University of Kalyani

M.Sc. Botany
Choice Based Credit System

Syllabus

(2021 – onwards)

Department of Botany
Kalyani - 741235

REGULATIONS RELATING TO THE CONDUCT OF UNIVERSITY EXAMINATIONS IN M.Sc. BOTANY - SEMESTER SYSTEM (CHOICE BASED CREDIT SYSTEM)

DEFINITIONS

1. ***'Programme'*** means the entire course of study and examinations (traditionally referred to as course).
2. ***'Duration of Programme'*** means the period of time required for the conduct of the program. The duration of post-graduate programme shall be 4 semesters.
3. ***'Semester'*** means a term consisting of a minimum of 90 working days including examination days distributed over a minimum of 18 weeks each of 5 working days.
4. ***'Course'*** means a segment of subject matter to be covered in a semester (traditionally referred to as paper).
5. ***'Credit'*** **(Cr*)*** of a course is a measure of the weekly unit of work assigned for that course.
6. ***'Letter Grade'*** or simply ***'Grade'*** in a course is a letter symbol (O, E, A, B, C, D, F) which indicates the broad level of performance of a student in a course.
7. Each letter grade is assigned a ***'Grade point'*** (G) which is an integer indicating the numerical equivalent of the broad level of performance of a student in a course.
8. ***'Credit point'*** (P) of a course is the value obtained by multiplying the grade point (G) by the Credit (Cr) of the course P=G x Cr.
9. ***Semester Grade point average'*** (SGPA) is the value obtained by dividing the sum of credit points (P) obtained by a student in the various courses taken in a semester by the total number of credits taken by him/her in that semester. The grade points shall be rounded off to two decimal places. SGPA determines the overall performance of a student at the end of a semester.
10. ***'Cumulative Grade point average'*** (CGPA) is the value obtained by dividing the sum of credit points in all the courses taken by the student for the entire program by the total number of credits and shall be rounded off to two decimal places.

PROGRAMME STRUCTURE

1. Students shall be admitted into post graduate Choice Based Course System in Botany under the Faculty of Science.
2. The programme shall include Core (COR) Courses, Ability Enhancement Compulsory Courses (AECC), Skill Enhancement Courses (SEC), Generic Elective Courses (GEC) and Discipline Specific Elective (DSE) courses. All core (COR) and Special paper DSE Courses have both theoretical and practical courses. COR, AECC, SEC and GEC courses are compulsory. DSE courses should be opted by the students and allotted to them as per availability of the faculty. GEC course should be offered to the students of other departments and M.Sc. Botany students should opt one GEC course from the P.G. subjects other than Botany. There shall be a Project /Dissertation in the DSE Course to be undertaken by all students.
3. The Course of study shall extend over a period of two academic years and will be offered in four semesters: I and III semesters: July to December; II and IV semesters: January to June, or as specified in the Academic Calendar of the University of Kalyani.

4. The admission to the PG programme shall be as per the rules and regulations of the University.
5. The eligibility criteria for admission shall be as announced by the University at the time of advertisement.
6. The admission to the course shall only be in the first semester at the beginning of each academic year.
7. M.Sc. degree will be awarded to students who complete a total of 84 credits in a minimum of two years.

ATTENDANCE

8. A student is required to attend all classes. Theoretical and Practical class attendance will be counted separately.
9. For candidates taking late admission in the 1st Semester, attendance will be counted from the date of their admission.
10. A candidate shall be allowed to appear at any of the Semester examinations if he/she has attended 75% or above of the course lectures/practical classes held during that semester. If the attendance falls short of 75% but not below 60%, he/she will be allowed to appear at the examination as non-collegiate candidate on payment of requisite fees. Candidates attending less than 60% classes in any semester will be treated as discollegiate and will be debarred from appearing at the examination of that semester. He/she will be allowed to take re-admission in subsequent one semester only in the next year.
11. Shortage of attendance up to a maximum of 10% will be condoned, if (i) A student was away representing the University/State/Country in Athletic/Sports and Games/Cultural/N.C.C or any other important socio-intellectual event; (ii) Parents' appeal on health or on other serious grounds duly recommended by the Head concerned (An authentic certificate from appropriate authorities must be produced).

EXAMINATION, EVALUATION AND GRADING

12. The EVALUATION SCHEME for each course shall contain two parts: (a) Term-end evaluation (TEE) and (b) Internal Assessment (IA). 20% weightage shall be given to internal assessment and the remaining 80% to Term-end evaluation. Therefore, the ratio and weightage between term-end and internal assessment is 4:1. The points (marks) in each Course will be as follows:

Courses	Points in theoretical courses			Points in practical courses		
	Term-end evaluation	Internal assessment	Total	Term-end evaluation	Internal assessment	Total
COR	60	15	75	20	5	25
AECC, SEC	20	5	25	-	-	-
GEC, DSE (soft core)	40	10	50			
DSE (special paper)	80	20	100	80	20	100
Project/**Dissertation**				80	20	100

13. Duration of examination of theoretical courses up to 25 points shall be one hour, 50 points two hours, 60 points two and half hours, 75 points three hours and 100 points

four hours. The same for the practical courses up to 25 points shall be two hours and up to 100 points six hours generally.

14. To ensure transparency of the evaluation process, the internal assessment grade awarded to the students in each course in a semester shall be published on the notice board at least one week before the commencement of Term end examination.

15. In order to qualify in a semester examination, a student shall have to get minimum aggregate 40 points (**D and above on grade point scale**) in each course.

16. There shall generally be no retest for internal assessment. If a student misses a class test during an on-going semester for health or other valid reasons, he/she may be given a second chance with the permission of the Departmental Committee. The student has to justify his/her absence by providing an authentic certified document. However, such a second chance shall not be the right of the student; it will be the discretion of the D.C. to give or not to give second chance to a student to appear for internal assessment.

17. For **Internal Assessment**, two class tests each for 12 points (for COR courses) or 8 points (for GEC and DSE soft core courses) or 15 points (for DSE special paper courses) will be conducted comprising of objective (1 mark) and short (3-5 marks) type questions for each Course. The Class test will be for a duration of 45 minutes (for 12 points), or 30 minutes (for 8 points), or 60 minutes (for 15 points). The average of marks obtained in two class tests will be considered. The mode of internal assessment of AECC and SEC courses will be informed later by the concerned teachers. Points will also be awarded for class attendance and/or assignments for each course during each semester (3 points for COR courses, 2 points for DSE soft core courses and 5 points for GEC and DSE major courses). For scoring of attendance, the following principle will be followed: for ≥80% attendance 100% point i.e., 3/2/5; 79-70% attendance 75% point i.e., 2/1/4; 69-60% attendance 60% point i.e., 1/1/3.

18. Internal marks will not change. A student cannot repeat Internal Assessment. Internal Assessment answer books shall be shown to the students concerned but not the end-semester answer scripts.

19. Students who have failed semester-end exam may reappear for the semester-end exam only twice in subsequent period. The student will be finally declared as failed if he/she does not pass in all credits within a total period of four years.

20. **(a)** A candidate who fails to qualify or fails to appear at not more than two theoretical / practical courses in a semester will be treated as Failed but Supplementary (FS) and will be allowed to prosecute studies in the next semester. He/she will generally be allowed to appear at supplementary examination for those papers in which he/she has failed. The date of supplementary examination will be announced as per University P.G. regulation. However, his/her marks of qualified papers will be retained. **(b)** If a candidate fails to qualify or fails to appear at more than two theoretical /practical courses in a semester, he/she will be treated as Failed but Repeat (FR) and will have to repeat that semester as a whole in the next year. He/she will not be allowed to join classes of the next semester.

21. The candidate eligible for supplementary examination as per **20(a)** or eligible for repeat semester as per **20(b)** will get a chance to appear at maximum of two consecutive supplementary / total examinations in any semester. However, a candidate will have to qualify in all the semesters within a span of four years from the year of admission.

22. A candidate who has failed in a theoretical course but has passed the practical course, based on the former, need not appear in the practical course in the supplementary examination.

23. According to the University Regulations, candidates can review only their theoretical answer scripts of Semester-End examination through the Office of the Controller of Examinations, Kalyani University. No application for reviewing of a practical paper shall be entertained. Similarly, the internal assessment answer scripts will also not be reviewed.
24. The written answer scripts of each term end semester examination will be preserved according to the University Rules. Class test answer scripts will however be preserved in the Department for two years from the date of start of the concerned Semester. After that period, the scripts will be disposed of.
25. The semester end and final grade sheets and transcripts will have only grades and grade points average.

GRADING SYSTEM

QUALIFICATION	GRADE	SCORE ON 100% POINTS	POINTS
Outstanding	O	90-100	10
Excellent	E	80-89	9
Very Good	A	70-79	8
Good	B	60-69	7
Fair	C	50-59	6
Below average	D	40-49	5
Fail	F	>40	

$SGPA^a = \frac{\text{Sun of [Credits X Grade Point]}}{\text{Sum of credits of all papers in the semester}}$ calculated for each semester

$CGPA^b = \frac{\text{Sem1GP X1 + Sem2GP X1 + Sem3GP X1.5 + Sem4GP X 1.5}}{5}$ for the entire course

[a] Semester Grade Point Average (SGPA)

[b] Cumulative Grade point Average (CGPA)

To satisfactorily complete the M.Sc. Course & qualify for the degree, a student must obtain a minimum CGPA of 5.

CGPA	Division
8-10	**1st Div with Distinction**
6.5-7.9	**1st Div**
5.5-6.4	**2nd Div**
6	**2nd Div with 55%***
5-5.4	**3rd Div**

(* To convert CGPA into %: CGPA – 0.5 X 100)

26. The following academic calendar will be followed for each semester:
    a. Duration of Classes: Four and half months
    b. Preparatory leave - Fifteen days maximum
    c. Examination including Practical - Twenty days

Outline of the Syllabus of the Choice Based Credit System

Course Categories: **COR:** Core; **AECC:** Ability Enhancement Compulsory Courses, **SEC:** Skill Enhancement Courses, **GEC:** Generic Elective Courses, **DSE:** Discipline Specific Elective

Course Transaction Categories: **T:** Theory; **P:** Practical**; PW:** Project Work

Evaluation Categories: **IA:** Internal Assessment; **TEE:** Term End Examination

Course No.	Course Name	Point	Credit	Hrs/ week	Page no. for detail
SEMESTER I					
CORE COURSE THEORY					
BOTCOR T101	Microbiology & Immunology	75	3	4	9-10
BOTCOR T102	Phycology & Mycology	75	3	4	11-13
BOTCOR T103	Bryology & Pteridology	75	3	4	14-15
BOTCOR T104	Taxonomy of Angiosperms & Biosystematics, Gymnosperms & Plant Anatomy	75	3	4	16-17
BOTAECC	Environmental Biology	25	2	2	19
CORE COURSE PRACTICAL					
BOTCOR P101	Practical based on Microbiology & Immunology	25	1	3	10
BOTCOR P102	Practical based on Phycology & Mycology	25	1	3	13-14
BOTCOR P103	Practical based on Bryology & Pteridology	25	1	3	15
BOTCOR P104	Practical based on Taxonomy of Angiosperms & Biosystematics, Gymnosperms & Plant Anatomy	25	1	3	17-18
Total Points & Credits in Semester I		**425**	**18**	**30**	
SEMESTER II					
CORE & GENERIC ELECTIVE COURSES THEORY					
BOTCOR T205	Palaeobotany & Palynology	75	3	4	20-21
BOTCOR T206	Plant Physiology & Biochemistry	75	3	4	22-24
BOTCOR T207	Genetics, Cytogenetics, Plant Breeding & Biometry	75	3	4	25-26
BOTGEC T	Plants in Human Welfare	50	4	4	27-29
CORE COURSE PRACTICAL					
BOTCOR P205	Practical based on Palaeobotany & Palynology	25	1	3	22
BOTCOR P206	Practical based on Plant Physiology & Biochemistry	25	1	3	24-25
BOTCOR P207	Practical based on Genetics, Cytogenetics, Plant Breeding & Biometry	25	1	3	26-27
LIBRARY/ FIELD WORK/ TUTORIAL/ REMEDIAL CLASSES / EXTRA-CURRICULAR ACTIVITIES				5	
Total Points & Credits in Semester II		**350**	**16**	**30**	

Course No.	Course Name	Point	Credit	Hrs/ week	Page no. for detail
SEMESTER III					
CORE COURSE THEORY					
BOTCOR T309	Plant Pathology & Crop Protection	75	3	4	30-31
BOTCOR T310	Plant Molecular Biology & Biotechnology	75	3	4	32-33
BOTCOR T311	Plant Ecology, Biodiversity & Conservation	75	3	4	34-36
CORE COURSE PRACTICAL					
BOTCOR P309	Practical based on Plant Pathology & Crop Protection	25	1	3	31
BOTCOR P310	Practical based on Plant Molecular Biology & Biotechnology	25	1	3	33-34
BOTCOR P311	Practical based on Plant Ecology, Biodiversity & Conservation	25	1	3	36-37
DSE (SOFT CORE) THEORY: Any **one** from the following;					
BOTDSE T301.1	Forensic Botany	50	2	2	37-38
BOTDSE T301.2	Fundamentals of Crop Physiology	50	2	2	38-40
BOTDSE T301.3	Industrial Microbiology	50	2	2	40
BOTDSE T301.4	Pharmacognosy	50	2	2	40-42
SKILL ENHANCEMENT COURSE THEORY					
BOTSEC T	Intellectual Property Rights	50	2	2	42-43
BOTDSE PW (Project/Dissertation/Review Work) **Discipline Specific Elective (DSE) special paper Courses are allotted & BOTDSE PW course is initiated in Semester III**				5	
Total Core Points/ Credits in Semester III		**300**	**12**	**21**	
Total DSE (Soft Core) Points/ Credits in Semester III		**50**	**2**	**2**	
Total SEC Points/ Credits in Semester III		**50**	**2**	**2**	
Total Points/ Credits in Semester III		**400**	**16**	**30**	
SEMESTER IV					
DISCIPLINE SPECIFIC ELECTIVE THEORY Any **one** single combination of Course – I & Course – II from the following**:**					
BOTDSE T402.1	Microbiology (Course – I)	100	8	8	44-45
BOTDSE T403.1	Microbiology (Course – II)	100	8	8	45-46
BOTDSE T402.2	Molecular Genetics, Advanced Cell Biology, Molecular Breeding & Plant Tissue Culture (Course – I)	100	8	8	47-48
BOTDSE T403.2	Molecular Genetics, Advanced Cell Biology, Molecular Breeding & Plant Tissue Culture (Course – II)	100	8	8	48-50
BOTDSE T402.3	Mycology & Plant Pathology (Course – I)	100	8	8	51-52

BOTDSE T403.3	Mycology & Plant Pathology (Course – II)	100	8	8	52-53
BOTDSE T402.4	Palaeobotany, Palynology & Evolution (Course – I)	100	8	8	55-56
BOTDSE T403.4	Palaeobotany, Palynology & Evolution (Course – II)	100	8	8	56-57
BOTDSE T402.5	Phycology (Course – I)	100	8	8	59-60
BOTDSE T403.5	Phycology (Course – II)	100	8	8	60-61
BOTDSE T402.6	Plant Physiology, Biochemistry & Plant Molecular Biology (Course – I)	100	8	8	62-63
BOTDSE T403.6	Plant Physiology, Biochemistry & Plant Molecular Biology (Course – II)	100	8	8	63-64
BOTDSE T402.7	Pteridology (Course – I)	100	8	8	65-67
BOTDSE T403.7	Pteridology (Course – II)	100	8	8	67
DISCIPLINE SPECIFIC ELECTIVE PRACTICAL					
BOTDSE P404.1	Practical based on Microbiology (Course I & II)	100	8	6	46-47
BOTDSE P404.2	Practical based on Molecular Genetics, Advanced Cell Biology, Molecular Breeding & Plant Tissue Culture (Course – I & II)	100	8	6	50-51
BOTDSE P404.3	Practical based on Mycology & Plant Pathology (Course – I & II)	100	8	6	54-55
BOTDSE P404.4	Practical based on Palaeobotany, Palynology & Evolution (Course – I & II)	100	8	6	57-58
BOTDSE P404.5	Practical based on Phycology (Course – I & II)	100	8	6	61-62
BOTDSE P404.6	Practical based on Plant Physiology, Biochemistry & Plant Molecular Biology (Course – I & II)	100	8	6	64-65
BOTDSE P404.7	Practical based on Pteridology (Course – I & II)	100	8	6	67-68
DISCIPLINE SPECIFIC ELECTIVE COURSE PROJECT /REVIEW WORK					
BOTDSE PW	Project / Dissertation/ Review Work	100	8	6	
DSE (SOFT CORE) THEORY: Any **<u>one</u>** from the following;					
BOTDSE T405.1	Advanced Immunology	50	2	2	68-69
BOTDSE T405.2	Advanced Pteridology	50	2	2	69-70
BOTDSE T405.3	Mushroom Biology	50	2	2	70-71
Total DSE (Special paper) Course Points/Credits in Semester IV		**400**	**32**	**28**	
Total DSE (Soft Core) Points/ Credits in Semester IV		**50**	**2**	**2**	
Total Points & Credits in Semester IV		**450**	**34**	**30**	
TOTAL POINTS & CREDITS : **425 (18) + 350 (16) + 400 (16) + 450 (34)**		**1625**	**84**		

Detailed Syllabus of the Choice Based Credit System

SEMESTER I

Course No.	Course Name	Points	Credits	Hrs./Wk.
BOTCOR T101	Microbiology & Immunology	75	3	4
BOTCOR P101	Practical based on Microbiology & Immunology	25	1	3
EVALUATION SCHEME –	THEORY:	Internal Assessment (15) + Term End Examination (60) TEE: 60 points		
	PRACTICAL:	Internal Assessment (5) + Term End Examination (20)		

Theoretical Course
BOTCORE T101
MICROBIOLOGY & IMMUNOLOGY

TEE points: 60 **Classes/ Semester: 60**

Course Objectives:
The course is designed to acquaint students with the enormous diversity that microbes exhibit and equip them with the understanding of their structure and biology.

Learning Outcomes:
- Make students understand the diversity in structure and functioning of prokaryotes.
- Learn the mechanism of disease development by pathogens.
- To provide insight of the technique in isolation, identification and maintenance of pure cultures.
- Understand the interaction of pathogen with host in relation to infectivity.
- Demonstrate skills in controlling microbial diseases in day-to-day life.

Course Content: **(No. of Classes allotted)**

1. **History and Development of Microbiology:** contributions of Leuwenhoek, Koch, Pasteur, Jenner and Flemming. (2)
2. **Bacterial Systematics:** Three kingdom concept of Haeckel, Five kingdom concept of Whittaker and three domain classification of Woese; Characters used in bacteriology; Classification- phenetic and phylogenetic; Major groups of microorganisms. (3)
3. **Thermodynamic Principles in Microbiology:** Concept of free energy, Entropy, Enthalpy, Energy rich bonds, Chemical potential, Membrane potential, Diffusion potential. (3)
4. **Bacterial Morphology:** Structure, chemistry and function of capsule,pili, flagella, cell wall, cell membrane, ribosome, chromosome and plasmid, reserve materials and cytoplasmic inclusions; endospore (structure, formation, germination). (5)
5. **History of Development of Virology:** nature, classification and nomenclature of viruses; structural organization and chemistry of viruses; assay of viruses, chemical and physical determination, assays of infectivity; Virus diseases in plants, symptoms of diseases, general transmission of viruses; Bacteriophages- isolation and demonstration, structure of adenoviruses, tobacco mosaic viruses and coliphage T_4; Multiplication of a virulent phage (lytic cycle); Lysogeny- nature of lysogeny, vegetative cycle, lysogenic state, prophage cycle,

induction of a lysogenic cell; Relation of viruses and plasmids in tumour formation-formation of tumours, formation of animal tumours by DNA viruses and RNA viruses; Brief idea about SARS virus, MARS virus, Zica virus, Nipah virus, Ebola virus and Hanta virus; General account of viroids, virusoids, and prions. (20)

6. **Microbial Growth and Nutrition:** Nutritional types and requirements; Types of media (natural, synthetic, semisynthetic, complex, selective); Growth- phases of growth, kinetics of growth, factors influencing growth; Batch culture, continuous culture, synchronous culture, Diauxie. (5)
7. **Control of Microorganisms:** physical, chemical and chemotherapeutic agents; antibiotic resistance; control of virus using chemicals and interferon. (2)
8. **Genetic Recombination:** transformation, transduction and conjugation, detection of recombinants, overview of bacterial genetic map. (5)
9. **Microbes in Nitrogen and Sulphur Cycle:** Nitrification, Denitrification, Ammonification; Mechanism of biological N_2 fixation and structure and regulation of *nif* gene; Microbial oxidation and reduction of sulphur. (4)
10. **Medical Microbiology:** Air borne diseases, water borne diseases, food borne diseases. (2)
11. **Industrial Microbiology:** industrial microorganisms, strain improvement, production of ethanol, penicillin and vitamin B_{12}. (3)
12. **Cosmetic Microbiology:** concept & current trends. (1)
13. **Fundamentals of Immunology:** Innate and Acquired immunity, T-cell, B-cell, MHC, Cytokines, Antigen - types and characteristics: Structure and functions of immunoglobins, Cell mediated and Humoral Immunity; Ag-Ab reactions and Immunological techniques. (5)

Practical Course

BOTCOR P101

Practical based on MICROBIOLOGY & IMMUNOLOGY

Points: 25 **3 hours/ week**

1. Study of symptoms of diseases of economically important plants caused by virus.
2. Study of inclusion bodies in virus infected plants.
3. Study of epidermal patterns of virus infected leaves with reference to change in stomatal index.
4. Biochemical tests for detection of plant viruses.
5. Isolation and staining of *Rhizobium* from root nodules.
6. Isolation and enumeration of bacteria from air, water and soil samples.
7. Enrichment and isolation of nitrogen fixing bacteria from soils.
8. Endospore and capsule staining of bacteria.
9. Determination of antibiotic sensitivity of bacteria by disc diffusion and agar cup method.
10. Determination of thermal death point of bacteria.
11. Study of bacterial growth and effect of inhibitor on bacterial growth.
12. Biochemical tests for characterization of microorganisms: catalase, protease, amylase, nitrate reductase, indole production.

Note: Regularly checked Laboratory records, permanent slides prepared during practical classes, preserved and dried (herbarium sheets) virus infected plants specimens collected during field works should be submitted at the time of TEE.

Suggested Readings:

1. Pelczar, M. J., Chan, E. C. S and Kreig, N. R. (1993). Microbiology. Tata McGraw Hill Education Private Limited, New Delhi
2. Prescott, L. M., Harley, J.P. and Klein, D. A. (1992). Microbiology, WCB Publishers
3. Madigan, M. T. Martinko, J. M. and Parker Jack. (2000). Brock's Biology of Microorganisms, 9th edition. Prentice Hall. NJ. USA
4. Sumbali, G. and Mehrotra, R. S. (2009). Principles of Microbiology, 1stedition. Tata McGraw Hill Publishing Co. Ltd. New Delhi
5. Demain A.L, Davis J.E. and Atlas R. M. (1999). Manual of industrial microbiology and biotechnology. American society for microbiology. Washington DC
6. Khan, J.A. and Dijkstra J. (2007). Handbook of Plant Virology, Taylor and Francis
7. Bos, L. Introduction to plant virology. Oxford and IBH publication
8. Ingraham, J. L. and Ingraham, C.A. (2005). Microbiology: An Introduction. Cengage Learning Ltd
9. Sinha S.N. (2006). Focus on college practical microbiology. Rita Book Agency, Calcutta-73
10. Talwar G.P., Gupta S.K.A handbook of practical and clinical immunology. CBS, New Delhi

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Course No.	Course Name	Points	Credits	Hrs./Wk.
BOTCOR T102 (Group A + B)	**Phycology & Mycology**	**75**	**3**	**4**
BOTCOR P102	**Practical based on Phycology & Mycology**	**25**	**1**	**3**

EVALUATION SCHEME –	**THEORY:**	**Internal Assessment (15) + Term End Examination (60)**
		TEE: Group A (40 points) + Group B (20 points)
	PRACTICAL:	**Internal Assessment (5) + Term End Examination (20)**

Theoretical Course
BOTCOR T102
Group A
PHYCOLOGY

TEE points: 40 **Classes/ Semester: 40**

Course Objectives:

To make students understand the conceptual nature of the polyphyletic group – algae, origin of various algal groups and the characteristic features of some major algal and their application in human welfare; and to enable them to apply their knowledge in practical field.

Learning Outcomes:

After completion of the course the students will be able to:

- Provide an overview of algal systematics and theories explaining chloroplast evolution and algal origin.
- Apply this knowledge in understanding the evolutionary significance of algae and use it as a basis for understanding the evolutionary pathways to other plant groups.

- ❖ Describe the general characteristics of important groups of algae and explain their ecology, role in environment and in human welfare, and a similar treatment for the phytoplankton as well.
- ❖ Apply the knowledge and skills acquired to identify various algae species.

Course Content: **(No. of Classes allotted)**

1. **Introduction to Phycology:** Polyphyletic group - Implications in definition and classification; Diversity of habitat, thallus organization and reproduction; Features considered in classification - storage products, cell wall composition, pigments, flagella, patterns of mitosis and cytokinesis, life cycle patterns; Endosymbiosis (primary, secondary and tertiary)and its role in evolution of chloroplast and origin of algae. (6)
2. **General Overview:** Prochlorophyta; Glaucophyta; Dinophyta; Heterokontophyta (Bacillariophyceae, Xanthophyceae, Eustigmatophyceae, Phaeophyceae). (12)
3. **Cyanophyta:** Diversity of forms and habitats; Systematics; Phylogeny and Evolution. (5)
4. **Rhodophyta:** Diversity of forms and habitats; Evolutionary trends; Ecological roles and responses. (5)
5. **Chlorophyta:** Diversity of forms and habitats; Evolutionary trends; Characteristics of major classes and orders. (5)
6. **Phytoplankton:** Types of phytoplankton; Community Indices; Ecological implications – Eutrophication, Algal Blooms and Toxins, Climate change impacts. (5)
7. **Algae in Human Welfare:** Biofertilizers; Bio-fuel; Commercially important Bio-molecules. (2)

Group B
MYCOLOGY

TEE points: 20 **Classes/ Semester: 20**

Course Objectives:

This course aims to enhance understanding of students the basic and molecular aspects of fungi, their current position, cytology, genetics, diversity among different groups and human pathogens and to develop skills for handling the fungi.

Learning Outcomes:

- ❖ Students will understand fungal biology, their phylogenetic position and major fungal lineages.
- ❖ Students will learn about variation of thallus and reproductive structure of different groups and how they cause disease and allergic response in human.
- ❖ Students will also gain skills to describe and identify macrofungi and microfungi based on their important macroscopic and microscopic features.

Course Content: **(No. of Classes allotted)**

1. **Distinctive Features of Fungi to form a Separate Kingdom & their Classification:** Modern trends, Phylogeny based on 18S rDNA gene sequencing. (1)
2. **The Architecture of Fungal Cell:** Cell wall composition and biogenesis, Cell membrane, Cell organelles and cytoskeleton, Nucleus and its division. (3)
3. **Somatic Recombination in Fungi:** Heterothallism; Heterokaryosis, Parasexuality. (2)
4. **Diversity of Somatic and Reproductive Structures in Different Groups:** Myxomycota, Oomycota, Chytridiomycota, Zygomycota, Ascomycota, Basidiomycota, Deuteromycotina.

(13)

5. **Fungi as Human Pathogens and Allergens.** (1)

Practical Course
BOTCOR P102
Practical based on PHYCOLOGY & MYCOLOGY

Points: 25 **3 hours/ week**

1. Morphological study and identification of members of the major algal groups – Cyanobacteria, Rhodophyta, Chlorophyta and Phaeophyceae.
2. Seaweed identification of members of the major algal groups – Rhodophyta, Chlorophyta and Phaeophyta.
3. Phytoplankton collection and identification of desmids, diatoms and dinoflagellates.
4. Collection of algae from different localities and local tours and submission as voucher specimens.
5. Study of morphological and reproductive structures of some macro- and micro-fungi.
6. Identification of different fruiting structures of macro-fungi, permanent slides with different reproductive structures of micro-fungi, spore forms of rust fungi.

Note: Regularly checked laboratory records, permanent slides prepared during practical classes, specimens collected during field works should be submitted at the time of TEE.

Suggested Readings:

1. Van Den Hoek, C., Mann D.G. & Jahns H.M. (2009). Algae – An Introduction to Phycology. Cambridge University Press
2. Graham, Linda, Graham J.M. &Wilcox L.W. (2009). Algae. Benjamin Cummings from Pearson Education
3. Bhattacharya, D. (Ed.) (1997). Origins of algae and their plastids. Springer Wien, New York
4. Smith, G.M. (1955). Cryptogamic Botany, Algae and Fungi Vol. 1. Tata McGraw-Hill Publishing Company Ltd
5. Ray, S. (2006). Cyanobacteria. New Age International Publishers, New Delhi
6. Bold, H.C. & Wynne,M.J. (1985). Introduction to the algae: Structure and Reproduction. Prentice-Hall
7. Lee, R.E. (2008). Phycology. Cambridge University Press
8. Harris, G.P. (1986). Phytoplankton Ecology. Chapman & Hall
9. Barsanti, L. & Gualtieri P. (2006). Algae- Anatomy, Biochemistry and Biotechnology. Taylor & Francis
10. Bhatia, Bela &VijayaraghavanM.R. (1997). Red Algae: Structure, Ultrastructure and Reproduction. APH Publication
11. Vijayaraghavan, M.R. & Kumari S. (1995). The Chlorophyta: Structure, Ultra-structure and Reproduction. Bishen Singh Mahendra Pal Singh
12. Alexopoulous, C.J., Mims, C.W. & Blackwell, M. (2007). Introductory Mycology. 4th Edition, Wiley
13. Webster, J. & Weber, R. (2007). Introduction to Fungi. 3rd Edition, Cambridge University Press
14. Sethi, I.K. & Walia, S.K. (2018). Text book of Fungi & their Allies, 2nd Edition, McMillan Publishers

15. Mehrotra R.S. &Aneja K.R. An Introduction to mycology, New age International publishers

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Course No.	Course Name	Points	Credits	Hrs./Wk.
BOTCOR T103 (Group A + B)	**Bryology & Pteridology**	**75**	**3**	**4**
BOTCOR P103	**Practical based on Bryology & Pteridology**	**25**	**1**	**3**

EVALUATION SCHEME –	**THEORY:**	**Internal Assessment (15) + Term End Examination (60)** **TEE: Group A (30 points) + Group B (30 points)**
	PRACTICAL:	**Internal Assessment (5) + Term End Examination (20)**

Course Objectives:

The objective is to acquaint the students with non-flowering non-vascular and vascular plants biology and systematics and their first establishment in terrestrial systems. To teach diversity and conservation of the organisms is another motto of this course as these organisms are associated with evolution and economy.

Learning Outcomes:

Students will learn about

- Biology and systematics of bryophytes and pteridophytes.
- Diversity, evolution and conservation of the organism.
- Economical approach of the subject.
- Present position of the subject and their future prospect.

Theoretical Course
BOTCOR T103

Group A
BRYOLOGY

TEE points: 30 **Classes/ Semester: 30**

Course Content: **(No. of Classes allotted)**

1. **Systematics and Evolutionary Biology:** Salient features of major lineages of Bryophytes, interrelationship and evolutionary trends among the three lineages (liverworts, mosses and hornworts), morphology, anatomy, ontogeny and differentiation of major plant parts, classification outlines and criteria used- present vs. past, secondary metabolites and chemical markers of different families. (10)
2. **Ecology, Diversity and Conservation:** Ecological significance of bryophytes, diversity and distribution pattern, conservation needs and strategies, physiological ecology: Water relations. (10)
3. Cytotogenetics of bryophytes; bryophyte as bioindicators, fossil bryophytes. (6)
4. **Model Organisms of Bryophytes:** Experimentation in different research fields with bryophytes, cross fertilization of the field bryology with the other field of plant science, bottleneck position of the bryology: an assignment (student's opinion and feedback to opt this paper for future study). (4)

Group B
PTERIDOLOGY

TEE points: 30 **Classes/ Semester: 30**

Course Content: **(No. of Classes allotted)**

1. **Terrestrialization and Evolution of First Vascular Land Plants:** Adaptive strategies of the first vascular land plants, Interrelationship with other groups (Algae, Bryophytes, Gymnosperm and Angiosperm), Evolutionary network in morpho-anatomy and organographic development in extinct to extant ferns (focussing major groups), Criteria of classification present vs. past, Classification outline, Chemotaxonomy (in brief) and Phylogeny. (15)
2. **Sexual Phase and Mating System:** Antheridogen, Cytogenetics of Pteridophytes. (5)
3. **Ecology and Diversity:** Conservation approach, Major world herbaria, Pteridophytes in phytomedicine, Fern cultivation and gardening. (5)
4. **Pteridophyte Research:** India vs. Global scenario, future prospect of the subject pteridology. (5)

Practical Course
BOTCOR P103
Practical based on BRYOLOGY & PTERIDOLOGY

Points: 25 **3 hours/ week**

1. Morpho-anatomical study and identification of members of the three lineages – Marchantiophyta, Bryophyta and Anthocerotophyta.
2. Identification of diagnostic features of preserved bryophytic specimens and permanent slides.
3. Collection of bryophytes from different localities and through local tours; their preservation and identification.
4. Workout of supplied pteridophytic taxa with special focus to morpho-anatomy, staining techniques of different tissue, study of systematic position (following the classification studied in theoretical syllabus) and selection of identification criteria upto genus level.
5. Field tour and collection of pteridophytes and preparation of herbarium, dry and wet preservation method.

Note: Regularly checked laboratory records, permanent slides prepared during practical classes, specimens collected during field works should be submitted at the time of TEE.

Suggested Readings:

1. Vanderpoorten, A. and Goffinet, B. (2009). Introduction to bryophytes. Cambridge University Press, Cambridge. ISBN 978-0-521-70073-3
2. Goffinet, B. and Shaw, A. J. (Edited) (2008). Bryophyte biology. 2nd ed. – XIV + 565 pp., Cambridge University Press, Cambridge. ISBN 978-0-521-69322-6
3. Rashid A. (1998). An introduction to Bryophyta. Vikas Publishing house Pvt. Ltd. First edition.
4. Rashid A. (1999). An introduction to Pteridophyta. Vikas Publishing house Pvt. Ltd. Second revised edition.
5. Gifford M.E. and Foster A.S. 1988 Morphology and Evolution of Vascular Plants. W H Freeman and Company
6. Willis, K.J., and McElwain, J. C. 2002. The Evolution of Plants. Oxford University Press, New York.

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Course No.	Course name	Points	Credits	Hrs./Wk.
BOTCOR T104 (Group A + B)	Taxonomy of Angiosperms & Biosystematics, Gymnosperms & Plant Anatomy	75	3	4
BOTCOR P104	Practical based on Taxonomy of Angiosperms & Biosystematics, Gymnosperms & Plant Anatomy	25	1	3

EVALUATION SCHEME –	THEORY:	Internal Assessment (15) + Term End Examination (60) TEE: Group A (40 points) + Group B (20 points)
	PRACTICAL:	Internal Assessment (5) + Term End Examination (20)

Theoretical Course
BOTCOR T104

Group A
TAXONOMY OF ANGIOSPERMS & BIOSYSTEMATICS

TEE points: 40 **Classes/ Semester: 40**

Course Objectives:

This course aims to enhance the understanding of the students about the system of classification of Flowering plants, their origin and diversification. The course also enhances the knowledge about data resources used in taxonomy, Botanical gardens and Herberia.

Learning Outcomes:

The course will prepare and train the student to

- Understand advanced aspects of the principles of taxonomy (identification, nomenclature, classification of flowering plants), evolution (speciation, reproductive biology, adaptation, convergence, biogeography), and phylogenetics (phenetics, cladistics, morphology and molecules).
- Do systematic survey of plant families, understand the evolutionary processes and patterns in the major families and develop expertise on the representative families and local flora.

Course Content: **(No. of Classes allotted)**

1. **Taxonomy:** Traditional and Modern concepts (1)
2. **Systems of Angiosperms Classifications:** Classifications of Cronquist (1988), Takhtajan (1997) up to Subclasses / Super orders and of Angiosperm Phylogeny Group (APG IV, 2016). (4)
3. **A General Survey of the Angiosperms Taxa (*sensu* Cronquist, 1988)** with reference to their characteristics, phylogeny and evolutionary trends: Amborellaceae, Magnoliales, Caryophyllidae, Nepenthales, Podostemales, Asterales, Alismatales and Orchidales. (10)
4. **ICN:** Changes, addition and alteration of latest code; principles, rank of taxa and names of taxa; nomenclatural types, priority of publication and limitation of the priority of publications; effective and valid publications, author's citation; changes and rejection of names, preliminary concept of appendices; Basic idea about Bio-codes and Phylocodes. (4)
5. **Concepts of Phytogeography:** Endemism in India; invasion and introduction of plants in India. (2)
6. **Botanic Gardens and Herbaria**: Importance, examples from India and abroad. (2)
7. **Biosystematics:** Definition, methods, categories, relationship with classical taxonomy. (2)

8. **Numerical Taxonomy:** Definition, principles, logical steps, applications, merits and demerits. (3)
9. **Evolutionary Concept:** Basic idea about following terms - Plesiomorphy and Apomorphy; Symplesiomorphy, Synapomorphy, Autopomorphy; Parallelism and Convergence; Homology and Homoplasy; Monophyly, Holophyly, Paraphyly and Polyphyly; Heterobathmy, Cline, Polarity, Anagenesis, Cladogenesis, Stasigenesis, Catagenesis, Phylogram, Dendrogram and Cladogram. (3)
10. **Cladistics:** Principles, methods, merits and demerits. (2)
11. **Data Sources of Taxonomy:** Embryology, phytochemistry; Macromolecules; brief account of DNA - Taxonomy, DNA - barcoding, Phylogenomics: nuclear rDNA, chloroplast and mitochondrial DNA; ultrastructure of sieve tube plastids. (4)
12. **Taxonomic Literature:** Definitions with examples of classical books, index, flora and manual, revision and monograph, icons, bibliography, catalogue, encyclopedias, glossary and dictionary;e-Taxonomy; Important periodicals of India and abroad. (3)

Group B

GYMNOSPERM & PLANT ANATOMY

TEE points: 20 **Classes/ Semester: 20**

Course Objectives:
Students should learn the gymnosperm diversity, evolution and the basic internal structure of the plant.

Learning Outcomes:
Students will learn about the
- ❖ Diversification and evolution of gymnosperms
- ❖ Internal organization of the plant system

Course Content: **(No. of Classes allotted)**

1. **Introduction to Gymnosperm:** A general account and an outline of recent system of classification of gymnosperms upto order level with characteristic features. (2)
2. **Extinct Groups:** Palaeozoic Pteridosperms (Lyginopteridaceae, Calamopityaceae, Medullosaceae, Callistophytaceae); Cycadeoids; more diversification of Gymnosperms; Caytoniaceae, Corystospermaceae, Peltaspermaceae, Glossopteridceae, Pentoxylaceae. (5)
3. **Extant Groups:** Ginkgos, Conifers and Gnetophytes. (5)
4. **Tissue & Differentiation:** Meristems and differentiation, origin and development of sclereids and fibres, phylogeny of xylem and phloem elements, wood anatomy: vascular cambium and its seasonal activity. (4)
5. **Anatomical Variations with Ecology:** leaf and root anatomy in ecological perspectives; hydraulic architecture of plant; application of anatomy. (4)

Practical Course

BOTCOR P104

Practical based on TAXONOMY OF ANGIOSPERMS & BIOSYSTEMATICS, GYMNOSPERMS & PLANT ANATOMY

Points: 25 **3 hours/ week**

1. Drawing and description of specimens from representative locally available families.
2. Identification of family with the help of Keys of angiosperms by Davis and Cullen's book and Hutchinson's book.

3. Identification of genera and species with the help of local and regional floras.
4. Preparation of an artificial indented /bracketed key at family/generic/ species level, from locally available plants as well as, from the worked-out plants.
5. Two compulsory local field excursions for familiarization with the local flora.
6. Herbarium specimens (at least 25) of wild plants abundant in the locality to be submitted at the term-end examination.
7. Studies of morpho-anatomy of conifer leaves and their identification (at least five taxa).
8. Studies of reproductive structures of at least two conifers.
9. Characterization of at least four taxa of gymnosperms for identification.
10. Field record and plant collection to be submitted (not more than 10 herbarium specimens).
11. Study of sclereids, fibres, tracheids and vessels, TS, TLS and RLS of woody plant.
12. Leaf anatomy of xeromorphic leaves, sun and shade leaves, succulent leaves.

Note: Regularly checked laboratory records, specimens collected during field works and permanent slides prepared during practical classes should be submitted in a standard manner along with Field Note Books at the time of TEE.

Suggested Readings:

1. Grant W.F., Plant Biosystematics, Academic Press, London.
2. Davis, P. H. and Heywood, V. H. 1963. Principles of Angiosperm Taxonomy. Princeton, NJ: VanNostrand.
3. Johnes, S. B. and Luchsinger, A. E. 1987. Plant Systematics. McGraw-Hill. London.
4. Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F., Donoghue, M. J. 2008. Plant Systematics– A Phylogenetic Approach. SinauerAssoociates, Inc., Sunderland, Massachusetts USA.
5. Lawrence, G. H. M. 1964. Taxonomy of Vascular Plants. Oxford & IBH Publishers, Calcutta.
6. Naik, V. N. 1984. Taxonomy of Angiosperms. Tata McGraw-Hill Publishing Company Limited, NewDelhi.
7. Radford, A. E. 1986. Fundamentals of Plant Systematics. Harper & Row, London.
8. Simpson, M. G. 2010. Plant Systematics. Elsevier Academic Press, Amsterdam.
9. Singh, G. 2012. Plant Systematics – Theory and Practice. Oxford& IBH Publishing Co. Pvt. Ltd.
10. Sivarajan, V. V. 1991. Introduction to the Principles of Plant Taxonomy. Oxford & IBH PublishingCo. Pvt. Ltd., New Delhi.
11. Stace, C. A. 1989. Plant Taxonomy and Biosystematics. Arnold Publishers, United Kingdom.
12. Stuessy, T. F. 2008. Plant Taxonomy – The Systematic Evaluation of Comparative Data. Columbia, University press, New York.
13. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International P Limited. Publishers, New Delhi
14. Taylor E.L., Krings M, and Taylor T.N. 2009. Paleobotany: The biology and evolution of fossil plants
15. Fahn A (1982). Plant Anatomy. Pergamon press
16. Dickison W.C. 2000. Integrative Plant Anatomy. Harcourt Academic Press. ISBN-13: 978-0-12-215170-5

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Course	Course Name	Points	Credits	Hrs./Wk.

BOTAECC (Ability Enhancement Compulsory Courses)	**Environmental Biology**	**25**	**2**	**2**

EVALUATION SCHEME – THEORY: Internal Assessment (5) + Term End Examination (20)

ENVIRONMENTAL BIOLOGY

TEE points: 20 **Classes/ Semester: 20**

Course Objectives: The course is designed to help students in understating principles of environmental biology, and the relationship of humans with the natural world.

Learning Outcomes:

- Understand mechanisms by which organisms interact with other organisms and with their physical environment.
- Describe biotic and abiotic factors that influence the dynamics of populations
- Appreciate the inter-relationship between organism in population and communities.
- Understand principles of toxicology and the harmful effects of toxic metals on humans and environment
- Realize the role of various International Organisations for the protection and safeguard of environment

Course Content: **(No. of Classes allotted)**

1. **Natural Resources**: Brief overview; degradation and conservation. (2)
2. **Environmental Pollution:** (10)
   - Air, water, soil – types of pollutants, sources, effects and remedial measures.
   - Electronic waste- source, types, components of e-waste, recycling of e waste, impact of e waste on environment and their management.
   - Ecotoxicology – Principles, mechanisms, types and effects.
   - Biomonitoring.
3. **Global Environmental Change:** Green house effects, Global warming– causes and effects; Ozone depletion. (3)
4. **Environmental Impact Assessment.** (2)
5. **Environmental Law and Policies.** (2)
6. **Sustainable Development:** Concept; National sustainable development strategies. (1)

Suggested Readings:

1. Douglas, J. Futuyma (1998). Evolutionary Biology, (3rd Edition). Sinauer Associates.
2. Eldon, D., Enger, Bradley, Smith, F. (1995). Environmental Science. W C Brown Publications.
3. Grant, W. E. and Swannack, T. M. (2008). Ecological Modelling. Blackwell.

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