India and submission of a certified report/ or placement training at a plant breeding institute for 30 days and submission of a certifiedreport.

References

Dalbholkar A.R. Elements of Biometrical Genetics. Concept Publishing Company.
Frankel O.H. and Bennet E. Genetic Resources in Plants. Black Well.
Sadhu M.K. Plant Propagation. New Age International Publishers.
Allard R.W. Principles of Plant Breeding. John Wiley & Sons.
Jain H.K. and Kharkwal M.C. Plant Breeding. Narosa Publishing House.
Chahal G.S. and Gosal S.S. Principles and Procedures of Plant Breeding. Narosa Publishing House.
Roy D. Plant Breeding. Narosa Publishing House.
Hayward M.D., Bosemark N.O. and Romagosa I. Plant Breeding- Principles and Prospects. Chapman and Hall.
Gupta S.K. Plant Breeding. Agrobios India.
Khan M.A. Plant Breeding. Biotech Books.
Sharma J.R. Plant Breeding. Tata McGraw Hill.
Joshi R.M. Biosafety and Bioethics. Isha Books.
Pagano M. and Gauvreau K. Principles of Biostatistics. Duxbury.
Sharma J.R. Statistical and Biometrical Techniques in Plant Breeding. New Age International Publishers.
Panse V.G. and Sukhatme P.V. Statistical Methods for Agricultural Workers. ICAR.
Rangaswamy R. A Text Book of Agricultural Statistics. New Age International Publishers.
Jasra P.K. Biostatistics. Krishna Prakasan Media (P) Ltd.
Mohanan K.V. Essentials of Plant Breeding. PHI Learning Pvt. Ltd.
Mohanan K.V. Essentials of Plantation Science. Penta Books Publishers & Distributers.

Course outcomes

1. Develop advanced understanding of various crops of commercial importance and their genetic characteristics.
2. Develop understanding of the genetic configuration of important crops and methods for its hybridization for the production of better varieties.
3. Provide insights onvarious farming systems and methods adopted for bringing sustainability.
4. Develop hands-on skills in the study of floral characteristics of major crops.
5. Develop skills for the identification of weeds, pests and diseases and the development of agents for their control.

BOT4E02-1. Molecular Plant Taxonomy

1. Systems of classification- natural, phylogenetic and biologicalsystems.
2. Importance of cytology, biochemistry and molecular biology in taxonomicanalysis.
3. Scope and importance of molecular planttaxonomy.

4. The material basis of systematics: The concept of characters, correlation of characters, character weighing, charactervariations.
5. Isolation and speciation: Geographical or ecological isolation-a pre-requisite for reproductive isolation. Sympatry as the test of biological species, Mechanisms of reproductive isolation- post-mating mechanisms, Incompatibility, Post-zygotic mechanisms,Speciation.
6. Biological classification- Cladistic versus phenetic approach. Definition and history of cladistics. Methodology, formal classification, impact ofcladistics.
7. Techniques in molecular taxonomy: Acquisition of Molecular data, DNA Sequence data, Polymerase chain reaction,DNAsequencingreaction, TypesofDNAsequencedata,AnalysisofDNAsequencedata.
8. Molecular markers in Plant taxonomy: Restriction site analysis (RFLPs), isoenzymes, Simple sequence repeats (SSR) or Microsatellite DNA, Random amplified polymorphic DNA (RAPDs), Amplified fragment length polymorphism (AFLPs), Internal transcribed spacer, Inter simple sequence repeats (ISSR), Single nucleotide polymorphisms(SNPs).
9. Softwares for MolecularTaxonomy.

Practicals
1. Extraction of DNA
2 RAPD, ISSR profiling
3. Molecular Phylogeneticanalysis
4. Demonstration and application ofSoftwares
5. Construction of phylogram using NTYSS.
6. Visit to a research centre in the subject area and submission of areport.

References
Baldwin, B. G., M. J. Sanderson, J. M. Porter, M. F. Wojciechowski, C. S. Campell, and M. J. Donoghue, 1995. The ITS region of nuclear ribosomal DNA; a valuable source of evidence on angiosperm phylogeny. *Annals of the Missouri Botanical Garden* 82: 247 – 277.
Bernard R.Glick and J. J.Pasternak. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press Washington.
Brown T. A. 2001. Gene cloning and DNA Analysis. Blackwell Science Pub.
Doyle, J.J. and J.J. Doyle 1987. A rapid DNA isolation procedure for small quantities of fresh leaf tissue. *Phytochemical Bull*. 19: 11-15.
Doyle, J.J. and J.J. Doyle. 1990. Isolation of plant DNA from fresh tissue. *Focus*. 12(1): 13-15.
Haywood W. H. & Moore D. M. Current concepts in plant taxonomy. Academic press, London
Hillis, D. M., C. Moritz, and B. K. Mable. Molecular Systematics. Sinauer, Sunderland, Massachusetts.
LenkaDrabkova, Jan Kirschner and CestmirVlcek. 2002. Comparison of seven DNA extraction and amplification protocols in historical herbarium specimens of Juncaceae. *Plant Molecular Biology Reporter* 20: 161-175.
Mabee, P.M., and J. Humphries. 1993. Coding polymorphic data: examples from allozymes and ontogeny. *Systematic Biology* 42: 166- 181.
Soltis, E. E., P. S. Soltis, and J. J. Doyle (eds.). 1998. *Molecular Systematic of Plants II: DNA Sequencing*. Kluwer Academic, Boston.
Simpson, M. G. Plant Systematics. Elsevier, Amsterdam.
Sivarajan, V. V and N. K. P. Robson. 1991. Introduction to Principles of Plant Taxonomy. Oxford and IBH.
Soltis, P. S., D. E. Soltis, and J. J. Doyle (eds.). 1992. Molecular Systematics of Plants. Chapman and Hall, New York.
Stace, C. A. Plant Taxonomy and Biosystematics. Edward Arnord, London.
Stebbins, G. L. Flowering Plants- Evolution above species level. Edward Arnord, London.
Walker, J. M. & R. Rapley. Molecular Biology and Biotechnology. Panima Publishing Corporation

Course outcomes

1. Develop advanced understanding on the importanceof Molecular Plant Taxonomy.
2. Provide insights onthe recent advancements in the area of molecular taxonomy.
3. Develop hands-on skills in the area of extraction of genetic materials, their characterization and thereby phylogenetic relationships

BOT4E02-2. Pathology of Plantation Crops and Spices.
1. Principles of plantpathology.
2. Major pathogens of crop plants.
3. Major pests of cropplants
4. Fugicides- contact, semi systemic and systemic- antibiotics- chemistry, mode of application and mode ofaction-

effects and sideeffects.
5. Bactericides- chemistry, mode of application and mode ofaction.
6. Pesticides- chemistry, mode of application and mode ofaction.
7. Biocontrol agents of disease management- fungal and bacterial products- mode of application and mode ofaction.
8. Botanicals as plant protectants- major sources, active principles, mode of application and mode ofaction.
9. Integrated pest and diseasemanagement.
10. Etiology and control measures of the following diseases: Bud rot of coconut, stem bleeding of coconut, nut fall of arecanut, foot rot of black pepper, anthrachnose of black pepper, fungal soft rot of ginger, bacterial wilt of ginger, rhizome rot of cardamom, capsule rot of cardamom, abnormal leaf fall of rubber, pod rot ofcocoa.

Practicals

1. Isolation of fungal and bacterial pathogens of the above diseases, growing them in appropriate nutrient media and identification of the pathogens and preparation of drawings andphotographs.
2. Field collection and preservation of the infected parts in the case of the above diseases and preparation of morphological and microscopic drawings and photographs and identification of the diseases at field and lablevels.
3. Study of disease cycle of a pathogen in any one of the above crop plants and demonstration of Koch's postulates and preparation of an illustratedreport.
4. Visit to two crop research stations and first hand acquaintance with the major plant protection activities in the station and submission of reports/ or lab placement training in the plant protection division of a crop research station for a period of 30 days and submission of areport.

References

Rangaswami G. Diseases of Crop Plants in India. Prentice Hall of India, New Delhi.
Singh R.P. and Singh U.S. Molecular Methods in Plant Pathology. CRC, Lewis.
Agrios, George N. Plant Pathology. Academic Press INC. , NY.
Mehrotra R.S. Plant Pathology. Tata Mc Graw Hill Publication, New Delhi.
Johnson L.F. and Curl E.A. Methods for Research on the Ecology of Soil Borne Plant Pathogens. Burgress Publishing Company, U.S.A.
Dhingra O.D. and Sinclair J.B. Basic Plant Pathology Methods. Academic Press, NY.
Aneja K.R. Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International Publishers, New Delhi.
Pelczar Jr., Michael J. Microbiology.Tata Mc Graw Hill Publication, New Delhi.
Nair L.N. Topics in Mycology and Plant Pathology. New Central Book Agency (P) Ltd., Kolkata.
Waller J.M., Lenne J.M. and Waller S.J. Plant Pathologists' Pocket Book. CABI Publication, NY.
Riker A.J. and Riker R.S. Introduction to Research on Plant Diseases. John S. Swift Co., St. Louis,MO.

Course outcomes

1. Develop advanced understanding of various concepts in Plant Pathology.
2. Provide insights on various crops plants, pests and methods used for the control of pests from various farming systems.
3. Understand various diseases associated with major plantation crops and analyze various methods adopted for their control.
4. Develop hands-on skills for the isolation of pathogens, analysis of disease cycles and measures for their control.

BOT4E02-3. Genetic Engineering

1. Structure of genes in prokaryotes and eukaryotes. Genetic code and codons. Geneexpression.
2. Recombinant DNA technology: Tools of rDNA technology, methods of creating rDNA molecules, restriction mapping, isolation and separation of genetic material, southern, northern, western, southwestern and northwestern blottingtechniques.
3. Gene transfer techniques in plants- Agrobacterium mediated transfer, gene gun method, electroporation, microinjection, chemicalmethods.
4. Molecular markers- RAMPO, SSCP, RFLP, RAPD, AFLP, EST markers, Repetitive DNA, Microsatellite and Minisatellite.
5. DNA sequencing- chemical and enzymatic methods. Importance of DNAsequencing.
6. Gel electrophoresis- techniques for visualization and readingsequences.
7. Polymerase Chain Reaction- history, methodology of PCR. Variations from Basic PCR- reverse transcriptase PCR, nested PCR, inverse PCR- applications ofPCR.
8. DNA profiling- history, methodology of genetic fingerprinting-applications.
9. Genetic engineering for crop improvement – transgenicplants.
10. Cloning of genes and production of vaccines, drugs, growth hormones andchemicals.

11. Gene therapy- types of gene therapy. Getting transgenes in to patients- viral and non viral approaches. Success of genetherapy.
12. Abatement of pollution through genetically engineered microorganisms- an emerging approach towards environmental clean upprogrammes.
13. Nanotechnology and its applications in geneticengineering.

Practicals

1. Working out problems in geneticengineering.
2. Isolation of plant DNA and its quantification byspectrophotometer.
3. Isolation of plasmid DNA from E.coli.
4. Gel electrophoresis- gel preparation, casting, elution andstaining.
5. VisualizationofDNAbyagarosegelelectrophoresisandgelreading.
6. Construction of coding sequence of DNA using amino acidsequence.
7. Visit to a genetic engineering lab and submission of areport.

References

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.
Brown T.A. Gene Cloning and and DNA Analysis. Blackwell Science Pub.
Dubey R.C. A Text Book of Biotechnology. Chand Pub.
Singh B.D. Biotechnology. Kalyani Publishers.
Walker and Rapley. Molecular Biology and Biotechnology..Panima Pub.
Chrispeels M.J. and Sadava D.E. Plants, Genes and Agriculture.
Lewin B. Genes. Oxford University Press.
Mason A.C. Principles of Gene Manipulation and Genomics.
Rissler J. and Mellon M. The Ecological Risks of Engineered Crops. MIT Press, Cambridge.
Avice, John C. The Hope, Hype and Reality of Genetic Engineering.
McYYan R.P. Genetics and Genetic Engineering. Saras Publications.
Narayana L.M. Molecular Biology and Genetic Engineering.
Khadpekar N.R. The Age of Nanotechnology. ICFAI University Press, Hyderabad.
Nalwa H.R. Encyclopedia of Nanoscience and Technology.

Course outcomes

1. Develop advanced understanding of various concepts in the genomic characteristics of prokaryotes and eukaryotes.
2. Provide detailed insights on various methods and techniques used in gene sequencing, amplification and transfer
3. Understand various concepts in the development of genetically engineered organisms for industries, health care and pollution abatement.
4. Develop hands-on skills in the separation / isolation of genetic materials and their characterization.

BOT4E02-4. Genomics and Proteomics

1. Comparative and functional genomics: whole genome sequencing- organisms picked for genome sequencing- protein functions from genome sequence- protein sequencing and annotated genomeonline.
2. Organising a large scale sequencing project: Hierarchical or 'BAC to BAC' genome sequencing- whole genome shotgun sequencing- resequencing- sequence data banking andannotation.
3. Pattern matching: basic tools of bioinformatics- sequence alignment- defining the optimum alignment- pattern matching in three dimensional structures- classification and assignment of proteinfunction.
4. Development of databanks in molecular biology: nucleic acid sequence databases- genome browsers- databases of genetic diseases- OMIM- databases ofstructure.
5. Classification of protein structure: Boutique databases- databases of metabolic pathways- expression and proteomics databases- molecular biology databases andservers.
6. Microarrays: analysis of microarray data- expression patterns in different physiological states- the dauxic shiftin *Saccharomyces cerivisiae*- sleep in rats and fruit flies- expression pattern changes in development- variation of expression patterns during the life cycle of *Drosophila melanogaster*- flower formation in roses- evolutionary changes in expression- application of microarrays- development of antibiotic resistance in bacteria.
7. Proteomics: protein nature and types- protein structure- separation and analysis of proteins- PAGE and Mass spectroscopy- classification of protein structures- SCOP- changes in folding patterns in proteinevolution.
8. Protein structure prediction and modeling: homology modeling- available protocols- directed evolution and protein design- directed evolution of Subtilisin E- enzyme design- protein complexes and multisubunitproteins.

9. Systems biology: Introduction- pictures networks as graphs- dynamic stability and robustness- sources of ideas for systems biology- Shannon's definition of entropy- randomness of sequences- static and dynamic complexity- computational complexity- metabolic net works and protein interaction networks- protein-DNA, protein-protein, protein-nucleic acid interactions- regulatory networks- lac operon- signal transduction and transcriptional control- structure of regulatory networks- genetic regulatory networks in *Saccharomyces cerivisiae*.
10. Ethical consequences of genomicvariation.

Practicals
1. Annotation projects in plants- rice (RGAP)
2. Interpretation of automated DNA sequence data fromchromatogram.
3. DNA sequence alignment using any standalonesoftware.
4. Protein structure elucidation from DNA sequence data and prediction of secondary and tertiary structure using proteindatabases.
5. Data mining for unique phenotypes in plants/ animals/ humans.
6. Microarray dataanalysis.
7. PAGE for total proteinanalysis.
8. Familiarising conformation ofproteins.
9. Online homology modeling of a givenprotein.
10. Visit to a research lab and submission of areport.

References
Anolles G.C. Evolutionary Genomics and Systems Biology. Willey Black well.
Lesk A.M. Introduction to Protein Science. Oxford University Press.
Lesk A.M. Introduction to Genomics. Oxford University Press.
Lee, Mei-Ling Ting. Analysis of Microarray Gene Expression Data. Springer.
Subramanian C. Analyzing Genome. Dominant.

Course outcomes

1. Develop advanced understanding of various concepts in genome sequencing
2. Understand various concepts in proteomics like separation, analysis and evolution.
3. Provide insights on prediction and modeling in proteomics
4. Develop hands-on skills in DNA sequencing, protein analysis and modeling, using computer software.

BOT4E02-5. Genetic Engineering and Bioinformatics
A. Genetic Engineering
1. Techniques in Molecular Biology: DNA markers and DNA probes- DNA sequencing methods (Maxam & Gilbert, *Sanger et al*., capillary)- RNA sequencing- Sequenator- *In situ* hybridization (DIRVISH & FISH), PRINS, colony hybridization, dot & slot blots; blotting (Southern, Northern, Western, South Western & North Western), RFLP, RAPD, STS & PCR – variants in PCR, Real time quantitative PCR, LCR); DNA and RNA fingerprinting, genomic library, cDNA library and gene bank; chromosome walking, protein sequencing- MALDI, Human Genome Project.
2. Recombinant DNA Technology: Tools in genetic engineering; prokaryotic and eukaryotic vectors; shuttle, expression, dominant selectable, amplifiable, integrating and broad host range vectors; positive and negative selection; enzymes involved; gene cloning and gene farming; single cell protein; shotgun cloning; gene library; comparison of cloningvectors.
3. Gene transfer in prokaryotes and eukaryotes: Recombinant viral method, DBA mediated gene transfer, protoplast fusion, micro-cell fusion; metaphase chromosome transfer; liposome mediated gene transfer; microinjection and electroporation, biolistics and organelleengineering.
4. Transgenesis in plants: Somaclones; plant cell-bacterium hybrids; biociders; biological control; pathogen resistance; herbicide resistance; stress resistance; homozygous cultivars; enrichment of storage proteins; improvement of photosynthesis; post harvest preservation; selection of auxotrophs; secondary metabolite production.
5. Genetic engineering: Single cell proteins; protein engineering; fusion proteins & designer enzymes; production of biopharmaceuticals; commodity and industrial chemicals. IPR and patenting; biological risks, GM food and terminator technology; biosafety and biohazards; physical and biological containment; genetic screening and privacy; ethical, economic and legal issues.

B. Bioinformatics
1. Data bases &Tools: Introduction, need of informatics tools and exercises, significance of databases in

informatics projects. Nucleotide and protein sequence databases: GenBank, DDBJ, EMBL, PIR, Primary and secondary databases, format of databases, gene bank flat file. Protein Data Bank flat file; FASTA format, PIR format; Structure file formats, PDBSUM, PDB Lite, MMDB, SCOP, Pfarm; Database of structure viewers. Specialized databases: NCBI, Pubmed, OMIM, Medical databases, KEGG, EST databases. Overview of other popular tools for bioinformaticsexercises.

2. Sequence alignment and database searches: Introduction, evolutionary basis of sequence alignment, modular nature of proteins, optimal alignment methods, substitution scores, PAM, BLOSUM, Gap penalties, statistical significance of alignments, database similarity searching, FASTA, BLAST, Low Complexity Regions, Repetitive Elements. Practical aspects of Multiple Sequence Alignment- Progressive Alignment Methods, CLUSTALW, Motifs and Patterns, PROSITE, 3DPSSM, Hidden Markov Models and Threading Methods. Conceptual numericals.

3. Phylogenetic analysis: Introduction, rooted and unrooted trees, elements of phylogenetic models, phylogenetic data analysis, alignment, substitution model building, tree building and tree evaluation, building data model (alignment), determining the substitution model, tree building methods, searching for trees, rooting trees, evaluating trees and data, phylogenetic softwares(CLUSTALW, PHYLIP, etc.). Conceptualnumericals.

4. Predictive methods: Predictive methods using nucleotide sequences: Framework, Masking repetitive DNA, Database searches, Codon Bias Detection, Detecting Functional Sites in DNA (promoters, transcription factor binding sites, translation initiation sites), Gene Parsing, finding RNA Genes, Web based tools (GENSCAN, GRAIL, GENEFINDER). Predictive methods using protein sequences: Protein identity based on composition, physical properties based on sequence, secondary structure and folding classes, specialized structures or features, tertiary structure. Related web based softwares (JPRED, PROSEC, NNPREDICT,SOPMA).

5. Plasmid mapping and primer design: Restriction mapping, utilities, DNA strider, Mac Vector and OMIGA, gene construction kit, VrctorNTI, Web based tools (MAP, REBASE); Primer design- need for tools. Primer design programmes and software (PRIME3). Conceptualnumericals.

6. Genome bioinformatics: Sequencing methods (qualitative), Bioinformatics tools and automation in Genome Sequencing. Analysis of Raw genome sequence data, Utility of EST data base in sequencing, Bioinformatics in detection of polymorphisms, SNPs and their relevance, Bioinformatics tools in microarray data analysis, tools for comparativegenomics.

7. Molecular visualization: Generation or retrieval; structure visualization, conformation generation. Graphical representation of molecular structures: small molecules (low molecular weight- peptides, nucleotides, disaccharides, simple drug molecules) and macromolecules: proteins, DNA, RNA, membranes). Use of visualization software available in public domain like VMD, Rasmol, Pymol, Spdb viewer, Chime, Cn3d. Rotameric structures of proteins (conformational flexibility). Canonical DNA forms (DNA Sequence Effects). Systematic methods of exploring conformationalspace.

8. Insilico modeling and drug design: Scope and applications of insilico modeling in modern biology. Comparative modeling, constructing an initial model, refining the model, manipulating the model, molecule superposition and structural alignment, concept of energy minimization, different types of interactions and formulation of force fields. Basic MD algorithm, its limitations, treatment of long range forces. Molecular modeling in drug discovery, deriving bioactive conformations, molecular docking, quantitative structure- activity relationship (QSAR), deriving the Pharmacophoric pattern, receptor mapping, estimating biological activities, Ligand- Receptor interactions: Docking, Calculation of Molecular Properties using Energy Calculations. Conceptualnumericals.

Practicals

A. Genetic Engineering

1. Genomic DNA isolation by CTAB method from planttissues.
2. Isolation of bacterial genomicDNA.
3. Molecular weight determination of DNA by Agarose gelelectrophoresis.
4. Reseticton fragment analysis ofDNA.
5. Plasmid DNAisolation.
6. Estimation of DNA concentration by spectrophotometricmethod.
7. Estimation of RNA concentration by spectrophotometricmethod
8. Lac induction by X- Galmethod.
9. Visit to a genetic engineering lab and submission of areport.

B. Bioinformatics

1. Exercises on Windows, Linux, UNIX, Networking, Internet search andGraphics.
2. Use of software for identification- accessing existing databases on WWW; software for identification ofspecies.
3. Use of softwares to elucidate structure of biomolecules; docking of molecules and molecular designing/ modeling. Analytical softwares related to Genomics andProteomics.
4. Use of similarity, homology and alignment softwares. Software of microarray analysis- design, processing and

analysis.
5. Visit to a research institute of the relevant area and submission of areport.

References

Lewin B. Genes. Humana Press.
Flynne W.G. Biotechnology and Bioengineering. Nova Science Publishers.
Lipps G. Plasmids: Current Research and Future Trends. Caister Academic Press.
Torr J.D. Genetic Engineering- Current Controversies. Greenhaven Press, San Diego, USA.
Engdahl S. Genetic Engineering- Contemporary Issues. Greenhaven Press, San Diego, USA.
Magnien E. and De Nettancourt D. Genetic Engineering of Plants and Microorganisms Important to Agriculture. Springer Verlag.
Fox M.W. Beyond Evolution: The Genetically Altered Future of Plants, Animals, the Earth … and Humans. Lyons Press.
HO R.J.Y. and Gibaldi M. Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes in to Drugs. Wiley-VCH.
Ausubel F.M. *et al*. Short Protocols in Molecular Biology. John Wiley & Sons.
Wilson J. and Hunt T. Molecular Biology of the Cell: Problems Book. Garland Science.
Lodish H. Students' Solutions Manual for Molecular Cell Biology. W.H. Freeman Co.
Innis M.A., Gelfand D.H. and Sninsky J.J. PCR Applications: Protocols for Functional Genomics. Academic Press.
Mitra S. Genetic Engineering. Macmillan India Ltd.
Reed R. *et al*. Practical Skills in Biomolecular Sciences. Benjamin Cummings.
Baxevanis, Andreas D. Bioinformatics. Wiley Interscicnce.
Mount, David W. Bioinformatics. Cold Spring Harbor.
Lesk, Arthur. Introduction to Bioinformatics. Oxford.
Brown, Stuart M. Bioinformatics. NYU Medical Center, NY,USA.
Krane D.E. and Raymer M.L. Fundamental Concepts of Bioinformatics. Pearson.
Bourne PE and WeissigH. Structural Bioinformatics.Wiley-Liss.
Doolittle R.F. Computational Methods for Macromolecular Sequence Analysis. Academic Press.
Salzberg S.L., Searls D.B., Kasif S. Computational Methods in Molecular Biology. Elsevier.
Rastogi S.C., Mendiratta N. And Rastogi P. Bioinformatics, Methods and Applications. PHI.
Cohen, N. Caude. The Molecular Modeling Perspective in Drug Design. Academic Press.
Markoff, Arseni. Analytical Tools for DNA, Genes & Chromosomes. New Age.
Tramontano, Anna. Introduction to Bioinformatics. Taylor & Francis.
Higgins, Des and Taylor, Willie. Bioinformatics. Oxford.
Campbel A.M. and Heyer L.J. Discovering Genomics, Proteomics and Bioinformatics. Pearson Education.

Course outcomes

1. Develop advanced understanding in molecular biology, recombinant DNA technology, gene transfer and genetic engineering for the production of value added products.
2. Provide insights on databases, tools and various applications in bioinformatics.
3. Develop hands-on skills and expertise in the isolation and characterization of DNA by various methods
4. Develop skills and expertise for the elucidation of biomolecules using Computer software.

BOT4E02-6. Biotechnology in Crop Improvement

1. **Introduction:** History and present status of biotechnology in Indian and globalcontext.
2. **Plant genetic resources:** Definition, components of plant genetic resources, classification of plant genetic resources, plant genetic resources activities, exploration, conservation, evaluation, documentation and utilization. Agencies involved in plant genetic resources activities: IPGRI and NBPGR. Erosion of plant genetic resources – Role of biotechnology in conservation of plant geneticresources.
3. **Crop Genetics:** General account of origin, genetic variability, breeding techniques and achievements in the area of (a) Rice, (b) Coconut, (c) Rubber, (d) Arecanut (e) Cashew (f) Pepper (g)Ginger.
4. Organizational set up, research activities and achievements of ICAR,CSIR.
5. **Organizational set up, research activities and achievements of national institutes:** IARI, CCMB, IISc, BARC, CPCRI, IISR, RRII and CTCRI.
6. **Plant type concept:** Introduction, History, designing and breeding of model plant types eg.Wheat
7. **Protoplasts in gene transfer systems:** Methods of isolation, culture and fusion of protoplasts, selection of heterokaryons, somatic hybrids and cybrids, somaclonal variation.
8. **Plant cell cultures as an *in vitro* system for crop improvement:** Cell culture systems – use of markers in cell line selection – incorporation of desirable agronomic traits such as salt tolerance, drought tolerance, disease resistance and herbicide tolerance in commercialcrops.

9. **Haploids in crop improvement:** Anther, pollen and ovary culture for production of hapoid plants and homozygouslines-useofpollensfor(a)identifyingplantswithusefulgenes(b)overcominghybridizationbarrier,
(c) handling back cross generations (d) stabilization of recombinants.
10. **Micropropagation:** Fundamental and applied aspects of the methodology – operation of commercial units in Indian and global context – advantages anddisadvantages.
11. **Immobilzation techniques:**Definition and concept of immobilization – enzyme and whole cell immobilization – adsorption, cross linking, ionic bonding, entrapment- advantages and disadvantages – industrial application of the technique.
12. **Post harvest protection:** Antisense RNA technology (ACC synthase and polugalacturonase) in tomato, banana and water melon- extending shelf life of fruits and flowers and post harvest production of cereals, millets andpulses.
13. **Bioreactor technology:** Large scale production of commercially important compounds using plant cells, hairy roots and microorganisms – types of bioreactors, tubular, membrane, tower, fluidized bed, packed bed, photobioreactores, bubble columns, air-lift bioreactors – operational procedures and optimization of culture conditions by monitoring parameters such as temperature, DO, pH,turbidity.
14. **Application of biotechnology:** Improvement of crop plants with enhanced essential amino acids, storage proteins, edible oil, improved growth rate and yield of wood in forest trees – stress tolerance in plants, drought and salinity – use of antifreeze gene for frost tolerance – environmentalprotection.
15. **Release and multiplication of varieties:** Channels of variety release – production of improved seeds – classes of seeds – seed certification – the India See Act(1966).
16. **Intellectualpropertyrights**:Definition–protectionofintellectualpropertyright(a)copyright(b)trademark
(c) designs (d) IC layout designs (e) Geographic indication (f) patents – objectives of patent system – basic principles and general requirements of patent laws – patent system in India – patent information and service by patent office – patent procedures. –Infringement problems – harmonization of patent laws – patenting biotechnological innovations – legal protection to microorganisms, higher plants and animals – IPR in relation to crop improvement. PPVFR Act (2001) – merits anddemerits.
17. **Globalization and Indian agriculture:** Plant variety protection – purpose of plant variety protection – UPOV: functions, organization and features. Responsibilities of membercountries.

Practicals

1. Determination of seed vigour and viability using (a) paper piercing test (b) GADA test (c) Tetrazolium test (d) Seedling growth rate and seedling dry weight test (e) speed of germinationtest.
2. Determination of pollen viability using (a) in vitro germination test (b) Tetrazolium test (c) *in vitro* germination and pollen tube growthtest.
3. Isolation and fusion of protoplast from pollen grains and cellcultures.
4. Initiation and establishment of hairy root cultures using *Agrobacteriumrhizogenes.*
5. Anther and pollen culture of Daturaspecies.
6. Visit to one crop improvement research institute and submission of a detailedreport.

References:

Allard R.W. Principles of plant Breeding.
Singh B.D. Plant Breeding – Principles & Methods. Kalayani Publishers, New Delhi.
Phundan Singh. Essentials of Plant Breeding. Kalayani Publishers, New Delhi.
Mohanan K.V. Essentials of Plant Breeding. PHI Learning Pvt. Ltd.
Chahal G.S. and Gosal S.S., Principles & Procedures of Plant Breeding. Narosa Publishing House.
Gupta P.K. (Ed.),Genetics& Biotechnology in Crop Improvement. Rastogi Publishers, Meerut.
ICAR – Now and Ahead. ICAR.
Ganguli P. Gearing up for patents. University Press, Hyderabad.
Melchias G. Biodiversity Conservation. Oxford IBHPublishers.
Anita Rao R. &Bhanoji Rao. Intellectual property Right- A Primer. Eastern Book Company.
Narayanan P. Intellectual Property Law. Eastern BookCompany.
Rana R.S. (Ed). *Ex situ* conservation of Plant Genetic Resources. NBPGR, New Delhi.
Paroda, R.S. (Ed). Plant Genetic Resources – Indian Perspectives. NBPGR, New Delhi.
Brown T. A. Gene cloning and DNA analysis. Blackwell Science Publishers.
Maarten J. Chrispeels and Sadava D.E., Plants, Genes and Agriculture, Jones and Barlett Publishers.

Course outcomes

1. Develop advanced understanding of various concepts in Plant Biotechnology
2. Provide insights on the applications of Biotechnology in crop improvement.
3. Develop hands-on skills in various Biotechnological applications for the development of crop varieties,

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

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

Course outcomes

1. Provide insights on data collection, organizing research schedules, collection of databases and its interpretation, scientific writing and presentation of research findings on various platforms.

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:BiotechnologyandIntellectualPropertyRights-PatentingBiotechInventions:Objective,Applications,Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnologicalinventions.

Course outcomes

1. Develop understanding of various legal provisions for safeguarding intellectual contributions from getting misused / exploited.

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