Learning Outcomes based Curriculum Framework (LOCF)

For

M.Sc. (Botany)
Postgraduate Programme

Department of Botany
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1. About the Department

The Department of Botany was established in 2018 to teach the students of M.Sc. Botany. The department expanded in terms of manpower as well infrastructure. Since its inception, faculty members of the department have been involved in teaching and mentoring students. The department focuses on postgraduate teaching-learning and appropriately combines classical teaching with innovative digital teaching tools to augment students understanding of the subjects

2.Learning Outcomes based Curriculum Framework

The Choice Based Credit Scheme has evolved into learning outcomes-based curriculum framework and provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enables the potential employers in assessing the performance of the candidates.

2.1 Objectives of the Programme

- To understand the scope and significance of the discipline.
- To imbibe love and curiosity towards nature through the living plants.
- To make students open-minded and to enhance and develop a scientific attitude.
- To make the students exposed to the diverse life forms.
- To encourage the students to do research in related disciplines.
- To make them skilled in practical work, experiments, laboratory equipment and to interpret correctly on biological materials and data.
- To develop the ability of the students to transform the society through their education.
- To acquaint the students about the methods used in the maintenance of different natural resources.
- To include creative thinking, innovation, inquiry and analysis, evaluation and synthesis of information.

2.2 Programme Outcomes (POs)

After completion of the programme, the students will have

PO1	*Knowledge*: Knowledge in the basic and advanced fields of the core and applied disciplines, for the fulfilment of professional requirements.
PO2	*Critical Thinking*: Capability ofcritical thinking based on the contextual knowledge of living beings/organisms, non-living components and environmental basis of life so as to enable the students to critically analyse everyday problems faced by society.
PO3	*Interdisciplinary approach &Adaptation*: Understanding of the vital connections, within and among-the flora, fauna and the physical environment, enabling them to integrate and synthesize the acquired knowledge within their fields and beyond
PO4	*Application Development*: Understanding for the development of the applications of biological materials in food, health, medicine and environment for sustainable development of the society
PO5	*Ethics and Leadership*: Awareness about sound professional and character ethics as well as the qualities of leadership and team building skills
PO6	*Problem Solving*: Capability for developing innovative and solution cantered approach for handling any kind of problem and the paradigm of scientific temperament
PO7	*Skills and Inferential knowledge*: Knowledge about various core and advanced skills for theoretical and practical understanding of different descriptive and inferential statistical tools and techniques

PO8	*Specialization and Employability*: Specialization in various skills based on practical training, fields visits and project based vocational training as well as specialization for an entrepreneurial thinking and career-oriented approach in research as well as in industries

2.3 Programme Specific Outcomes (PSOs)

After completing the programme, the student will

PSO1	gain core and advanced knowledge in different areas of Botany which will enable them to develop the powers of inquiry, critical analysis, logical thinking for finding solutions for biological problems.
PSO2	acquire knowledge about various analytical and technical skills related to plant sciences.
PSO3	be able to identify various life forms of plants, design and execute experiments related to basic studies on evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology, proteomics and transgenic technology. Students will also be familiarized with the application of statistics to biological data.
PSO4	be capable of executing short research projects using various tools and techniques in plant sciences and develop scientific temperament and research attitude.

3. Programme Structure

M.Sc. Botany- a four-semesters postgraduate programme is 108 credits weightage consisting of Core Courses (CC), Discipline Specific Elective Courses (DSC), Skill Enhancement Courses (SEC) and Open Elective Courses (OEC).

Table 1: Courses and Credit Scheme

Semester	Core Courses (CC) 1 2		Discipline Specific Elective Courses (DSC) 3 4		Skill Enhancement Courses (SEC) 56		Open Elective Courses (OEC) 7		Grand Total Credits
	No. of Courses	**Total Credits**	**No. of Courses**	**Total Credits**	**No. of Courses**	**Total Credits**	A total of 12 credits are to be earned from other Departments or from MOOCs *Students have to opt open elective course in consultation with chairperson and Director, University Centre for Outreach Programmes and Extension*		**2+4+6+7**
I	5	**16**	-	**0**	2	**8**			**108**
II	5	**16**	2	**8**	1	**Non-credit**			
III	5	**18**	-	**0**	2	**8**			
IV	4	**14**	2	**8**	-	**0**			
Total	**Core Credits**	**64**	**Discipline Specific Elective Credits**	**16**	**Skill Enhancement Credits**	**16**	**Open Elective Credits**	**12**	**108**
Per-cent	**Core Credits**	**59.3**	**Discipline Specific Elective Credits**	**14.8**	**Skill Enhancement Credits**	**14.8**	**Open Elective Credits**	**11.1**	**100**

Table 2: Detailed break-up of Credit Courses

	Core Courses	Discipline Specific Elective Courses	Skill Enhancement Courses	Open Elective Courses	Total Courses
	CC	DSC	SEC	OEC	CC+DSC +SEC
Semester I	CC1	-	SEC1 SEC2	OECs offered by other departments or MOOCs **(May be enrolled in any of the four semesters)** *Students have to opt open elective course in consultation with chairperson and Director, University Centre for Outreach Programmes and Extension*	7
	CC2				
	CC3				
	CC4				
	CC5				
Semester II	CC6	DSC1 DSC2	SEC3		8
	CC7				
	CC8				
	CC9				
	CC10				
Semester III	CC11	-	SEC4 SEC5		7
	CC12				
	CC13				
	CC14				
	CC15				
Semester IV	CC16	DSC3 DSC4	-		6
	CC17				
	CC18				
	CC19				

Table 3: Course code and Title along with credits detail

Sr. No.	Course Code	Course Title	Credits		
Semester I			**Theory**	**Practical**	**Total**
1.	MSc/BOT/1/CC1	Biology and Diversity of Viruses, Bacteria and Fungi	4		4
2.	MSc/BOT/1/CC2	Biology and Diversity of Algae & Bryophytes	4		4
3.	MSc/BOT/1/CC3	Cell Biology	4		4
4.	MSc/BOT/1/SEC1	Biochemical and Biophysical Techniques	4		4
5.	MSc/BOT/1/CC4	Lab – I Pertaining to theory Paper CC1, CC2		2	2
6.	MSc/BOT/1/CC5	Lab – II Pertaining to theory Paper CC3		2	2
7.	MSc/BOT/1/SEC2	Lab – III Pertaining to theory Paper SEC1		4	4
		Total	**16**	**8**	**24**
Semester II					
1.	MSc/BOT/2/CC6	Biology and Diversity of Pteridophytes & Gymnosperms	4		4
2.	MSc/BOT/2/CC7	Cytogenetics	4		4
3.	MSc/BOT/2/CC8	Molecular Biology	4		4
4.	MSc/BOT/2/DSC1	A. Principles of Plant Pathology B. Principles of Plant Breeding C. MOOC	4		4
5.	MSc/BOT/2/CC9	Lab – IV Pertaining to Theory Paper CC6		2	2
6.	MSc/BOT/2/CC10	Lab – V Pertaining to Theory Paper CC7, CC8		2	2
7.	MSc/BOT/2/DSC2	Lab – VI Pertaining to Theory Paper DSCIA Lab – VI Pertaining to Theory Paper DSCIB		4	4
8.	MSc/BOT/2/SEC3	Summer Training (3-4 weeks) (Field Visit/ Survey/ In-house Training/ Industrial Training)	Non-credit		
Total			**16**	**8**	**24**
Semester III					

1.	MSc/BOT/3/CC11	Plant Systematics & Biology of Reproduction	4		4
2.	MSc/BOT/3/CC12	Plant Physiology & Biochemistry	4		4
3.	MSc/BOT/3/CC13	Plant Tissue Culture	4		4
4.	MSc/BOT/3/SEC4	Biostatistics & Bioinformatics	4		4
5.	MSc/BOT/3/CC14	Lab – VII Pertaining to Theory Paper CC11		2	2
6.	MSc/BOT/3/CC15	Lab – VIII Pertaining to Theory Paper CC12, CC13		4	4
9.	MSc/BOT/3/SEC5	Lab – IX Pertaining to Theory Paper SEC4		4	4
		Total	**16**	**10**	**26**
Semester IV					
1.	MSc/BOT/4/CC16	Plant Ecology: Principles and Concepts	4		4
2.	MSc/BOT/4/CC17	Plant Biotechnology	4		4
3.	MSc/BOT/4/CC18	Cardinal Principles of Academic Integrity and Research Ethics	2		2
4.	MSc/BOT/4/DSC3	A. Plant Growth and Development B. Genomics C. MOOC	4		4
5.	MSc/BOT/4/CC19	Lab – X Pertaining to Theory Paper CC16, CC17		4	4
6.	MSc/BT/4/DSC4	A. Lab – XI Pertaining to theory paper DSC3A B. Lab – XI Pertaining to theory paper DSC3B		4	4
		Total	**14**	**8**	**22**

Note for the paper setters:

1. For one credit of theory, one hour of lecture will be delivered while for one credit of practical, two hours of laboratory work will be conducted, per week.
2. Practical will be conducted in groups; one group may have maximum 20 students.
3. Students will have to submit a certificate declaring successful completion of summer training from competent authority within one month of completion of training.

4. Evaluation of Non-credit courses will be entirely internal. Award will be submitted in the form of Satisfactory (S) (in case marks obtained are 60 % or more) or Unsatisfactory (US) (in case marks are less than 60 %) grades.
5. Besides credits from above courses, students will need to earn additional 12 credits from open elective courses (OECs) offered by other departments of the University or from MOOCs on SWAYAM portal. Students are free to get enrolled for this category courses in any of semesters. Further, students may get enrolled in any of the various PG MOOCs available at SWAYAM portal for this category for the desired credits.
6. MOOC coordinator will display the list of MOOCs for each Discipline Specific Elective Course (DSC) before the commencement of respective semester.
7. A Discipline Specific Elective Course will be started only when least 10 students opt for a particular course.

Table 4: Core Courses Offered by the Department

Course Code	Course Title	Credits
Core Courses		
MSc/BOT/1/CC1	Biology and Diversity of Viruses, Bacteria and Fungi	4
MSc/BOT/1/CC2	Biology and Diversity of Algae & Bryophytes	4
MSc/BOT/1/CC3	Cell Biology	4
MSc/BOT/1/CC4	Lab-I Pertaining to theory paper CC1, CC2	2
MSc/BOT/1/CC5	Lab-II Pertaining to theory paper CC3	2
MSc/BOT/2/CC6	Biology and Diversity of Pteridophytes & Gymnosperms	4
MSc/BOT/2/CC7	Cytogenetics	4
MSc/BOT/2/CC8	Molecular Biology	4
MSc/BOT/2/CC9	Lab-IV Pertaining to theory paper CC6	2
MSc/BOT/2/CC10	Lab-V Pertaining to theory paper CC7, CC8	2
MSc/BOT/3/CC11	Plant Systematics & Biology of Reproduction	4
MSc/BOT/3/CC12	Plant Physiology & Biochemistry	4
MSc/BOT/3/CC13	Plant tissue culture	4

MSc/BOT/3/CC14	Lab-VII Pertaining to theory paper CC11	2
MSc/BOT/3/CC15	Lab-VIII Pertaining to theory paper CC12, CC13	4
MSc/BOT/4/CC16	Plant Ecology: Principles and Concepts	4
MSc/BOT/4/CC17	Plant Biotechnology	4
MSc/BOT/4/CC18	Cardinal Principles of Academic Integrity & Research Ethics	2
MSc/BOT/4/CC19	Lab-X Pertaining to theory paper CC16, CC17	4
	Total	**64**

Table 5: Discipline Specific Courses offered by Department

MSc/BOT/2/DSC1	A. Principles of Plant Pathology	4
	B. Principles of Plant Breeding	
	C. MOOC	
MSc/BOT/2/DSC2	A. Lab-VI Pertaining to theory paper DSC1A	4
	B. Lab-VI Pertaining to theory paper DSC1B	
MSc/BOT/4/DSC3	A.Plant Growth & Development	4
	B. Genomics	
	C. MOOC	
MSc/BOT/4/DSC4	A. Lab-XI Pertaining to theory paper DSC3A	4
	B. Lab-XI Pertaining to theory paper DSC3B	
	Total	**16**

Table 6: Skill Enhancement Course offered by the Department

MSc/BOT/1/SEC1	Biochemical and biophysical techniques	4
MSc/BOT/1/SEC2	Lab-III Pertaining to theory paper SEC1	4
MSc/BOT/2/SEC3	Summer Training (3-4 weeks) (Field Visit/ Survey/ In-house Training/ Industrial Training)	Non-credit
MSc/BOT/3/SEC4	Biostatistics & Bioinformatics	4

MSc/BOT/3/SEC5	Lab-IX Pertaining to theory paper SEC4	4
	Total	**16**

Table 7: Open Elective Courses offered by the Department

MSc/BT/9/OEC1	Plant Resource & Utilization - I	4
MSc/BT/9/OEC2	Plant Resource & Utilization - II	4
Total		**8**

4. Attainment Level

Table 8: CO-PO-PSO mapping matrix for all the courses offered by Department of Botany

Course Outcome (CO)	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
Semester – I												
MSc/BOT/1/CC1	2	2	1.75	2.50	1	2	1	1	2.25	1.75	2.50	2
MSc/BOT/1/CC2	2.25	1.25	2.25	2	2	2	1.50	2	2.50	1	2.25	2.50
MSc/BOT/1/CC3	2.50	2	2.50	1.50	2	1.50	1.25	1	2.25	2.25	2	2
MSc/BOT/1/SEC1	2.25	1.50	2	1.25	2	2.50	2.25	2.25	2.50	3	2.75	2.25
MSc/BOT/1/CC4	2.25	2	1.50	2	2	2.50	2	1.50	2	2.50	2.50	2
MSc/BOT/1/CC5	2.50	1.75	2	1.50	1.50	2.50	1.50	2	2.50	2.50	2	2
MSc/BOT/1	2	2	2.25	1.50	1.50	1.50	2	1.50	2.25	2.50	2.50	2

/SEC2												
Semester – II												
MSc/BOT/2/CC6	2.25	2	2	2.50	2	2	2	1	2.50	2.25	2.50	2
MSc/BOT/2/CC7	2.50	1.75	2.25	2	1.50	2	1.50	2	2	2	2.50	1.50
MSc/BOT/2/CC8	2.25	1.50	1.50	1.50	1.50	2.50	1.50	1	2	2	2.75	1.50
MSc/BOT/2/DSC1/A	2.50	1.50	2	1.50	1.75	2	1.50	2	2.50	1.75	2.75	2.25
MSc/BOT/2/DSC1/B	2.50	1.75	2	2.50	2	1.50	1	1.50	2	2	2	2
MSc/BOT/2/CC9	2.50	2	2	2.50	2	2.50	1.50	1.25	2.50	2	2	2
MSc/BOT/2/CC10	2	1.50	1.50	2	1.50	1.50	2	2	2	1.50	2.50	1.50
MSc/BOT/2/DSC2/A	2.25	1.75	1.75	2	1.75	2	1.50	1.50	1.50	1	2.50	2
MSc/BOT/2/DSC2/B	2.25	1.50	2	1.50	2	2	2	2	2	1.50	2.50	1.50
Semester – III												
MSc/BOT/3/CC11	2.50	1.25	1	1.50	1.25	1.50	1.50	1.25	2.25	2	0.50	2
MSc/BOT/3/CC12	2.50	2	2	2.50	2	1.75	1	1	2	2	1.75	2
MSc/BOT/3/CC13	2.50	2	2	2	1.75	2.50	1.50	1.50	2.50	2.50	2.50	2.25
MSc/BOT/3/SEC4	2.50	2.25	2	2.50	2	2.50	2	1	3	2	2	1.50
MSc/BOT/3/CC14	2.50	2	2.50	2.50	2	2.50	1.25	1.50	2.50	2.50	2	2
MSc/BOT/3/CC15	2	1.50	2.50	2	1	1.50	1.50	1	2.50	2.50	2.50	1.50
MSc/BOT/3/SEC5	2	1.50	2	1.50	2	2	2	1.50	1.50	1.50	2	1.50

Semester – IV												
MSc/BOT/4/CC16	2	2	2	2.50	2.25	2	1	2	2	1.50	2	2
MSc/BOT/4/CC17	2	2	2.25	1.50	2	2.25	1	1.50	2.50	2.25	2.25	2.25
MSc/BOT/4/CC18	2	1	2	2.50	1.50	1.50	2	2	2.25	2	2.50	2
MSc/BOT/4/DSC3/A	1.75	1.75	2	1.50	1	1.50	1.5	1	2	1.75	2.50	2
MSc/BOT/4/DSC3/B	1.75	2	2.50	2.25	2	2.50	2	2	2.50	2	2.25	2
MSc/BOT/4/CC19	2.50	1	2	2.50	2	2	2.50	1	2.50	2	2	2
MSc/BOT/4/DSC4/A	2	2.25	2	2.50	1.50	1.50	2.25	1.50	2	2	2.50	2.50
MSc/BOT/4/DSC4/B	2.50	2	2	2	2	2	2	1.25	2	2	2.25	2.50

4.1 Attainment of COs:

Table 9: CO Attainment Levels for a Semester Examination of a course

Attainment Level	
1 (Low level of attainment)	50% of students obtained letter grade of A or above (for CBCS programs) or score more than 60% of marks (for non-CBCS programs) of a course.
2 (Medium level of attainment)	60% of students obtained letter grade of A or above (for CBCS programs) or score more than 60% of marks (for non-CBCS programs) of a course.
3 (High level of attainment)	70% of students obtained letter grade of A or above (for CBCS programs) or score more than 60% of marks (for non-CBCS programs) of a course.

The CO attainment level for all the courses of the program can be obtained in a similar manner.

4.2 Calculation of Attainment values of POs and PSOs:

PO attainment value (for example for PO1) for a course can be obtained as follows:

$$\frac{(\quad)\quad(\quad)}{}$$

Where

AV = Attainment value

MFCPO1 = Mapping factor for a course with PO1 as obtained from table 1

Likewise, PSO attainment value (for example for PSO1) for a course can be obtained as follows:

$$\frac{(\quad)\quad(\quad)}{}$$

Where

AV = Attainment value

MFCPSO1 = Mapping factor for a course with PSO1 as obtained from table 1

After finding the attainment values of each PO and PSO for various courses, we may write them in table form as given below:

Table 10: The calculated PO and PSO Attainment Values for all the courses

Course Code	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4
Semester-I												
MSc/BOT/1/CC1												
MSc/BOT/1/CC2												
MSc/BOT/1/CC3												
MSc/BOT/1/SEC1												
Semester-II												
MSc/BOT/2/CC5												
MSc/BOT/2/CC6												
MSc/BOT/2/CC7												
MSc/BOT/2/DSC1/A												
MSc/BOT/2/DSC1/B												
Semester-III												
MSc/BOT/3/CC9												
MSc/BOT/3/CC10												
MSc/BOT/3/CC11												
MSc/BOT/3/SEC4												
Semester-IV												
MSc/BOT/4/CC14												
MSc/BOT/4/CC15												
MSc/BOT/4/CC16												
MSc/BOT/4/DSC3/A												
MSc/BOT/4/DSC3/B												
Average of above values												

The attainment of POs and PSOs is the average of individual PO and PSO attainment values. The PO and PSO attainment values obtained above are compared with set target. The set target for each PO and PSO may be different and can be finalized by the staff councils of the departments/institutes as described in the following table:

Table 11: PO and PSO Attainment Values and Set Target values

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
PO attainment values	2.25	1.75	2	2	1.75	2	1.5	1.5	2.25	2	2.25	2
Target Values	2	1.5	2	2	1.5	2	1.5	1.5	2	2	2	2

If PO and PSO attainment value is less than the set target value then an action plan may be prepared for improvement in the subsequent academic session.

6. Course Wise Content Details for MSc. Botany Programme is given on following pages.

M.Sc. (Botany) – 1st Semester

MSc/BOT/1/CC1 - Biology and Diversity of Virus, Bacteria and Fungi

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge pertaining to the enormous diversity that Virus, Bacteria and fungi exhibit and equip them with the understanding of their structure and biology.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Acquire knowledge about virus structure, steps in virus infection and role of phytoplasma in causing plant diseases.
CO2	Describe the morphological features, cell arrangement and structural components of bacterial cell in detail; will be able to differentiate between Gram-positive and Gram-negative bacteria.
CO3	Enlist the characteristics of Archaea that differentiate it from Eubacteria.
CO4	Demonstrate an understanding of various fungal groups, their classification, characteristics, reproduction and economic importance.

Note for the paper setter: *The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.*

UNIT-I

1. **Viruses:** Characteristics and ultrastructure of virions, Isolation and Purification, Chemical nature, Replication, Transmission and economic importance of viruses.
2. **Phytoplasma:** General characteristics and role in causing plant diseases.

UNIT- II

3.**Archaebacteria and eubacteria**: General account, Ultrastructure, nutrition and reproduction, Economic importance.

4. **Cyanobacteria**: Salient features and biological importance.

UNIT-III

5. A general account of fungi, their structure including ultrastructure of cell wall, major growth forms and differentiation. Fungal nutrition (saprobic, biotrophic and symbiotic).

6. Classification of fungi byKirk et.al (2008) - phylogeny of fungi - characters used in classification.

7. General account of Chytridiomycota, Zygomycota, Glomeromycota, Ascomycota, Basidiomycota and Mitosporic fungi.

UNIT-IV

8. Heterokaryosis, homothallism, heterothallism, parasexuality, sex hormones, mycorrhizae and predaceous fungi.

9. **Lichens:** Structure, Reproduction and Economic importance.

10. Importance of fungi in different microbiological and Biotechnological processes: role of fungi in industry (alcohol), medicine (Antibiotics and steroids) and food (edible mushrooms).

Suggested Readings:

1. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996. *Introductory Mycology*, John Wiley and Sons, New York.
2. Brock, Madigan, M.T., Martinko, J.M. and Parker, J. 2015. *Biology of Microorganisms* (14th Edition), Prentice Hall, New Jersey.
3. Deacon, J.W. 2013, *Fungal Biology*, John Wiley and Sons.
4. Sumbali, G., 2018, The Fungi (Second Edition), Alpha Science International Ltd.
5. Kirk, P.M., Canon, P.F., Minter, D.W. and Stalpers, J.A. Dictionary of the Fungi (10th Edition), CAB International, U.K, 2008.
6. Mandahar, C. L. 1978. *Introduction to Plant Viruses*. S. Chand & Co. Ltd., Delhi.
7. Mehrotra, R.S. &Aneja, K.R., 2015. *An Introduction of Mycology*, New Age International Press, New Delhi.

8. Prescott, I.M., Harley, J.P.2013, *Microbiology* (9th Revised Edition), Tata McGraw Hill, USA.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/1/CC1

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 2	2	2	1.50	2.50	1	2	1	1	2.25	1.50	2.75	2
CO 3	2	2	1.50	2.50	2	1.50	1	1	2.50	2	2.50	2
CO 4	2	2	2	2.50	0	2.50	1	1	2.25	1.50	2.50	2
Average	2	2	1.75	2.50	1	2	1	1	2.25	1.75	2.50	2

M.Sc. (Botany) – 1st Semester

MSc/BOT/1/CC2 - Biology and Diversity of Algae and Bryophytes

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge pertaining to the enormous diversity that Algae and Bryophytes exhibit and equip them with the understanding of their structure and biology.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Demonstrate an understanding of various algal groups, their classification, characteristics.
CO2	Acquire knowledge about the strategies for the evolution of sex of algae and economic importance of algae.
CO3	Describe characteristic features of bryophytes and their classification; will be able to learn about the strategies for the evolution of land habit of bryophytes.
CO4	Gain knowledge about the *invitro* reproduction of bryophytes and their economic importance.

Note for the paper setter: *The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.*

UNIT-I

1. **Algal classification:** Criteria for algal classification (pigments, reserve food, flagella, chloroplasts, pyrenoids, eye spots, endoplasmic reticular membrane etc.); Comparative account of important systems of classification (Fritsch, Round, Chapmann and Lee).
2. **Salient features of algae**: Cell Structure, thallus organization, reproduction and broad classification of i) Chlorophyta ii) Phaeophyta iii) Cryptophyta and iv) Rhodophyta

UNIT-II

3. **Reproduction in algae**: Vegetative, asexual and sexual reproduction; origin and evolution of sex; life cycles.
4. **Rhythms and bioluminescence in dinoflagellates**.
5. **Economic importance of algae**: Algal biofertilizers, Algal blooms, Algae as food and feed, uses in industries; Algae in biotechnology.

UNIT-III

6. **General characteristics and classification**: General characteristic feature of bryophytes and their classification up to order level.
7. **Salient feature of bryophytes:** General account of structure and development of gametophyte and sporophyte of following orders: Sphagnales, Andreaeales, Takakiales, Funariales (*Funaria*, *Physcomitrium*)) and Polytrichales (*Polytrichum*).
8. Origin and evolution of sporophytes in bryophytes, Cytology of bryophytes, Chromosome number, sex chromosome, m chromosomes, accessory chromosomes.

UNIT-IV

9. **Biology of reproduction:** *in vitro* regulation of gametangia formation, effect of chemical and physical factors, Morphogenetic studies on spore germination, protonemal differentiation and bud initiation.
10. **Economic importance of bryophytes:** Medicinal uses of Bryophytes especially as a source of biologically active compounds, Ecological importance of Bryophytes, Bryophytes as a source of biologically active compounds, Role of Brypophytes in Succession.

Suggested Readings:

1. Ahluwalia, A.S.,2003, *Phycology: Principles, Processes and Applications*, Daya Publishing House, New Delhi.
2. Fritsch, F.E., 1979, *The Structure and Reproduction of Algae* (Vol. I & II), Vikas Publishing House Pvt. Ltd., New Delhi.
3. Goffinet, B. and Shaw, A.J. 2008, *Bryophyte Biology* (2nd Edn.), Cambridge University. Press, Cambridge.

4. Graham, L. E., Graham, J.M. and Wilcox, L.W. 2000, *Algae*, Prentice Hall, USA.
5. Kumar, H.D., 1999, *Introductory Phycology*, East West Press, New Delhi.
6. Lee, R. E., 2008, *Phycology*, Cambridge University Press, Cambridge, 2008.
7. Rashid, A. 1998, *An Introduction to Bryophyta.* Vikas Pub. House Pvt.Ltd., New Dehli.
8. Schofield, W.B. 1985, Introduction to Bryology, Macmillan, New York.
9. Vasishta, B. R. 1996, *Bryophyta*, S.Chand& Co. Ltd., New Delhi.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/1/CC2

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2.25	1	3	1	2	2	1	2.50	2.50	1	2	2.75
CO 2	2.25	2	2	3	2	2	2	2	2.25	1	2.50	2.50
CO 3	2.25	1	2	1	2	2	1	1.50	3	1	2	1.75
CO 4	2.25	1	2	3	2	2	2	2	2.25	1	2.50	2
Average	2.25	1.25	2.25	2	2	2	1.50	2	2.50	1	2.25	2.50

M.Sc. (Botany) – 1st Semester

MSc/BOT/1/CC3 - Cell Biology

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge pertaining to Cell Biology deals with the detailed study of a cell including cell structure, cell composition, cell organelles.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Demonstrate an experiential learning and critical thinking of the structure and function of Both prokaryotic and eukaryotic cells.
CO2	Demonstrate an experiential learning and critical thinking of the structure and function of Both prokaryotic and eukaryotic cells.
CO3	Acquire knowledge of cell cycle, cell division and cell death mechanisms.
CO4	Learn about antigen and antibodies and how do they interact with each other.

Note for the paper setter: *The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.*

UNIT-I

1. **Cell and Cell wall:** Ultrastructure of prokaryotic and eukaryotic cells. Structural organization and function of plant cell wall**.**
2. **Membrane structure and functions:** Structure of model membrane, lipid bilayer and membrane proteins. Diffusion, Osmosis, ion channels, active transport, pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

UNIT-II

3. **Structural organization and function of intracellular organelles:** Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, ER, peroxisomes, plastids, vacuoles, chloroplast,

structure and function of cytoskeleton and its role in motility.

4. **Cellular energy transactions:** role of mitochondria and chloroplast.

UNIT-III

5. **Cell division and cell cycle:** Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.
6. **Signal Transductio**n: Overview, second messengers, receptors and G-proteins, phospholipid signalling, role of cyclic nucleotides, calcium-calmodulin cascade, diversity in protein kinases and phosphatases, specific signalling mechanisms and their regulation, e.g., simple and hybrid type of two-component sensor-regulator system in bacteria and plants (examples of chemotaxis, osmosensing, ethylene and cytokinin signalling), quorum sensing.

UNIT-IV

7. **Cancer:** Biochemistry and molecular biology of cancer, Genetic rearrangements in progenitor cells, Oncogenes and Tumour suppressing genes, Cancer and Cell cycle, Virus induced cancer, Metastasis, Interaction of cancer cells with normal cells, Apoptosis, Therapeutic interventions of uncontrolled cell growth, Chemical carcinogenesis.
8. **Antigen:** Structure and functions of different clauses of immunoglobulins; Primary and Secondary immune response; lymphocytes and accessory cells; Humoral and Cell Mediated Immunity; MHC; Mechanism of Immune response and generation of immunological diversity; Genetic control of immune response, Effector mechanisms; Application of Immunological principles (Vaccines and Diagnostics).

Suggested Readings:

1. Alberts, Bruce, Watson, J.D. 2015, *Molecular Biology of Cell* (6th Edition), Garland Science Publishing, New York.
2. Cooper et al. 2004, *The Cell: A Molecular Approach* (3rd ed.) ASM Press, Washington DC.
3. Gahlawat et al. 2017, *Plant Biotechnology: Recent Advancement and Developments*, Springer Nature, Germany.
4. Karp, J.G. 2007, *Cell and Molecular Biology*, John Wiley & Sons, USA.
5. Lodish, H., Berk, A.,Matsudaira, P., Kaiser, C.A., Krieger, M. et al. 2016, *Molecular Cell*

Biology (8th Edition), W.H. Freeman and Co., New York.

6. Robertis, EDP De &Robertis, EMF De, 2002, *Cell and Molecular Biology* (8th Edition), Lippincott Williams & Wilkins International Student Edition, Philadelphia.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/1/CC3

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2.25	2	2	1.50	2	1.75	1.75	1	2	2.50	2	2
CO 2	2.50	2	3	1.50	2	1.75	1	1	2	2	2	2
CO 3	2.75	2	2.50	1	2	1	1	1	2.50	2.50	2	2
CO 4	2.50	2	2.50	2	2	1.50	1.25	1	2.50	2	2	2
Average	2.50	2	2.50	1.50	2	1.50	1.25	1	2.25	2.25	2	2

M.Sc. (Botany) – 1st Semester

MSc/BOT/1/SEC1 - Biophysical and Biochemical Techniques

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge pertaining to various tools and techniques used to gain insight into cell structure and biological processes. The focus is on studying the techniques used for isolation, purification and characterization of biomolecules.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Acquire in-depth knowledge of microscopic technology.
CO2	Understand the various methods used in separation, purification and quantification of biomolecules.
CO3	Intensive study of different structures of DNA, RNA and proteins by various techniques.
CO4	Develop ability and confidence of students by using advance techniques.

Note for the paper setter: *The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.*

UNIT-I

1. **Microscopic techniques**: Introduction; Light microscope; Phase contrast microscope; Fluorescent microscope; Electron microscope (EM) – SEM, TEM and STEHM; Scanning probe microscopes- scanning tunneling microscope and atomic force microscope; Different fixation and staining techniques.
2. **Centrifugation**: Principles of sedimentation; Types, care and safety aspects of centrifuges; Differential centrifugation; Density gradient centrifugation and their applications.

UNIT-II

3. **Chromatographic techniques:** Theory of chromatography; Types of chromatography- Paper chromatography, thin layer chromatography, Adsorption chromatography, Partition chromatography, Affinity chromatography, Ion exchange chromatography, HPLC and Size-exclusion chromatography.
4. **Spectrophotometry:** colorimetry; UV and Visible spectrophotometry.

UNIT-III

5. **Electrophoresis**: Principle; Agarose gel electrophoresis; Polyacrylamide gel electrophoresis; 2-Dimensional gel electrophoresis; Capillary electrophoresis; Microchip electrophoresis and Isoelectric focusing.
6. **Mass spectrometry:** Introduction; Theory; Mass spectrometer; Ionization of molecules; Mass analysers- MALDI; Detectors and Applications.

UNIT-IV

7. **Immunotechniques**: Antibody generation; Detection of molecules using ELISA, RIA, Immunoprecipitation and Immunofluorescence microscopy; Detection of molecules in living cells.
8. **Radioisotope techniques**: Radioactive isotopes; Nature of radioactivity; Detection and measurement of different types of radioisotopes normally used in biology; Incorporation of radioisotopes in biological tissues and cells; Molecular imaging of radioactive material; Disposable of radioactive wastes and safety guidelines.

Suggested Readings:

1. Hegyi, G., Kardos, J., Kovacs, M., Csizmadia, A.M., Nyitray, L., Pal, G., Radnai, L., Remenyi, A.,Venekei, I., 2013,*Introduction to Practical Biochemistry*, Eotvos Lorand University, Hungary.
2. Plummer, D.T., 1990, *An Introduction to Practical Biochemistry*, Tata Mc-Graw-Hill Publishing Company Ltd., New Delhi.
3. Prescott, L., Harley, J., Klein, D., 2005, *Microbiology* (6th Ed) Mc Graw-Hill.
4. Ranade, R. and Deshmukh, S., 2013, *Handbook of Techniques in Biotechnology*, Studium Press (India) Pvt. Ltd. New Delhi.

5. Sawhney, S.K. and Singh, R., 2000, *Introductory Practical Biochemistry* (Ed.), Narosa Publishing House Pvt. Ltd., New Delhi.
6. Wilson, K., and Walker, J., 2010, *Principles and Techniques of Biochemistry and Molecular Biology* (7th Ed.), Cambridge University Press, New Delhi.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/1/SEC1

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2	2	1.50	1	1.50	2.50	2	2.50	2.50	3	2.75	3
CO 2	2.50	2	2.50	1	2	2.50	2	2.50	2.50	3	2.75	2
CO 3	2.50	1	2	2	2	2.50	2.75	2	2.50	3	2.75	2
CO 4	2	1	2	1	2.50	2.50	2.75	2	2.50	3	2.75	2
Average	2.25	1.50	2	1.25	2	2.50	2.25	2.25	2.50	3	2.75	2.25

M.Sc. (Botany) – 1st Semester

MSc/BOT/1/CC4 - Lab-I – Pertaining to Theory Papers BOT-CC1, CC2

Credit: 2 (Lectures: 60) **Marks: 50**

Duration of exam: 3 Hrs.

Course Objective: The aim of this course is to give the students essential practical knowledge pertaining to virus, bacteria, fungi and bryophytes.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Get acquaint with vegetative and reproductive structure of different algae.
CO2	Get knowledge of various types of diseases caused by virus, bacteria and fungi.
CO3	The structure of various fungi and bryophytes by permanent slides.
CO4	Make permanent slides of sections of various fungi and bryophytes.

1. Study of the vegetative and reproductive structures in *Nostoc, Chlamydomonas, Volvox, Oedogonium, Coleochaete, Chara, Vaucheria, Ectocarpus, Fucus, Polysiphonia, Prochloron* through, Microscope, temporary and permanent slides.
2. Ems/models of viruses and virus infected plants.
3. Types of bacteria from temporary/permanent slides. Study of bacterial infected plants and Root nodules, Gram staining.
4. Study of *Phaneroplasmodium* from actual specimens and/or photograph. Study of *Physarum* sporangia.
5. Study of symptoms of plants infected with *Albugo*; asexual and sexual structures of through sections/tease mounts and permanent slides.
6. *Rhizopus*: Students to culture Black bread mould in the laboratory to study asexual stage from temporary mounts, Sexual stages of mould to be studied from permanent slides.
7. *Aspergillus* and *Penicillium*: asexual stages from tease mounts.
8. *Neurospora*: Asexual and sexual stage from culture/permanent slides/photographs.
9. *Peziza*: Habit; sectioning through ascocarp, and permanent slides.

10. *Puccinia*: section/tease mounts of spores on wheat, and permanent slides of Both the hosts.
11. Study of growth forms of lichens (crustose, foliose, fructicose) on different substrata.
12. Mushrooms: Specimens of button stage and full-grown mushroom; sectioning of gills of gills of *Agaricus*, study of basidiocarp from permanent slides; Photograph of fairy ring, edible and poisonous fungi (two each), bioluminescent mushroom to be shown.
13. Section/tease mounts of *Alternaria*, and *Colletotrichum.*
14. Applied mycology: Photographs of Mycorrhizae, fungi used in medicine (*Penicillium, Claviceps, Cephalosporium* – **any one**), fungi used as biological control agents (fungi used in control of seeldling, soil borne, post-harvest diseases and in control of nematodes, insects & weeds – **any one**), photographs/mounts of spores of fungi causing human infections along with pictures of patients suffering from such infections (*Aspergillus, Candida, Cryptococcus, Histoplasma, Microsporum, Trichophyton* – **any one**).
15. Study of thallus and reproductive structures (soredia, apothecium) through permanent slides.
16. White rust of Crucifers, Early & Late blight of Potato, Herbabrium/museum specimens of the diseased plants.
17. Preparation of media to isolate bacteria, fungi and other microbes.
18. Isolation of *Rhizobium* from legume root nodules.
19. Sensitivity tests of bacteria using different antibiotics.
20. Structural details of *Marchantia, Asterella, Plagiochasma, Targionia, Pellia, Frullania, Porella, Notothylas, Anthoceros, Sphagnum, Pogonatum, Barbula, Bryum and Entodon and Thuidium.*
21. Morphology and Internal Organization of the following: Representatives of Polytrichales: *Polytrichum, Atrichum;* Sphagnales: *Sphagnum*; Fissidentales: *Fissidens;* Pottiales; *Barbula*;Eubryales: *Mnium*; Entodontales: *Entodon*; Thuidiales: *Thuidium*; Jungermanniales: *Porella, Frullania*; Metzgeriales: *Pellia*; Marchantiales: *Targionia, Plagiochasma, Athalamia, Conocephalum, Reboulia, Wiesnerella, Dumortiera;* Anthocerotales: *Anthoceros, Phaeoceros, Notothylas.*
22. To compare the structure and behavior of endohydric and ectohydric mosses.
23. To study regeneration potential of dried moss leaves and stem fragments.

Students should submit six specimens of algae, fungi, Bryophytes and other microbes at the time of examination.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested readings:

1. Agrios, G.N. (2005) *Plant pathology*, 5th Edition, Academic Press, U.K.
2. Jain, Amita., Agarwal, J. and Venkatesh. 2018. *Microbiology Practical Manual*. 1st Edition. Elsevier india.
3. Khan, M.G., Gatew S. and Bekele Bedilu. 2012. Practical Manual for Bryophytes and Pteridophytes.
4. Rajan, S.S., 2000. *Practical Manual of Fungi*. Anmol Publications Pvt. Ltd.
5. Rajan, S.S., 2000. *Practical Manual of Algae*. Anmol Publications Pvt. Ltd.
6. Sigurd, Funder. 1961. *Practical Mycology* – Manual for Identification of Fungi. Hafner Publishing Co., New York.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/1/CC4

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2	2	2	2	2	2	1	1	2	2.50	2.50	3
CO 2	2	2	2	2	2	3	2	2	2	2.50	3	2
CO 3	3	2	1	2	2	2.50	3	1	2	3	2	1
CO 4	2	2	1	2	2	2.50	2	2	2	2	2.50	2
Average	2.25	2	1.50	2	2	2.50	2	1.50	2	2.50	2.50	2

M.Sc. (Botany) – 1st Semester

MSc/BOT/1/CC5 - Lab-II – Pertaining to Theory Papers BOT- CC3

Credit: 2 (Lectures: 60) **Marks: 50**

Duration of exam: 3 Hrs.

Course Objective: The aim of this course is to give the students essential practical knowledge pertaining to experiments related to cell biology.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Get introduced will all the instruments used in cell biology lab.
CO2	Prepare solutions of stains, prefixatives, fixatives, buffers.
CO3	Study the meiosis and mitosis in plant cells.
CO4	Get acquaint with movement of solvents in the cell.

1. Introduction to various instruments and their working principles used in Cell Biology laboratory.
2. Preparation of normal and moral solutions, buffers, pH setting etc.
3. Preparation and study of prefixatives, fixatives and stains.
4. To study various parts of microscope and demonstrate of microscopic techniques.
5. Study of the structure of cell organelles through photomicrographs.
6. Demonstration of Brownian movement.
7. Demonstration of tyndall effect.
8. Demonstration of plasmolysis and deplasmolysis in plant cell.
9. Demonstration of exosmosis and endosmosis in grapes and resins.
10. Study of structure of plant cell through temporary mounts.
11. To discriminate between viable and non-viable cells using staining techniques.
12. Effect of solution concentration on plant cells.
13. To study the structural diversity of fungi, algae and plant cells.
14. Cell division: Mitosis and meiosis in higher plants.
15. Study of various stages of mitosis using cytological preparation of onion root tips.
16. Microtomy.

17. Histochemical techniques.
18. Cell counting haemocytometer.
19. Cell disruption using Sonicator.
20. Organelle isolation, mitochondrion and chloroplast.
21. Fixation and maceration techniques, staining techniques of plant tissues.
22. Study of effect of temperature & organic solvent on permeability of cell membrane.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested readings:

1. Gupta, R., 2018. *Cell Biology – Practical manual.* Prestige Publishers.
2. Majumdar, R., Sisodia, R., 2019, *Laboratory Manual of Cell Biology, with reference to Plant Cells.* New Delhi, Delhi: Prestige Publication.
3. Sharma, A.K., and Sharma, A., 1980, *Chromosome techniques: theory and practice*. Butterworth-Heinemann.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/1/CC5

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2.50	2	2	1	1	2.50	2	2	2.50	3	1.50	3
CO 2	2	2	2	2	1	2.50	2	2	2	2	2.50	1
CO 3	2.50	1	2	1	1	2	1	2	2.50	2	2	2
CO 4	3	2	2	2	3	3	1	2	3	3	2	2
Average	2.50	1.75	2	1.50	1.50	2.50	1.50	2	2.50	2.50	2	2

M.Sc. (Botany) – 1st Semester

MSc/BOT/1/SEC2 - Lab-III- Pertaining to Theory Papers BOT – SEC1

Credit: 4 (Lectures: 120) **Marks: 100**

Duration of exam: 4 Hrs.

Course Objective: The aim of this course is to give the students essential knowledge pertaining to

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Get working knowledge of various instruments used in the laboratory.
CO2	Know about principles and demonstration of various analytical techniques.
CO3	Get practical knowledge of techniques used in the laboratory.
CO4	Perform techniques and get practical knowledge

1. Demonstration of working of weighing balances, autoclaves, incubators, laminar air flow, water bath.
2. Principle and demonstration of various analytical techniques:

a) Chromatography (HPLC, TLC, Paper Chromatography, Column Chromatography, Ion exchange chromatography.
b) Centrifugation
c) UV –visible spectrophotometer
d) Nanodrop
e) ELISA reader
f) Sonicator
g) Microtome
h) PCR/ Real Time PCR
i) Electrophoresis (AGE and PAGE)

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Sawhney, S.K. and Singh, Randhir (2000) *Introductory Practical Biochemistry*, Narosa

Publishing House, New Delhi.

2. Upadhyay, A., Upadhyay, K. and Nath, N. (1998) *Biochemistry Chemistry: Principle and Techniques*, (2nd ed.), Himalaya publication House, Delhi.
3. Wilson, K. and J. Walker (2018*). Principles and Techniques of Practical Biochemistry and Molecular Biology* (8th Edition). Cambridge University Press, Cambridge.
4. Recent reviews in scientific journals.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/1/SEC2

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2	2	3	1	2	1	2	1	2	3	2.50	2
CO 2	2	2	2	2	2	2	2	1	3	2	2	2
CO 3	2	2	2	1	1	1	2	2	2	2.50	2.50	2
CO 4	2	2	2	2	1	2	2	2	2	2.50	3	2
Average	2	2	2.25	1.50	1.50	1.50	2	1.50	2.25	2.50	2.50	2

M.Sc. (Botany) – 1st Semester

MSc/BOT/9/OEC1 - Plant Resource & Utilization-I

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge pertaining to plant bioresources, their traditional and non-traditional uses. To make the students familiar with economic importance of diverse plants that offer resources to human life.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Understand the beginning of agriculture and its diversification and centre of origin of different bioresources.
CO2	Learn about the different types of bioresources e.g., in service of mankind (as medicine, as food, as timber, as fibre and dye yielding plants,)
CO3	Explore the regional diversity in food crops and other plants and their ethno-Botanical importance as well.
CO4	Learn about various beverage plants and gums.

Note for the paper setter: *The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.*

UNIT-I

1. **Plants and civilization:** Origin of agriculture, world centers of primary diversity of domesticated plants. Secondary centers of origin. Origin and evolution of economically important plants.
2. **Plant as a resource of renewable energy**: Innovations for meeting world food demands.
3. **Green revolution**: Benefits and diverse consequences.

UNIT-II

4. **Important fibres:** Origin and uses of important fibres (Cotton, Jute)
5. **Cultivation and uses:** Origin, Cultivation and uses of Cereals (wheat, rice), Sugarcane, Potato, Oil yielding plants (Groundnut, mustard, sunflower).

UNIT-III

6. **General account of important medicinal plants:** Aconite, Cinchona,Belladonna, Digitalis, Glycyrrhiza, Rauvolfia, Papaver, Vasaka, Aloe and Ginseng.
7. **Brief account of major medicinal plants:** Amla, Neem, Arjun, Harad, Bahera, Isabgol, Ashwagandha, Bhringraj and Senna.

UNIT-IV

8. **Beverage plants:** Source and general account of Tea and coffee.
9. **Gums:** Important commercial gums and their uses.
10. General account of important timber and dye yielding plants.

Suggested Readings:

1. Cobley, L.S. and Steele, W.M., 1976, *An Introduction to the Botany of Tropical Crops* (2nd Ed.), Longmans, London.
2. Hancock, J.F., 2004, *Plant Evolution and the origin of crop species* (2nd Edition) CABI Publishing, Cambridge, MA, USA.
3. Hill, A.F., 1952, *Economic Botany* (2nd Ed.), McGraw Hill, New York.
4. Kochar, S.I., 1981, *Economic Botany in the Tropics*, Macmillan India Ltd., New Delhi.
5. SambaMurthy, A.V.S. and Subrahmanyam, N.S., 1989, *A Text Book of Economic Botany*, Wiley Eastern Ltd., Delhi.
6. Simmonds, N.W., 1976, *Evolution of Crop Plants*, Longman, London, New York.
7. Simpson B.B. and Ogorzaly M.C., 2001, *Economic Botany: Plants of our world* (3rd ed.), McGraw Hill, New York, USA.

M.Sc. (Botany) – 2nd Semester

MSc/BOT/2/CC6 - Biology and Diversity of Pteridophytes and Gymnosperms

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to familiarize the students the classification of both Pteridophytes and Gymnosperms, comparative study of morphological and reproductive characters of Pteridophytes, brief study on family level.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	To enhance the students' ability to perform and comparative demonstrate the difference between Pteridophytes and Gymnosperms.
CO2	Demonstrate an understanding of comparative morphology and reproduction of various Pteridophytes.
CO3	Enlist the different modern methods of propagation of gymnosperms.
CO4	Reproductive mechanism during course of evolution of Pteridophytes and Gymnosperms.

Note for the paper setter: *The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.*

UNIT-I

1. **General characteristics of pteridophytes and classification.**
2. **Comparative morphology and reproduction of the following:** Psilophytales (*Rhynia. Zosterophyllum*), Psilotales (*Psilotum*), Lycopodiales (*Lycopodium, Selaginella*), Lepidodendrales (*Lepidodendron*), Sphenophyllales (*Equisetum*).

UNIT-II

3. **Comparative morphology and reproduction of the following:** Ophioglossales (*Ophioglossum, Botrychium*), Marattiales (*Marattìa, Angiopteris*), Osmundales, Filicales

(*Pteris, Dryopteris*), Marsileales, Salviniales.

UNIT-III

4. **Classification of gymnosperms and their distribution in India.**
5. **Brief account of the following families:** Lyginopteridaceae, Medullosaceae, Glossopteridaceae, Caytoniaceae.
6. **General account of the following orders:** Cycadeoidales (Cycadeidea), Pentoxyalales, Cordiatales.
7. **Comaparative account of Structure and reproduction in the following orders:** Cycadales (*Cycas*), Ginkgoales (*Ginkgo*), Coniferales (*Pinus, Cedrus*), Ephedrales (*Ephedra),* Welwitschiales, Gnetales.

UNIT-IV

8. Teleome Theory, Evolution of stellar system. Apogamy, apospory, significance experimental induction, Heterospory and origin of seed habit in Pteridophytes.
9. **Modern methods of propagation of gymnosperms:** Somatic embryogenesis, haploids protoplast culture, Economic importance of gymnosperms.

Suggested Readings:

1. Bhatnagar, S.P. and Moitra, A.1996, *Gymnosperms*, New Age International Pvt. Ltd., New Delhi.
2. Parihar, N.S., 1977, *The Biology and Morphology of Pteridophytes*, Central Book Depot, Allahabad.
3. Rashid, A. 1999, *An Introduction to Pteridophyta*, Vikas Publishers, New Delhi.
4. Sporne, K.R. 1965, *The Morphology of Pteridophytes*, B.I. Publications Pvt. Ltd., Delhi.
5. Sporne, K.R. 1965. *The Morphology of Gymnosperms*. B.I. Publications Pvt. Ltd., New Delhi.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/2/CC6

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2	2	1	3	2	2	2	1	3	2	3	2
CO 2	2	2	3	3	2	2	2	1	2	2	3	2
CO 3	2	2	2	2	2	2	2	1	3	2	2	2
CO 4	3	2	2	2	2	2	2	1	2	3	2	2
Average	2.25	2	2	2.50	2	2	2	1	2.50	2.25	2.50	2

M.Sc. (Botany) – 2nd Semester

MSc/BOT/2/CC7 - Cytogenetics

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge pertaining to structure and functions of a chromosome in detail. The course also explains the chromosomal variations and their effects on biological system.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Acquire knowledge about the different cytogenetic and molecular techniques used for genome analysis.
CO2	Learn about role of chromosomes in sex determination and generation.
CO3	linkage and recombination frequencies in gene mapping.
CO4	Enhance knowledge and ability of students for determining the role of genetics in evolution.

Note for the paper setter: *The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.*

UNIT-I

1. **Chromatin structure and organization:** Chromosome structure and DNA packaging; euchromatin and heterochromatin.
2. **Organization of plastid and mitochondrial genomes.**
3. **Special Chromosomes:** Structure, occurrence and behaviour of polytene, lampbrush, B and sex chromosomes.
4. **Karyotype:** Karyotype analysis and its evolution; FISH, GISH and flow cytometery, Chromosome banding techniques and their applications.

UNIT-II

5. **Mendelian principles:** Dominance, segregation, independent assortment.
6. **Concept of gene:** Allele, multiple alleles, pseudoallele, complementation tests.

7. **Extension of Mendelian principles:** Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

UNIT-III

8. **Structural alterations in chromosomes:** Origin, meiosis and breeding behaviour of duplication, deficiency, inversion and translocation heterozygotes.
9. **Variation in chromosome number:** Haploids, aneuploids and euploids- origin, production, effects and uses; polyploidy and crop improvement.
10. **Linkage and crossing over:** Molecular mechanism of crossing over and role of different enzymes; linkage groups**.**
11. **Chromosome mapping:** Two point and three-point test crosses.

UNIT-IV

12. **Recombination:** homologous and non- homologous recombination including transposition.
13. **Human genetics:** Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders
14. **Population Genetics and Evolution:** Allele frequencies and genotype frequencies, random mating and Hardy-Weinberg principle, inbreeding, mutation, migration, natural selection, random genetic drift, quantitative inheritance.

Suggested Readings:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P., 2008, *Molecular Biology of the Cell (5th Ed.)*. Garland Publishing Inc., New York.
2. Karp, G., 1999, *Cell and Molecular Biology*, John Wiley and Sons, USA
3. Lewin, B., 2010, *Gene X*, Jones and Barlett Publishers.
4. Lodish, H., Berk, A. Zipursky S. L., Matsudaira, P. Baltimore, D. Darnell, J., 2005, *Molecular Cell Biology*, W.H. Freeman & Co., U.S.A.
5. Pierce, B.A., 2012, *Genetics- A Conceptual Approach* (4th Ed.), W.H. Freeman and Company, New York, USA
6. Russell, P.J, 2006, *Genetics (5th Ed.),* Addison Wesley Longman, California, USA.
7. Snustad, P., and Simmons, M.J, 2011, *Principles of Genetics.* (6th Ed.), John Wiley, New York.

8. Weaver, R.F, 2005, *Molecular Biology*, McGraw Hill International Edition.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/2/CC7

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2.50	2	3	2	1.50	2	1.50	2	2	3	2	1.50
CO 2	2.50	1.50	2	2	1.50	2	1.50	2	2	3	2	1.50
CO 3	2.50	1.50	2	2	2	2	1.50	2	2	1	3	2
CO 4	2.50	2	2	2	1	2	1.50	2	2	1	3	1
Average	2.50	1.75	2.25	2	1.50	2	1.50	2	2	2	2.50	1.50

M.Sc. (Botany) – 2nd Semester

MSc/BOT/2/CC8 - Molecular Biology

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge pertaining to biological processes such as DNA replication, transposition and mutations. A key thrust of this paper is towards the molecular mechanisms involved in the control of gene expression and regulation.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	The students will have enhanced understanding of genome structure, evolution and its replication.
CO2	This course will impart the knowledge of basics of mutations and their importance; DNA repair mechanisms.
CO3	The students will learn about the methods of genetic recombination in bacteria.
CO4	The students will gain insight into the principal mechanisms of genome expression and its regulation.

Note for the paper setter: *The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.*

UNIT-I

1. **Eukaryotic genome:** Different forms of DNA, C- value paradox, unique and repetitive DNA, gene families, hybridization kinetics and split genes.
2. **Transposable elements:** Mechanisms of transposition; transposons in bacteria, maize, Drosophila and yeast**.**
3. **DNA Replication:** Semi-conservative, bidirectional, replication origins, replication machinery.

UNIT-II

4. **Mutations:** types, isolation of mutants, molecular basis of mutations.
5. **DNA damage and repair:** Causes of DNA damage; Photoreactivation, excision, mismatch, post replication and error prone repair systems.
6. **Fine structure of gene:** cis-trans test, rII locus, fine structure analysis of eukaryotes.
7. **Bacterial genetics:** conjugation, transduction and transformation.

UNIT-III

8. **Transcription**: Initiation, elongation and termination in prokaryotes and eukaryotes, RNA polymerases.
9. **RNA Processing:** Processing of mRNA, rRNA and tRNA.
10. **Genetic code:** Deciphering the genetic code, characteristics.
11. **Translation:** Initiation, elongation and Termination in prokaryotes and eukaryotes.

UNIT-IV

12. **Regulation of gene expression in prokaryotes:** Operon concept, lac operon regulation by positive and negative mechanism, trp operon, regulation by negative and attenuation.
13. **Regulation of gene expression in eukaryotes:** Transcriptional level (Regulatory sequences, nucleosome positioning, chromatin remodeling, histone modifications.); post-transcriptional level (RNA splicing, RNA stability); Translational level and post-translational level.

Suggested Readings:

1. Alberts, B., and Johnson, A., 2016, *Molecular Biology of Cell*, Gerland Science Publisher.
2. Brown, T.A, 1999, *Genomes.* John Wiley & Sons (Asia) Pvt. Ltd., Singapore.
3. Karp, G., 2010, *Cell and Molecular Biology – Concept and Experiments*, 5th Edition.
4. Lewin, B., 2010, *Gene X*, Pearson Prentice and Hall, New Delhi.
5. Lodish, et. al., 2013, *Molecular Cell Biology*, 7th Edition, W.H. Freeman Publisher.
6. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., and Losick, R., 2008, *Molecular Biology of the Gene* (6th Ed.), CSHLP, New York.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/2/CC8

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2	2	2	1.50	1.50	2	1.50	1	2.50	2	2.75	1.50
CO 2	3	1	1	1.50	1.50	2	1.50	1	1.50	2	2.25	1.50
CO 3	2	2	1	1.50	1.50	2	1.50	1	2	2	3	1.50
CO 4	2	1	2	1.50	1.50	3	1.50	1	2	2	3	1.50
Average	2.25	1.50	1.50	1.50	1.50	2.50	1.50	1	2	2	2.75	1.50

M.Sc. (Botany) – 2nd Semester

MSc/BOT/2/DSC1/A - Principles of Plant Pathology

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge pertaining to various aspects of Plant Pathology like Symptomatology, Defence mechanisms, Host Parasite interactions, Role of enzymes and toxins in pathogenesis. It also aims to study the Etiology, Epidemiology and Control of different plant diseases caused by Fungi and other micro-organisms.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Understand the interaction between plant and pathogen in relation to the overall environment
CO2	Demonstrate an understanding of the principles of plant pathology and the application of these principles for the control of plant disease.
CO3	Acquire physiology, photosynthesis, respiration, transpiration, translocation. Knowledge about cause of plant diseases and effect of microbial infections on plant
CO4	Demonstrate skills in laboratory and field related to plant pathology.

Note for the paper setter: *The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.*

UNIT-I

1. **Symptomatology in Fungal infections of plants.**
2. **Fundamentals of plant pathology**: History of plant pathology; various levels of parasitism; classification of plant diseases.
3. **Pathogenesis**: Penetration and entry of plant pathogens; development inside host tissue, Host – parasite Interactions: Alteration in plant physiological functions.

UNIT-II

4. **Agents of plant diseases:** General characteristics and symptoms caused by – agents of infectious diseases (fungi, bacteria, mycoplasma, virus, MLOs, Spiroplasma, Viriods, Mycoviruses and nematodes) and agents of non-infectious diseases (Air pollution, chemicals, minerals excesses, temperature)**.**
5. **How pathogens attack plants:** chemical weapons of pathogens (enzymes and toxins)
6. **Nutrition in Fungi.**

UNIT-III

7. **Etiology, Epidemiology and control of the following diseases:**
   a) Paddy: Paddy Blast, Brown Leaf Spot, Bacterial Blight
   b) Wheat: Rusts, Bunt and Smuts, Tundu disease
   c) Sugarcane: Red Rot, smut
   d) Grapes: Downy and Powdery Mildews
   e) Peach: Leaf Curl
   f) Groundnut: Tikka disease
   g) Apple: Apple Scab
   h) Mustard: White Rust, Downy Mildews
   i) Potato: Early and Late Blight, Wart Disease
   j) Linseed: Rust
   k) Damping off of the seedlings
   l) Ergot of Rye
8. **Applications of biotechnology in Plant Pathology:** The use of tissue culture techniques (callus culture, apical meristem culture and protoplast fusion), Recombinant DNA technology, use of monoclonal antibodies in plant pathology.

UNIT-IV

9. **How plants defend themselves against pathogens**: structural defense and biochemical defense.
10. **Plant disease epidemiology and plant disease forecasting**: Importance of disease forecasting services, methods used in plant disease forecasting**.**

11. **Management of plant pathogens:** cultural, chemical and biological methods.
12. **Detoxification of pathogen toxin**: Application of molecular biology in diseases control strategies, Plant quarantine.

Suggested Readings:

1. Agrios, G.N., (2005), *Plant Pathology*, Acad. Press, Inc. California.
2. Bilgrami, K.S. and Dube, H.C., (1990), *A Text Book of Modern Plant Pathology*, Vikas Publishing House, New Delhi.
3. Mehrotra, R.S. and Aggarwal, A., (2013), *Fundamentals of Plant Pathology*, Tata Mc Graw Hill Publ. Ltd., New Delhi.
4. Mehrotra, R.S. and Ashok Aggarwal (2017): *Plant Pathology*, Tata Mc Graw Hill Publ. Ltd., New Delhi.
5. Singh, R.S., (2018), *Plant Disease*, 9th Edition, Oxford, IBH Publ., New Delhi.
6. Singh, R.S., (2017), *Principles of Plant Pathology*, 5th Edition, Medtech.
7. Recent and important review articles from scientific journals.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/2/DSC1/A

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	3	1	2	1	2	2	0	1	3	0	2.25	1
CO 2	3	3	2	1	1	2	0	1	2	1	2.75	2
CO 3	2	2	2	2	2	2	3	3	3	3	3	3
CO 4	2	1	2	2	2	2	3	3	2	3	3	3
Average	2.50	1.50	2	1.50	1.75	2	1.50	2	2.50	1.75	2.75	2.25

M.Sc. (Botany) – 2nd Semester

MSc/BOT/2/DSC1/B - Principles of Plant Breeding

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge pertaining to basic principles and various methods of breeding in plants reproducing sexually and asexually, and also importance of plant genetic resources in plant breeding.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Understand the experimental steps and methods involved in generating new varieties using classical and contemporary breeding practices.
CO2	It will help to understand the beginning of agriculture and its diversification and centre of origin of different bioresources.
CO3	Spreads awareness about different aspects of plant breeding.
CO4	enhance knowledge in molecular breeding and cultivar development.

Note for the paper setter: *The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.*

UNIT-I

1. **History of Plant Breeding (Pre- and post-Mendelian era).** Objectives of plant breeding. characteristics improved by plant breeding: Patterns of Evolution in Crop Plants- Centres of Origin-biodiversity and its significance. Primary and secondary centres of diversity, utilization of wild plants in crop improvement.
2. **Introduction and domestication as methods of plant breeding.**

UNIT-II

3. **Principles of plant breeding:** Principles and objectives, methods of breeding self- and cross-pollinated crops, heterosis and hybrid vigour; utility of hybrids in genetics and plant breeding.

4. **Molecular breeding.**

UNIT-III

5. **Asexual breeding systems:** Methods of breeding of vegetatively propagated crops: non-conventional methods: gene variability.
6. **Male sterility:** Concept; classification; genetic control; inheritance pattern and breeding utility

UNIT-IV

7. **Plant genetic resources:** Importance of plant genetic resources and diversity in plant breeding, collection, evaluation and conservation of germplasm**.** Breeding for disease resistance: classification of resistance, responses of the host to pathogens. variability systems of pathogenic fungi. Breeding disease resistant varieties; multiline varieties.
8. **Cultivar development:** testing, release and notification. maintenance breeding, Participatory Plant Breeding. Plant breeders' rights and regulations for plant variety protection and farmers rights**.**

Suggested Readings:

1. Allard, R.W. (1960), *Principles of Plant Breeding*, John Wiley & Sons, N. York.
2. Anonymous (1997), *National Gene Bank: Indian Heritage on Plant Genetic Resources* (Booklet), National Bureau of Plant Genetic Resources, New Delhi.
3. Chopra, E.I. (Ed.) (1989), *Plant Breeding: Theory and Practice*. (Reprint 1994), Oxford and HBH Publ. Co. New Delhi.
4. Poehlman, J.M., 1986, *Breeding Field Crops*, AVI Publishing Company, Connecticut.
5. Pochlman, J.M., and Sleper, D.A (1995) *Breeding Field Crops*, A.V.I. Publ., USA.
6. Singh, B.D., (2005), *Plant Breeding – Principles and Methods*, Kalyani Publishers, Ludhiana.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/2/DSC1/B

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	2	3	2	2	2	2	2	2	3	2
CO 2	3	2	2	3	2	2	0	0	2	2	1	0
CO 3	2	2	2	2	2	1	1	2	2	2	1	1
CO 4	2	1	2	2	2	1	1	2	2	2	2	1
Average	2.50	1.75	2	2.50	2	1.50	1	1.50	2	2	1.75	1

M.Sc. (Botany) – 2nd Semester

MSc/BOT9/OEC2 - Plant Resources & Utilization - II

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge pertaining to avenue trees, origin crop plants, spices and condiments, medicinal plants, fruits and vegetables, common ornamental plants common food adulterants wood and its uses, wood and its uses. Students will also be introduced to major role of plant as a source of renewable energy, Genetic resources and their conservation.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Students are also acquainted to important topics such as origin of crop plant and food adulteration.
CO2	Medicinal plants and aromatic plants and their importance is made known along with their identification.
CO3	Important avenue, pollution and aesthetically beautiful plants of the city and adjoining area are shown to the students.
CO4	Develop the ability of students about determining the property of spices and condiments.

Note for the paper setter: *The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.*

UNIT-I

1. **Avenue trees:** Plants used as avenue trees for shade, pollution control and aesthetics.
2. **Origin Crop Plants:** Idea about centre of origin of common crop plants.
3. **Spices and Condiments:** Saffron, Clove, Cardamom, Ginger, Turmeric, Cinnamon, Capsicums, Asafoetida, Coriander, Fennel, Fenugreek.

UNIT-II

4. **Medicinal Plants:** Importance of medicinal plants – role in human health care.

5. **Tradiotional knowledge and utility of some common medicinal plants:** Sarpgandha, Isabgol, Vsaka, Neem, Bhringraj, Amla, Harad, Bahera, Arjun, Punarnava, Brahmi, Kasondi, Ghritkumari, Quinine and Eucalyptus. Insecticides from plants (Pyrethrum), Hallucinogenic Plants- General Account.

UNIT-III

6. **Fruits and Vegetables:** Cultivation and uses of Fruits and Vegetables, Nutritive and medicinal values of some fruits and vegetables (Guava, Sapota, Orange, Mango, Banana, Lemon, Pomegranate, Moringa, Cabbage)
7. **Common Ornamental Plants**
8. **Common Food adulterants**

UNIT-IV

9. **Wood and its uses:** soft woods and Hard Woods; wood as fuel, constructional material (Pilings, Veneers, Plywood), wood containers (cooperage), chemically derived products and wood distillation, Common timber yielding plants and minor forest products.
10. **Unexploited plants of potential economic value**: plants as a source of renewable energy, Genetic resources and their conservation.

Suggested Readings:

1. Cobley, L.S. and Steele, W.M. 1976, *An Introduction to the Botany of Tropical Crops* (2nd Ed.), Longmans, London.
2. Hill, A.F. 1952, *Economic Botany* (2nd Ed.) McGraw Hill, New York.
3. Kochar, S.L. 2016, *Economic Botany: A Comprehensive Study*, 5th ed., Cambridge University Press
4. Kochar, S.L. 1981, *Economic Botany in the Tropics*, Macmillan India Ltd., Delhi.
5. Simmonds, N.W., 1976, *Evolution of Crop Plants* Longman, London, New York.
6. SambaMurthy, A.V.S., and Subrahmanyam, N.S., 1989, *A Text Book of Economic Botany*, Wiley Eastern Ltd., Delhi.

M.Sc. (Botany) – 2nd Semester

MSc/BOT/2/CC9 - Lab-IV Pertaining to Theory Papers BOT – CC6

Credit: 2 (Lectures: 60) **Marks: 50**

Duration of exam: **3 Hrs.**

Course Objective: The aim of this course is to give the students essential knowledge pertaining to biology and diversity of pteridophytes and gymnosperms.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Know about morphology and anatomy of pteridophytes and gymnosperms.
CO2	Study about fossil pteridophytes through specimens.
CO3	Prepare permanent slides.
CO4	Study about fern spores and their morphology.

1. Study of the morphology, anatomy and reproductive structures of the representatives of the fern families mentioned in the theory part.
2. Study of morphology and anatomy of vegetative and reproductive organs using cleared whole mounts, sections, macerations and permanent preparations of following living genera: *Psilotum, Lycopodium, Isoetes, Selaginella, Equisetum, Angiopteris, Ophioglossum, Botrychium, Osmunda, Marsilea, Salvinia, Azolla, Lygodium, Hymenophyllu, Cyathea, Pteris, Asplenium, Dryopteris, Polystichum, Adiantum, Polypodium and Lepisorus.*
3. Study of some fossil pteridophytes through specimens and permanent slides.
4. Preparation of permanent slides/charts.
5. Taxonomical characters of ferns for generic identification and characterization of families.
6. Study on the fern spores and their morphology.
7. Wood Anatomy in *Cedrus, Ginkgo, Ephedra and Gnetum.*
8. Leaf anatomy in *Cedrus, Abies, Picea*, *Podocarpus*, *Cryptomeria*, *Cephalotaxus.*
9. Male cones (External morphology) & microsporophylls in *Cedrus, Abies*, *Cephalotaxus, Podocarpus, Cryptomeria*, *Cupressus and Thuja.*
10. Female cones in *Cedrus, Abies, Picea, Taxodium, Auraucaria, Cunninghamia,* Seed scale complex in *Cryptomeria, Cupressus and Thuja.*

11. Field Trips to familiarize with natural habitats, growth forms and diversity of Bryophytes, Pteridophytes and Gymnosperms.

Students should submit six specimens of pteridophytes and gymnosperms at the time of examination.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Bhatnagar. S.P., and Moitra, A. *Gymnosperms*. New Age International Limited, New Delhi.
2. Dyer, A.F., 1979.*The Experimental Biology of Ferns*. Academic press. London.
3. Rashid, A., 1991.*An Introduction to Pteridophyta*, Vikas Publishers, New Delhi.
4. Sporne, K.R.1974. *The Morphology of Gymnosperms*, B.I. Publications, Delhi, 1974.
5. Sporne, K.R. *The morphology of Pteridophyta*, B.I., Publications. Bombay, Delhi, Madras.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/2/CC9

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2.50	2	2	2	2	2.50	2	1	2.50	2	2	2
CO 2	3	2	2	2.50	2	3	1	2	3	2	2	2
CO 3	2.50	2	2	3	2	2.50	2	1	2.50	2	2	2
CO 4	2	2	2	2.50	2	2	1	1	2	2	2	2
Average	2.50	2	2	2.50	2	2.50	1.50	1.25	2.50	2	2	2

M.Sc. (Botany) – 2nd Semester

MSc/BOT/2/CC10 - Lab-V Pertaining to Theory Papers BOT – CC7, CC8

Credit: 2 (Lectures: 60) **Marks: 50**

Duration of exam: **3 Hrs.**

Course Objective: The aim of this course is to give the students essential practical knowledge pertaining to cytogenetics and molecular biology.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Study about problems related to Mendelian and non-mendelian genetics.
CO2	Solve problems related to Population genetics, Linkage mapping and pedigree analysis.
CO3	Get knowledge about different techniques used in Molecular Biology.
CO4	Isolate Nucleic acid and plasmid DNA.

1. Study of problems on Mendelian Genetics, Gene interactions. Multiple allele and multiple gene inheritance.
2. To test the genetics hypothesis by Chi-square Test and study goodness of fit.
3. Preparation of Linkage Maps in Diploids using three points test cross method.
4. Tetrad analysis and centromere mapping in ordered and unordered tetrads.
5. Pedigree analysis.
6. Problem relating to population genetics.
7. Study of B chromosome in Maize/Drimia.
8. Induction of polyploidy, using Colchicine.
9. Study different stages of mitosis in root rips of *Allium* species.
10. Study meiotic behaviour of chromosomes in Anthers of *Allium* sp. or *Rhoeo.*
11. Separation of membrane and demonstration of permeability.
12. Isolation and demonstration of mitochondria activity.
13. Isolation of chloroplast and demonstration of chloroplast activity.
14. Histochemical localization of nucleus and nucleolus.
15. Isolation of Nucleic acid.
16. Gel electrophosis separation of nucleic acid.
17. Molecular size determination of DNA samples by Agarose gel electrophoresis.

18. Isolation of nucleic acid.
19. PAGE.
20. Quantitative analysis of DNA.
21. Restriction digestion of DNA and ligation of DNA fragments.4
22. Isolation of plasmid DNA.
23. Southern blotting.
24. Western Blotting.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Cox, M.M., Doudna J.A., O. Donnell M. *Molecular Biology: Principles and Practices* (1st Edition). W.H. Freeman and Company, 2012.
2. Sharma, A.K., and Sharma, A., 1980, *Chromosome techniques: theory and practice*. Butterworth-Heinemann.
3. Singh, R. J., 2018. *Plant Cytogenetics.* CRC Press.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/2/CC10

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2	1	1	2	1	1	2	2	2	1	2.50	2
CO 2	2	2	2	2	2	2	2	2	2	2	3	1
CO 3	2	1	2	2	1	2	2	2	2	1	2.50	1
CO 4	2	2	1	2	2	1	2	2	2	2	2	2
Average	2	1.50	1.50	2	1.50	1.50	2	2	2	1.50	2.50	1.50

M.Sc. (Botany) – 2nd Semester

MSc/BOT/2/DSC2/A - Lab-VI– Pertaining to Theory Papers DSC1/A

Credit: 4 (Lectures: 120) **Marks: 100**
Duration of exam: **4 Hrs.**

Course Objective: The aim of this course is to give the students essential practical knowledge pertaining to Plant Pathology.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Get practical knowledge of plant diseases.
CO2	Study the symptoms and diagnostic features of casual organisms of various plant diseases.
CO3	Isolate and purify single spore culture of pathogens.
CO4	Collect and preserve specimens and make a herbarium.

1. Study of plant diseases mentioned in theory syllabus.
2. Isolation, purification and single spore culture of pathogens.
3. Isolation of pathogens from diseased tissues (leaf, stem and fruit) by serial dilution method.
4. To study the symptoms and diagnostic features of causal organisms of the following plant diseases:
   a) White Rust of Crucifer.
   b) Linseed Rust.
   c) Rust on Wheat and Berbery.
   d) Smut diseases: wheat, Rice, Sorghum, Sugarcane and Grass.
   e) Downy mildew of Grapes.
   f) Powdery mildew of Grapes.
   g) Red rot of sugarcane.
   h) Tikka disease of Groundnut.
   i) Late blight of potato.
   j) Early blight of Potato.
   k) Diseases caused by fungi imperfecti.
   l) Study of Viral diseases.

m) Study of Nematode diseases.

n) Bunt diseases of Wheat and Rice.

o) Wart disease of potato.

p) Apple scab.

q) Citrus canker.

r) Tundu disease of Wheat.

5. Collection and preservation of specimens from infected plants. Submit 5 herbarium sheets/live specimens along with a report.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Agrios, G.N. 2005.*Plant Pathology*, 5th Ed. Elsevier Academic Press, San Diego, 922 pp. 2005.
2. Bhale, U., Mishra, M., Kumar, S., and Gupta, Om. 2015. *Laboratory Manual on Plant Pathology*. Astral International Pvt. Ltd.
3. Mehrotra, R.S. and Ashok Aggarwal (2017): *Plant Pathology*, Tata Mc Graw Hill Publ. Ltd., New Delhi.
4. Singh, R.S., (2018): *Plant Disease*, 9th Edition, Oxford, IBH Publ., New Delhi.
5. Singh, R.S., (2017): *Principles of Plant Pathology*, 5th Edition, Medtech.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/2/DSC2/A

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2.25	2	2	2	2	2	1	1	2	1	2.50	2
CO 2	2	1	2	2	2	2	2	2	1	1	3	2
CO 3	2.50	1	1	2	1	2	1	2	1	1	2.50	2
CO 4	2.25	3	2	2	2	2	2	1	2	1	2	2
Average	2.25	1.75	1.75	2	1.75	2	1.50	1.50	1.50	1	2.50	2

M.Sc. (Botany) – 2nd Semester

MSc/BOT/2/DSC2/B - Lab-VI– Pertaining to Theory Papers DSC1/B

Credit: 4 (Lectures: 120) **Marks: 100**

Duration of exam: **4 Hrs.**

Course Objective: The aim of this course is to give the students essential practical knowledge pertaining to Plant Breeding.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Study mitosis and meiosis in higher plants.
CO2	Prepare and study karyotype.
CO3	Get knowledge about various steps involved in breeding.
CO4	Estimate heritability and genetic advance.

1. Preparation and study of karyotype.
2. Mitosis and meiosis in higher plants.
3. Study of aberrant meiosis in *Rhoeo*, *Tradescantia* and *Chrysanthemum*.
4. Calculation of mitotic index and chiasma frequency.
5. Floral biology in self- and cross-pollinated species, selfing and crossing techniques.
6. Selection methods in segregating populations and evaluation of breeding material.
7. Estimation of heritability and genetic advance.
8. Determination of extent of outcrossing.
9. Learning techniques in hybrid seed production using male-sterility in field crops.
10. Self-incompatibility and techniques of maintenance and overcoming sporophyte and gametophytic incompatibility.
11. Selection methods in segregating populations selection differential and intensity – demonstration of their relationship and effect on genetic gain.
12. Screening for quality traits, resistance/tolerance to biotic & abiotic stresses.

13. Demonstration of quality seed production through nucleus and breeders seed production techniques.
14. Maintenance of experimental records.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Bhandari, M.M. (1974), *Practicals in Plant Breeding: A Manual cum practical record*, Oxford and HBH Publ. Co., New Delhi.
2. Chopra, E.I. (Ed.) (1989), *Plant Breeding: Theory and Practice*. (Reprint 1994), Oxford and HBH Publ. Co. New Delhi.
3. Chopra, V.L., 2004, *Plant Breeding*, Oxford & IBH.
4. Gupta, S.K, 2005, *Practical Plant Breeding*, Agribios.
5. Sharma, A.K., and Sharma, A., 1980, *Chromosome techniques: theory and practice*. Butterworth-Heinemann.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/2/DSC2/B

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2.50	2	2	1	2	2	2	2.50	2	1.50	2.50	2
CO 2	2	1	2	1	2	1.50	2	2	2	2	3	1
CO 3	2	1	2	2	2	2	2	1.50	2	1.50	2.25	1
CO 4	2.50	2	2	2	2	2.50	2	2	2	1	2.25	2
Average	2.25	1.50	2	1.50	2	2	2	2	2	1.50	2.50	1.50

M.Sc. (Botany) – 3rd Semester

MSc/BOT/3/CC11 - Plant Systematics & Biology of Reproduction

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: This course aims to educate students on concept of systematics, taxonomic keys, classification of flowering plants, botanical nomenclature, plant molecular systematics, plant collection and documentation, male and female gametophyte, pollination and pollen pistil interaction**.**

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	To acquaint students with systematics, taxonomic evidences and botanical nomenclature.
CO2	Students will be learnt about plant molecular systematics and plant documentation methods.
CO3	This course explores the reproductive biology. The students will effectively communicate scientific knowledge of how plant reproduce.
CO4	Acquire knowledge about the different interaction and apomixes.

Note for the paper setter: *The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.*

UNIT-I

1. **Systematics:** Concepts and components; Plant identification: Taxonomic keys.
2. **Classification of flowering plants:** APG IV classification. Taxonomic evidence: structural and biochemical characters.
3. Salient Features of International Code of Nomenclature of Algae, Fungi and Plants (ICN), [Shenzhen Code (2018)].

UNIT-II

4. **Botanical Nomenclature:** Principles of nomenclature, Scientific names, Ranks, Author

citation, Nomenclatural types, Valid publications, Priority of publications, Conservation of names, Name changes, Synonyms.

5. **Plant Molecular Systematics:** DNA sequence data, Types of sequence data, Sequence alignment, Phylogenetic analysis (parsimony, Maximum Likelihood, Bayesian approaches, Neighbour-Joining).
6. **Plant Collecting and Documentation**: Methods of collecting plants, Herbaria and data information systems, Herbarium specimens, Herbarium operations, Data Information Systems.

UNIT-III

7. **Male gametophyte:** Structure of anther, microsporogenesis, role of tapetum, Pollen development, male sterility; pollen germination, pollen tube growth and guidance; pollen allergy.
8. **Female gametophyte:** ovule development, megasporogenesis, Organisation of the embryo sac, structure of embryo sac cells

UNIT-IV

9. **Pollination:** Pollination mechanisms and vectors.
10. **Pollen-pistil interaction and fertilization:** structure of pollen; pollen – stigma interaction, sporophytic and gametophytic incompatibility, double fertilization, Endosperm development, polyembryony; apomixis.

Suggested Readings:

1. Bhojwani, S.S., and Bhatnagar, S.P., 2000, *The Embryology of Angiosperms* (4th Ed.), Vikas Publishing House, New Delhi.
2. Crawford, D.J., 2003, *Plant Molecular Systematics*, Cambridge University Press, Cambridge, UK.
3. Judd, W.S., Campbell, C.S, Kellogg, E.A., Stevens, P.A. and Donoghue, M.J.,2016, *PlantSystematics: A Phylogenetic Approach*. Sinauer Associates, Inc., Massachusetts.
4. Shivanna, K.R. and Johri, B.M., 1985, *The Angiosperm Pollen: Structure and Function.* Wiley Eastern Ltd., New Delhi.
5. Simpson, M.G., 2010, *Plant Systematics*, Elsevier, Amsterdam.
6. Steussy, T.F., Crawford, D.J., Soltis, D.E. and Soltis, P.S., 2014, *Plant Systematics: The*

origin, interpretation, and ordering, of plant biodiversity, Koeltz Scientific Books, Konigstein, Germany.

7. Radford, A.F.,1986, *Fundamentals of Plant Systematics*, Harper and Row Publishers, Inc.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/3/CC11

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2	0	1	2	1.25	2	1	1	3	2	0	2
CO 2	3	1	1	2	1.25	2	1	2	2	2	0	2
CO 3	3	2	1	1	1.25	1	2	1	2	2	1	2
CO 4	2	2	1	1	1.25	1	2	1	2	2	1	2
Average	2.50	1.25	1	1.50	1.25	1.50	1.50	1.25	2.25	2	0.50	2

M.Sc. (Botany) – 3rd Semester

MSc/BOT/3/CC12 - Plant Physiology & Biochemistry

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge pertaining to plant physiology especially the water transport, absorption, photosynthesis, respiration and nitrogen metabolism.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Students will be taught about carbon fixing pathways, oxidative pathways.
CO2	Enhance knowledge of students about nitrogen fixation and translocation of photosynthates.
CO3	structure and role of amino acids and proteins their biosynthesis and their modification into specific structure.
CO4	will gain the knowledge on nucleic acids, their synthesis and regulation, fatty acids their types and synthesis.

Note for the paper setter: *The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.*

UNIT-I

1. **Photosynthesis:** the four major complexes of thylakoids: path of carbon in photosynthesis (C_2, C_3 and CAM plants). Rubisco, structure and its association with the mechanism of carboxylation and oxygenation of RUBP. Effect of environmental factors on photosynthetic rates.
2. **Respiration:** Glycolysis, Krebs cycle, ETC and ATP synthesis, pentose phosphate pathway, glyoxylate cycle. Cyanide insensitive respiration: its mechanism and significance.

UNIT-II

3. Solute transport and photoassimilate translocation – uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes,

through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates.

4. **Nitrogen Metabolism:** Biological nitrogen fixation, nodule formation and nod factors, mechanism of nitrate uptake and reduction, ammonium assimilation; nitrogen transformation during plant development.

UNIT-III

5. **Amino acids and Proteins:** Classification, Structure types; Primary, Secondary, Tertiary and Quaternary structure of proteins; stability of protein structure; Classification of proteins based on composition, solubility function; Reverse turns and Ramachandran plot.
6. **Enzymes:** Nomenclature and Classification; Enzyme Kinetics; Mode and Mechanism of Enzyme Action, Enzyme Regulation, Activators, Inhibitors and Isoenzymes, Allosteric enzymes.

UNIT-IV

7. **Nucleic Acids:** Structure and properties of nucleic acid bases, nucleosides and nucleotides. Biosynthesis and degradation of purines and pyrimidines, salvage pathway.
8. **Lipid Metabolism:** Structure of fatty acids, classification of lipids. Fatty acids biosynthesis, degradation and their regulation, Ketone bodies synthesis.

Suggested Readings:

1. Hopkins, W.G. and Hüner, N.P.A., 2009, *Introduction to Plant Physiology* (4th Ed.) Wiley & Sons. Inc. USA.
2. Nelson, D. L., and Cox, M. M., 2017, *Lehninger principles of biochemistry* (7th Ed.). W.H. Freeman.
3. Salisbury, F.B. and Ross, C.W., 1992, *Plant Physiology*, (4th Ed.), Wadsworth Publishing Co. Belmont, California, USA.
4. Srivastava, L.M., 2006, *Plant Growth and Development: Hormones and Environment*, Academic Press, Published by Elsevier India Pvt. Ltd., New Delhi.
5. Taiz, L., Zeiger, *et al*., 2018, *Fundamentals of plant physiology*, Sinauer Associates.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/3/CC12

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	1	2	2	1.75	1	1	2	2	1.75	2
CO 2	2	2	1	2	2	1.75	1	1	2	2	1.75	2
CO 3	3	2	1	3	2	1.75	1	1	2	2	1.75	2
CO 4	2	2	1	3	2	1.75	1	1	2	2	1.75	2
Average	2.50	2	1	2.50	2	1.75	1	1	2	2	1.75	2

M.Sc. (Botany) – 3rd Semester

MSc/BOT/3/CC13 - Plant Tissue Culture

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge pertaining to micropropagation, somatic embryogenesis, haploid production, somatic hybridization, cryopreservation and secondary metabolite production.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Acquire knowledge about the non - conventional methods of plant propagation.
CO2	Learn about regeneration of complete plants from plant organs/cell other than seeds
CO3	Apply knowledge regarding in vitro techniques in Agriculture and forestry.
CO4	Attain practical knowledge of preparing artificial seeds. Develop curiosity about use of non - conventional methods in storage and conservation of germplasm.

Note for the paper setter: *The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.*

UNIT-I

1. **Plant Tissue Culture:** History of Plant Tissue Culture, Basic concept, principles and scope of plant cell and tissue culture, concepts of cellular differentiation; Totipotency; basic techniques of plant tissue culture; callus formation, organogenesis and embryogenesis.
2. Protoplast isolation, fusion and culture, somatic hybridization, hybrid selection and regeneration. Cybrids and their application.

UNIT-II

3. *In vitro* haploid production and its significance, Anther/Pollen culture and ovary culture; Embryo and ovule culture Production of triploids through endosperm culture.
4. **Micropropagation:** meristem culture and virus-free plants; Cryopreservation of plant cell and tissue cultures and establishment of gene banks.

UNIT-III

5. Somaclonal variations and isolation of useful mutants; mechanisms and applications in genotype improvement.

Plant Secondary Metabolites: Sources and production of secondary metabolites; criteria for cell selection, factors affecting the culture of cells; different bioreactors and their use in secondary metabolite production; biochemical pathways for the production of different secondary metabolites; biotransformation.

UNIT-IV

6. Somatic embryogenesis, production of synthetic seeds, importance, limitation and their utilization.
7. Application of tissue culture in forestry and agriculture; status of tissue and cell culture technology in India edible vaccines, and their prospects.

Suggested Readings:

1. Bhojwani, S.S. and Razadan, M.K., 1996, *Plant Tissue Culture: Theory and Practice* (A revised Edition), Elsevier Science Pub., New York, USA.
2. Chawla, H.S., 2020, *Introduction to Plant Biotechnology* (3rdEdition), Oxford and IBH Pub. Co., New Delhi.
3. Collins, H.A. and Edwards, S. 1998, *Plant Cell Culture*, Bios Scientific Pub., Oxford, U.K.
4. Glick, B.R., and Pasternak, J.J., 1998, *Molecular Biotechnology: Principles and Applications*, ASM Press, Washington, DC.
5. Razadan, M.K., 1993, *An introduction to Plant Culture*, Oxford & IBH Pub., Co., New Delhi, India.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/3/CC13

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	2	2	1.75	3	0	0	2	1	2	1
CO 2	2	2	2	2	1.75	3	2	2	3	3	2	2
CO 3	2	2	2	2	1.75	2	2	2	3	3	3	3
CO 4	3	2	2	2	1.75	2	2	2	2	3	3	3
Average	2.50	2	2	2	1.75	2.50	1.50	1.50	2.50	2.50	2.50	2.25

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M.Sc. (Botany) – 3rd Semester

MSc/BOT/3/SEC4 - Biostatistics & Bioinformatics

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: This course has a strong interdisciplinary component and is designed to equip students with essential skills in bioinformatics (at basic level). It will introduce applications of computational biology in diverse areas of biological sciences and provide training in the use of statistics in biological sciences.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Get introduced to basic tools and concepts of Bioinformatics and their significance in applied and basic biology. They will also learn application of various bioinformatics tools, biodiversity databases and biological resources.
CO2	Learn about various biological databases and bioinformatics tools.
CO3	Get conceptual understanding of Statistic and Statistics.
CO4	Learn about the various types of estimations and tests used in biostatistics.

Note for the paper setter: *The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.*

UNIT-I

1. **Introduction to Bioinformatics:** Definition, history, role and applications of bioinformatics.
2. **Biodiversity databases:** IUCN, Species 2000, Fish Base, IPNI, ICTV, ITIS, Tree of life.
3. **Biological materials resources:** ATCC, MTCC, NCCS.

UNIT-II

4. **Biological databases:** Primary, secondary and structural Protein and Gene Information Resources–PIR, SWISSPROT, PDB, Gene bank, DDBJ, EMBL-EBI, Specialized genomic resources

5. **Bioinformatics Tools:** homology and similarity tools (BLAST, FASTA, SSEARCH, or HMMER search), protein functional analysis tools (Pfam Scan, HMMER3 phmmer, Phobius, Pratt RADAR), sequence analysis tools.

UNIT-III

6. **Biostatistics:** Conceptual understanding of Statistic and Statistics; Parameters; Variable; Population, Finite and Infinite Populations; Sample; Discrete and Continuous Variable;
7. **Sample:** Simple random sample, Stratified Sample, Clustered Samples, Judgement Sample, Countable and Uncountable Sample; Variable and Attributes; Dichotomous attributes.

UNIT-IV

8. **Estimation:** Point Estimation; Interval estimation; Confidence Interval, Arithmetic mean, Median, Mode, Merits and demerits of Mean, Median and Mode; Range; Roles of t – statistic; when and where do we use it, Independent t – statistic, Paired t – statistic, Two samples t – statistic, One sample t – statistic, F – statistic; Chi-square test and its uses; "testing" in statistic, Hypothesis, Null hypothesis, Two-sided hypothesis, One-sided hypothesis; Critical region; Level of significance, P – value; Standard deviation; Variance.

Suggested Readings:

1. Attwood, T.K. and Parry-Smith, D.J., 2004, *Introduction to Bioinformatics*, Pearson Education, Singapore, Pvt. Ltd.
2. Dwyer, R.A., 2004, *Genomic Perl: From Bioinformatics Basics to Working Code*, Cambridge University Press, 1st south Asian edition.
3. Edwards, D., 2007, *Plant Bioinformatics: Methods and Protocols*, Humana Press, new Jersey, USA.
4. Kulas, J.T., 2008, *SPSS Essential: Managing and Analyzing Social Science Data*, John Wiley and Sons, New York.
5. Rosenkrantz, W.A., 2009, *Introduction to Probability and Statistics for Science, Engineering and Finance*, CRC Press, Boca Raton.
6. Schwartz, R., Phoenix, T. and d Foy, B., (2005), *Learning Perl* (4th edition), O'Reiley and Associates, ISBN: 0-596-10105-8.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/3/SEC4

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	2	2	2	2.50	2	1	3	2	2	2
CO 2	2	2	2	2	2	2.50	2	1	3	2	2	1
CO 3	2	2	2	3	2	2.50	2	1	3	2	2	1
CO 4	3	2	2	3	2	2.50	2	1	3	2	2	2
Average	2.50	2.25	2	2.50	2	2.50	2	1	2	2	2	1.50

M.Sc. (Botany) – 3rd Semester

MSc/BOT/3/CC14 - Lab-VII– Pertaining to Theory Papers CC11

Credit: 2 (Lectures: 60) **Marks: 100**

Duration of exam: (3+3 Hrs.)

Course Objective: The aim of this course is to give the students essential knowledge pertaining to locally available different specimen by using keys at family level, preparation of herbarium, test of pollen viability, different types of ovules by permanent slides and different pollination mechanism.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	To acquaint to student about locally available families such as Apiaceae, Asclepiadaceae, Asteraceae, Apocynaceae, Brassicaceae, Chenopodiaceae etc.
CO2	Students to prepare the herbarium of locally available wild plants, after that to give the training in how to using floras and herbarium for identification of specimens described in fields or class.
CO3	Students will be taught about different test of pollen viability and how to identify the percentage of viable and non - viable pollens.
CO4	The course will also teach about different pollination mechanism in locally available flowers and study of different types of ovules by permanent slides.

1. Description of a specimen from representative, locally available families such as Apiaceae, Asclepiadaceae, Asteraceae, Apocynaceae, Brassicaceae, Chenopodiaceae, Convolvulaceae, Caryophyllaceae, Cucurbitaceae, Euphorbiaceae, Fabaceae, Lamiaceae, Liliaceae, Malvaceae, Myrtaceae, Poaceae, Ranunculaceae, Rosaceae, Rubiaceae, Solanaceae, Verbenaceae etc.
2. Location of key characters and use of keys at family level.
3. Description of various species of a genus, location of key characters and preparation of keys at generic level.
4. Preparation of herbarium of locally available wild plants.
5. Training in using floras and herbarium for identification of specimens described in fields or class.
6. Field trips/ excursion, compilation of field Note for the paper setters and preparation of

herbarium specimens of wild plants.

7. Field study of angiosperm in different types of habitats and preparation of plant herbarium.
8. Study of morphology, primitive and advanced characters of cultivated and wild representatives of various families. Study of basic structure of flower, variations, floral parts in details, floral symmetry, insertion of floral parts etc.
9. Study of microsporogenesis and gametogenesis in sections of anthers.
10. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (maize, grasses, *Cannabis sativa, Tradescantia, Crotolaria, Brassica, Petunia, Solanum melanogena,* etc.).
11. Tests for pollen viability using strains and in vitro germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface cultures.
12. Estimation percentage pollen viability and average pollen tube length *in vitro*.
13. Role of transcription and translation inhibitors on pollen germination and pollen tube growth.
14. Pollen storage, pollen-pistil interaction, self-incompatibility, *in vitro* pollination.
15. Study of ovules in cleared preparations; study of monosporic, bisporic and tetrasporic type of embryo sac development through examination of permanent, stained serial sections.
16. Field study of several types of flowers with different pollination mechanisms (wind pollination, thrips pollination, bee/butterfly pollination, bird pollination).
17. Emasculation, bagging and hand pollination to study pollen germination, seed set and fruit development using self – compatible and obligate out crossing systems.
18. Study of cleistogamous flowers and their adaptations.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Bhojwani, S.S. and Bhatnagar, S.P., 2000. *The embryology of Angiosperms* (4th revised and enlarged Ed.), Vikas Publishing House, New Delhi.
2. Kumar, S., *Plant Taxonomy and Embryology (With practical Manual),*Kedar Nath Ram Nath Publications.
3. Pandey, S.N. and Misra, S.P., 2000, *Taxonomy of angiosperms*, Ane Books, India.
4. Raghavan, V. 1997. *Developmental biology of Flowering Plants*. Springer verlag, New

York.

5. Subramanyam, N.S., *Laboratory manual of Plant Taxonomy,* Vikas Publishing House Pvt. Limited.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/3/CC14

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2.50	2	3	2	2	2.50	1	2	2.50	2	2	2
CO 2	2.50	1.50	2	2	2	1.50	1	1	2.50	2	2	2
CO 3	3	2.50	2	3	2	2	2	1	2.50	3	2	2
CO 4	2	2	3	3	2	3	1	2	2.50	3	2	2
Average	2.50	2	2.50	2.50	2	2.50	1.25	1.50	2.50	2.50	2	2

M.Sc. (Botany) – 3rd Semester

MSc/BOT/3/CC15 - Lab-VIII– Pertaining to Theory Papers CC12, CC13 Credit: 4 (Lectures: 120) Marks: 100

Duration of exam: **4 Hrs.**

Course Objective: This course aims to educate students on concept quantitative estimation of protein by Lowry's method, qualitative estimation of lipids, qualitative estimation of carbohydrates, determination of chlorophyll a, chlorophyll b, and total chlorophyll, carotenoids and anthocyanins under varied environmental conditions and determination of chlorophyll a and chlorophyll b ratio in C_3 and C_4 plants.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Students will be taught about quantitative estimation of protein by Lowry's method, qualitative estimation of lipids, qualitative estimation of carbohydrates.
CO2	To prepare the standard curve of protein, carbohydrates and amino acids and to detect the reducing, non-reducing and total sugars.
CO3	During the course students will gain knowledge about determination of chlorophyll a, chlorophyll b, and total chlorophyll, carotenoids and anthocyanins under varied environmental conditions and determination of chlorophyll a and chlorophyll b ratio in C_3 and C_4 plants
CO4	Demonstration of plasmolysis and deplasmolysis in plant cell and demonstration of exoosmosis and endosmosis in grapes and resins.

1. Introduction to various instruments and their working principles used in biochemistry laboratory.
2. Preparation of buffers.
3. To prepare the standard curve of protein, carbohydrates and amino acids.
4. Qualitative estimation of amino acid and protein.
5. Qualitative estimation of lipids.
6. Qualitative estimation of carbohydrates.
7. Quantitative estimation of protein by Lowry's method.
8. Detection of reducing, non-reducing and total sugars.
9. Quantitative estimation of total carbohydrates by anthrone reagent.

10. Quantitative estimation of amino acid and phenols by using Spectrophotometer.
11. Determination of total soluble sugars by ferricynide method.
12. Separation of various components in the different lipid fraction by thin layer chromatography.
13. To measure the activity of enzyme: alpha amylase/catalase/peroxidase and any other.
14. To study the effect of temperature on enzyme activity.
15. To study the effect of substrate concentration on enzyme activity.
16. Determination of water potential by various methods.
17. Spectroscopic determination of chlorophyll a, chlorophyll b, and total chlorophyll, carotenoids and anthocyanins under varied environmental conditions.
18. Determination of chlorophyll a and chlorophyll b ratio in C_3 and C_4 plants.
19. Seed germination as affected by environmental factors.
20. Bioassays of Hormones.
21. Preparation of solutions of various concentrations of a few selected solutes.
22. Introduction to Plant Physiology Laboratory; A review of plant structure.
23. Mineral nutrition and nutrition deficiency symptoms.
24. Seed viability test
25. Plant movements: gravitropism and phototropism.
26. Light and hormone on seed germination and seedling growth
27. To demonstrate the process of imbibition by using raisins.
28. Demonstration of working of different types of microscopes.
29. To demonstrate osmosis in living plant cells by potato osmoscope.
30. Demonstration of plasmolysis and deplasmolysis in plant cell.
31. Demonstration of exoosmosis and endosmosis in grapes and resins.
32. To demonstrate the process of osmosis with varying solution concentration.
33. To demonstrate the process of plasmolysis in onion cells.
34. To demonstrate unequal transpiration from the two surfaces of a leaf.
35. To demonstrate the presence of starch histochemically.
36. Effect of temperature on cell membrane permeability.
37. Effects of Environmental factors on Photosynthesis.

***Some changes in the contents of the practical can be expected depending upon the**

availability of the material and the required equipment.

Suggested Readings:

1. Bajracharya, D., 1999, *Experiments in Plant Physiology: A Laboratory Manual*, Narosa Publishing House.
2. Bala, M., Gupta, S. and Gupta, N.K., 2012, *Practicals in Plant Physiology and Biochemistry,* Scientific Publishers.
3. Plummer, D., 1988, *An introduction to practical biochemistry*, Tata McGraw Hill.
4. Sawhney, S.K. and Singh R., 2000, *Inductory practical biochemistry*, Narosa Publishing House, New Delhi.
5. Sharma P., Paul, V. and Deshmukh, P.S., 2004, *Laboratory Manual: Experimental Plant Physiology – I*, Division of Plant Physiology, IARI, New Delhi.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/3/CC15

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2	1	3	1.50	1	2	1	1	2.50	3	2	2
CO 2	2	2	2	2	1	1	1	1	2.50	3	3	1
CO 3	2	1	2	2.50	1	2	2	1	2.50	2	3	1
CO 4	2	2	3	2	1	1	2	1	2.50	2	2	2
Average	2	1.50	2.50	2	1	1.50	1.50	1	2.50	2.50	2.50	1.50

M.Sc. (Botany) – 3rd Semester

MSc/BOT/3/SEC5 - Lab-IX– Pertaining to Theory Papers SEC4

Credit: 4 (Lectures: 120) **Marks: 100**

Duration of exam: **4 Hrs.**

Course Objective: The aim of this course is to give the students essential knowledge about testing of hypotheses: Tests of significance chi-sqaured test for goodness of fit, test for independence of attributes, non-parametric tests (run test), design of experiments, ANOVA, descriptive statistics.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Descriptive statistics: Systematic tabular summarization of data data (before analysis), measures of central tendency, measures of dispersion,
CO2	Students will be gaining the knowledge about Correlations (product-moment coefficient, Spearman's rank coefficient) and regression (linear regression, curve fitting).
CO3	To enhance the knowledge about testing of hypotheses: Tests of significance chi-sqaured test for goodness of fit, test for independence of attributes, non-parametric tests (run test), design of experiments, ANOVA.
CO4	To give the students working knowledge of Microsoft Windows, mean, median and mode, BLAST/FASTA.

1. Descriptive statistics: Systematic tabular summarization of data (before analysis), measures of central tendency, measures of dispersion, measures of skewness (using calculators).
2. Correlations (product-moment coefficient, Spearman's rank coefficient) and regression (linear regression, curve fitting).
3. To develop null and alternate hypothesis.
4. Data presentation (tables/figures): 1-D and 2-D bar charts, pie diagrams, graphs (using computer software packages).
5. Statistical distributions: fitting discrete uniform, binomial, Poisson and normal probability distributions to given data.
6. Testing of hypotheses: Tests of significance (mean, standard deviation, and correlation coefficient), chi-sqaured test for goodness of fit, test for independence of attributes, non-parametric tests (run test), design of experiments, ANOVA.

7. Numerical problems on mean, median and mode.
8. Working knowledge of Microsoft Windows.
9. Demonstration of online database search.
10. Similarity searching using BLAST/FASTA.
11. Demonstration to access full text journals.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Baxevanis, A.D. and Ouellette, B.F., John, 2005, *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins* (3rd Ed.), New Jersey, U.S., Wiley & Sons, Inc.
2. Andreas, D., Baxevanis, B.F., Francis, Ouellette, 2004, *Bioinformatics: A practical guide to the analysis of genes and proteins* (3rd Ed.), New Jersey, U.S., Wiley & Sons, Inc.
3. Ghosh, Z., Mallick, B., 2008, *Bioinformatics – Principles and Applications (*1st ed.), New Delhi, Delhi: Oxford University Press.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/3/SEC5

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2	1	2	2	3	1.50	2	1	2	1	1.50	2
CO 2	2	2	2	2	1	2.50	2	2	1	2	1.50	2
CO 3	2	1	2	1	1	2	2	1	1	2	2.50	1
CO 4	2	2	2	1	3	2	2	2	2	1	2.50	1
Average	2	1.50	2	1.50	2	2	2	1.50	1.50	1.50	2	1.50

M.Sc. (Botany) – 4th Semester

MSc/BOT/4/CC16 - Plant Ecology: Principles and Concepts

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge about basic concepts of plant ecology especially of structure of ecosystem, different niches, community, different energy flow pathways, biogeochemical cycles, population properties and ecological succession.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Understand mechanisms by which organisms interact with other organisms and with their physical environment.
CO2	Develop insights about the concepts of populations, community and ecosystems and can use in management of natural resources for sustainable development.
CO3	Acquire knowledge about limiting factors controlling distribution and growth of organisms. Comprehend interactions among components of ecosystems for better stability.
CO4	Describe biotic and abiotic factors that influence the dynamics of populations.

Note for the paper setter: *The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.*

UNIT-I

1. **Concept and structure of ecosystem:** Cybernetic nature and stability (resistance and resilience) of ecosystems; structure and function of some Indian ecosystems: forest, grassland, freshwater, marine and eustarine. Brief idea of microcosms, spacecraft and city as ecosystems.
2. **Concept of Habitat and ecological niche; fundamental and realized niche; resource portioning:** ecological equivalents, natural selection, allopatric and sympatric speciation. Artificial section and domestication.

UNIT-II

3. **Concept of community:** intra-community classification, analysis of communities (analytic and synthetic characters), species diversity, ecotones and edge effect.
4. **Concept related to energy:** primary productivity and its measurements, global pattern and controlling factors; food chain, food web, trophic levels, energy flow pathways, ecological energetics, energy budgets, ecological efficiencies.

UNIT-III

5. **Concept of limiting factors**; Liebig's law of minimum, Shelford's law of tolerance, factor compensation and ecotypes, ecads, ecological indicators.
6. **Pattern and basic types of biogeochemical cycles** (C, N, P and S), sedimentary cycle, cycling of non-essential elements and organic nutrients; nutrient cycling in the tropics, recycle index.

UNIT-IV

7. **Population group properties:** life history strategies (r and k selection), carrying capacity, population regulation, types of interactions, concept of metapopulation – demes and dispersal, interdemic extinctions.
8. **Ecological succession and its types,** relay floristics and initial floristics composition, bioenergetics, models (facilitation, tolerance and inhibition), causes, changes in ecosystem properties during succession, concept of climax; its unit's theories and forms.

Suggested Readings:

1. Chapman, J.L. and Reiss, M.J. 1998, *Ecology Principles and Applications* (2nd Edition), Cambridge University Press, U.K.
2. Odum, E.P. and Barrett, G.W., 2005, *Fundamentals of Ecology*, Thomson Books/Cole, U.S.A.
3. Sharma, P.D., 2011, *Ecology and Environment*, Rastogi Publ. Meerut.
4. Singh, J.S., Singh, S.P. and Gupta, S.R., 2006, *Ecology, Environment and Resource Conservation*, Anamaya Publishers, New Delhi.
5. Stiling, P., 1999, *Ecology: Theories and Applications*, Prentice Hall Inc., London.
6. Tiwari, S.C. 2005, *Concept of Modern Ecology*, Bishan Singh Mahendra Pal Singh, Dehra Dun.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/4/CC16

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2	2	2	2	2	2	1	2	2	3	2	2
CO 2	2	2	2	3	3	2	1	2	2	1	2	2
CO 3	2	2	2	2	2	2	1	2	2	1	2	2
CO4	2	2	2	3	2	2	1	2	2	1	2	2
Average	2	2	2	2.50	2.25	2	1	2	2	1.50	2	2

M.Sc. (Botany) – 4thSemester

MSc/BOT/4/CC17 - Plant Biotechnology

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge pertaining to Recombinant DNA Technology, DNA cloning, gene amplification, genetic transformation methods and IPRs

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Understand various tools and techniques used in genetic engineering.
CO2	Demonstrate the strategies and measures for manipulation of genome by incorporating desirable genes pertaining to specific traits.
CO3	Acquire knowledge about different methods for genetic transformation of plants
CO4	Understand patent, copyright and trademark, the acts and policies in India and abroad.

Note for the paper setter: *The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.*

UNIT-I

1. **Techniques used in DNA technology:** Gel electrophoresis, PFGE, Southern and western blotting, Dot blots, Chemical synthesis of genes, DNA chip technology.
2. **Isolation of genes, Sequencing of genes:** Maxam & Gilbert's method, Sanger's method and next generation sequencing technologies.
3. **Brief account of proteomics and genomics**

UNIT-II

4. **DNA cloning methods:** using vectors (Plasmids, phages, cosmids, phagemids, transposons, artificial chromosomes, BAC, YAC, MAC), cloning in bacteria and eukaryotes, genomic and C-DNA libraries.

5. **Gene amplification by PCR:** different types, DNA fingerprinting, molecular probes: General features and applications.

UNIT-III

6. **Genetic engineering:** Principles, methods and applications in agriculture. Methods for genetic transformation and transgenic plants production through *Agrobacterium tumefaciens* and *A. rhizogenes*, Gene transfer methods in plants; viral vectors and their applications, Bt cotton and Golden rice (A brief introduction).
7. **Chloroplast transformation:** its success with tobacco and potato.

UNIT-IV

8. **Intellectual Property Rights:** Patents, trade secrets, copyright, trademarks; Geographical Indicators (GI); Registration, subject matter and ownership of IPRs.
9. Plant genetic resources; GATT & TRIPPS; Patenting of biological material; Plant breeder's rights (PBRs) and farmer's rights. Infringement, passing off action and remedies available to IPR holder. Some legal cases related to trademarks, copyrights and patents.

Suggested Readings:

1. Brown, T.A., 1999, *Genomes*, John Wiley & Sons (Asia) Pvt. Ltd., Singapore
2. Chawla, H.S., *Introduction to Plant Biotechnology* (2nd edition), Oxford and IBH Publishing, Co. Pvt. Ltd., New Delhi.
3. Glick, B.R. and Pasternak, J.J., 1998, *Molecular Biotechnology: Principles and Applications*, ASM Press, Washington DC.
4. Gupta, P.K. 1996, *Elements of Biotechnology*, Rastogi & Co., Pub., New Pub., Meerut, India.
5. Henry, R.J. 1998. Practical Applications of Plant Molecular Biology, Chapman & Hall, London, UK.
6. Lewin, B. 2005. Genes VIII, Oxford University Press, Oxford, UK.
7. Singh, B.D., 2007, *Biotechnology: Prospects and Applications*. Springer, Germany.
8. Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics (2nd Ed.) John Wiley & Sons. Inc., New York, USA

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/4/CC17

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2	2	3	1	2	2	2	2	3	3	3	3
CO 2	2	2	3	2	2	2	1	2	3	3	3	3
CO 3	2	2	3	3	2	2	1	2	2	3	3	3
CO 4	2	2	0	0	2	3	0	0	2	0	0	0
Average	2	2	2.25	1.50	2	2.25	1	1.50	2.50	2.25	2.25	2.25

M.Sc. (Botany) – 4thSemester

MSc/BOT/4/CC18 - Cardinal Principles of Academic integrity and Research Ethics

Credit: 2 (Lectures: 30) **Marks: 50**

Exam duration: 2 Hrs. **Theory: 30; IA: 20**

Course Objective: The aim of this course is to give the students essential knowledge aboutacademic integrity values**,** writing skills, UGC policy for academic integrity and prevention, identification of publications misconduct, complains and appeals, conflicts of interest, predatory publisher and journals.

Course outcomes: At the end of the course, the students will know:	
CO1	Academic Integrity, Plagiarism (prevention and detection) and UGC regulations
CO2	Research and Publications ethics and best practices

Note for the paper setter: *The question paper will consist of five questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, four more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt two more questions selecting at least one question from each unit.*

UNIT-I

1. **Academic Integrity:** Introduction, Academic Integrity Values- Honesty and Trust, Fairness and Respect, Responsibility and Courage, Violations of Academic Integrity- types and consequences, Plagiarism -definition, Plagiarism arising out of misrepresentation-contract cheating, collusion, copying and pasting, recycling, Avoiding Plagiarism through referencing and writing skills, UGC Policy for Academic Integrity and prevention, Some Plagiarism detection tools.

UNIT-II

2. **Research and Publication ethics:** Scientific misconducts- Falsifications, Fabrication and Plagiarism (FFP), Publication ethics- definition, introduction and importance, Best practices/standard setting initiatives and guidelines-COPE, WAME etc., Violation of publication ethics, authorship and contributor-ship, Identification of publications

misconduct, complains and appeals, Conflicts of Interest, Predatory publisher and journals.

Suggested Readings:

1. Beall, J., 2012, *Predatory publishers are corrupting open access*, Nature, 489 (7415), 179.
2. Chaddah, P., 2018, *Ethics in Competitive Research: Do not get scooped; do not get plagiarized*, ISBN: 978-9387480865.
3. Indian National Science Academy (INSA), 2019, *Ethics in Science Education, Research and Governance*, ISBN: 978-81-939482-1-7.
4. MacIntyre, A., 1967, *A short History of Ethics*, London.
5. National Academy of Sciences, National Academy of Engineering and Institute of Medicine, 2009, *On being a Scientist: A guide to Responsible Conduct in research*, (Third Edition), National Academics press.
6. Resnik D. B., 2011, *What is ethics in research & why is it important*, National Institute of Environmental Health Sciences, 1-10.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/4/CC18

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2	1	2.50	2	2	1	2	2	2.50	2	2.50	2.50
CO 2	2	1	2.50	1	1	0	2	2	2	2	2.50	2.50
Average	2	1	2.50	1.50	1.50	0.50	2	2	2.25	2	2.50	2.50

M.Sc. (Botany) – 4th Semester

MSc/BOT/4/DSC3/A - Plant Growth & Development

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge different aspects of plant growth and development especially germination and dormancy of seeds, plant growth regulators, senescence and abscission, photomorphogenesis and response of plant to different abiotic stresses.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Understand the basic concepts of plant growth and development.
CO2	Acquire in depth knowledge about various plant growth regulators and their role in physiology of growth and development.
CO3	Describe metabolic changes associated with the senescence and abscission and their hormonal control.
CO4	Demonstrate an understanding of physiology of flowering and sensory biology.

Note for the paper setter: *The question paper will consist of five questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, four more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt two more questions selecting at least one question from each unit.*

UNIT-I

1. **Plant Growth**: Growth concepts, Growth curves, Growth analysis. Germination and Dormancy of seeds; factors affecting dormancy and its regulation by plant growth regulators and environmental factors.
2. **Stress Physiology**: Response of plants to abiotic stresses: abiotic stress affecting plant productivity. Basic principles of crop improvement programme under stress.

UNIT-II

3. **Plant Growth Regulators:** Discovery, biosynthetic pathways, transport, influence on plant growth and mechanism of action of: Auxins, Gibberellins, Cytokinins, Ethylene,

Abscisic acid.

4. **Senescence and Abscission:** Physiological and biochemical changes associated with senescence and abscission.

UNIT-III

5. **Tropism:** Phototropism, nature of receptors, role of hormones, Geotropism and nastism.
6. **Secondary metabolites and chemical defence:** Natural products (secondary metabolites), their range and ecophysiological functions. Overview of terpenoidal, alkaloidal, and phenolic metabolites and their biosynthesis. Biochemical mechanisms of plants' chemical war against other plants and animals.

UNIT-IV

7. **Phytochromes:** mechanism of phytochrome action, photomorphogenesis and cryptochromes.
8. **The Flowering Process:** Photoperiodism and its significance, importance of dark periods, role of vernalization. Nature and events during flowering, florigen concept, chemical control of flowering.

Suggested Readings:

1. Garrett, R.H. and Grisham, C.M., 1999, *Biochemistry* (Second edition), Saunders College Publishing, Philadelphia.
2. Huner, N. and Hopkins, W., 2013, *Introduction to Plant Physiology*, (4th ed.), John Wiley & Sons, Inc.
3. Krishnamoorthy, H.N, (1993), *Physiology of Plant Growth and Development*, Atma Ram and Sons, Delhi.
4. Kumar, H.D. and Singh, H.N. (1993), *Plant Metabolism* (Second edition), Affiliated East-West Press Pvt Ltd. New Delhi.
5. Salisbury, F.B. and Ross, C.W. (1992). Plant Physiology. Fourth edition, Wadsworth Publishing Co. Belmont, California, USA.
6. Srivastava, L.M. (2006). Plant Growth and Development: Hormones and Environment. Academic Press. Published by Elsevier India Pvt. Ltd., New Delhi.
7. Taiz, L., Zeiger, P. E. E., Mller, P. E. I. M., & Murphy, P. A. C. A., 2018, *Fundamentals of plant physiology*, Sinauer Associates.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/4/DSC3/A

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2	2	2	1	1	2	2	1	2	2	3	2
CO 2	1.50	1.50	2	2	1	2	2	1	2	1	3	2
CO 3	1.75	1.75	2	2	1	1	1	1	2	1	2	2
CO 4	1.75	1.75	2	1	1	1	1	1	2	2	2	2
Average	1.75	**1.75**	2	1.50	1	1.50	1.50	1	2	1.75	2.50	2

M.Sc. (Botany) – 4th Semester

MSc/BOT/4/DSC3/B - Genomics

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students detailed knowledge of basic methods involved in genome studies, their organization and function.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Enhance knowledge about human genome project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from web
CO2	Develops ability to use genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs, different methods of gene annotation and approaches of gene expression.
CO3	Spread awareness about the concept of forward and reverse genetics, gene tagging.
CO4	To acquaint students with RNAi, gene silencing, genome imprinting different method of genome engineering

Note for the paper setter: *The question paper will consist of five questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, four more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt two more questions selecting at least one question from each unit.*

UNIT-I

1. **Genomics:** Human Genome Project- methodology, outcomes and lessons learnt, Genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from web, Annotation of genome/gene sequence, Synthetic genomes- current status and future prospects
2. **Comparative Genomics**: Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in

genome sequence.

UNIT-II

3. **Methods of gene annotation:** Principle of analyzing genome wide gene expression and its utility.
4. **Approaches to analyze differential expression of genes** - ESTs, SAGE, microarrays and their applications. Use of high throughput RNA sequence data for differential expression analysis using various new approaches.

UNIT-III

5. **Concept of forward and reverse genetics** as applied to designing genome wide screens for deciphering gene function.
6. **Gene tagging:** gene and promoter trapping, knockout and knockdown mutants.
7. **Introduction to comparative genomics of model plants and related crop species**.

UNIT- IV

8. **Introduction to RNAi and gene silencing.**
9. **Genome imprinting**: small RNAs and their biogenesis, role of small RNAs in heterochromatin formation and gene silencing.
10. **Introduction of genome engineering**: a comparative study of genome engineering methods.

Suggested Readings:

1. Birren, B., Green, E.D., Klapholz, S., Myers, R.M. and Roskams, J., 1997, *Genome Analysis*, CSHL Press.
2. Brown, T.A., 2007, *Genomes 3*, Garland Science Publishing New York, London.
3. Chawla, H.S., 2009, *Introduction to Plant Biotechnology* (3rd Ed.), Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Hartl, D.L. and Ruvolo, M., 2011, *Genetics- Analysis of Genes and Genomes* (8th Ed.), Jones and Bartlett Publishers, Inc., USA.
5. Hunt, S.P. and Livesey, F.J., 2000, *Functional Genomics*, Oxford University Press, New York. London.
6. Lewin, B., 2005, *Genes VIII*, Oxford University Press, Oxford, UK

7. Singer, M., and Berg, P., 1991, *Genes and Genomes: A Changing Perspective*; University Science Books, CA, US.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/4/DSC3/B

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2	2	3	3	2	3	2	2	2.50	2	1.50	2
CO 2	2	2	2	2	2	3	2	2	1.50	2	1.50	2
CO 3	1	2	2	2	2	2	2	2	3	2	3	2
CO 4	2	2	3	2	2	2	2	2	3	2	3	2
Average	1.75	2	2.50	2.25	2	2.50	2	2	2.50	2	2.25	2

M.Sc. (Botany) – 4th Semester

MSc/BOT/4/CC19 - Lab-X– Pertaining to Theory Papers CC16, CC17

Credit: 4 (Lectures: 120) **Marks: 100**

Duration of exam: **4 Hrs.**

Course Objective: The aim of this course is to give the students essential knowledge pertaining to production of *Bt* cotton, Golden rice, Flavr Savr tomato by genetic engineering and gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment, qualitative and quantitative analysis of DNA using spectrophotometer, how to determine water holding capacity pH and conductivity of soils, study of community by quadrat method by determining frequency, density and abundance of different species

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Spread awareness about production of *Bt* cotton, Golden rice, Flavr Savr tomato by genetic engineering and gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
CO2	Enhance knowledge about the qualitative and quantitative analysis of DNA using spectrophotometer, restriction digestion and isolation of chromosomal DNA from plant cells, replica plating and blue white selection, southern blotting, restriction digestion and gel electrophoresis of plasmid DNA (demonstration/ photographs). Demonstration of DNA amplification by PCR.
CO3	Students will be taught about how to determine water holding capacity pH and conductivity of soils collected from different locations and also determine the dissolved oxygen in a given water sample by winkler's method
CO4	To gain deep knowledge of determination of species diversity index and importance value index of local vegetation. Study of community by quadrat method by determining frequency, density and abundance of different species present in the community and also compare protected and unprotected grasslands using community coefficients (similarity index).

1. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct

gene transfer by electroporation, microinjection, microprojectile bombardment.

2. Study of steps of genetic engineering for production of *Bt*cotton, Golden rice, FlavrSavr tomato through photographs.
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Restriction digestion of DNA
5. Isolation of chromosomal DNA from plant cells
6. Isolation of RNA from plants.
7. Quantification of DNA from plants.
8. Quantification of RNA from plants
9. Isolation of plasmid DNA.
10. Replica plating and Blue white selection.
11. Southern blotting
12. Restriction digestion and gel electrophoresis of plasmid DNA (demonstration/ photographs)
13. Demonstration of DNA amplification by PCR.
14. Separation of proteins by electrophoresis.
15. Separation of AMs by electrophoresis
16. To study the physical characteristics (temperature, colour and texture) of soil.
17. To determine water holding capacity of soils collected from different locations.
18. To determine pH and conductivity of soils and water collected from different locations.
19. To determine the dissolved oxygen in a given water sample by winkler's method.
20. Estimate primary productivity in an aquatic ecosystem light and dark bottle experiment
21. To determine percentage organic carbon and organic matter in the soils of crop land, grassland and forest.
22. To estimate dissolved oxygen content in eutrophic and oligotrophic water samples.
23. To determine the minimum size of the quadrat by species-area curve.
24. To study the community by quadrat method by determining frequency, density and abundance of different species present in the community.
25. Determination of species diversity index and importance value index of local vegetation.
26. To compare protected and unprotected grasslands using community coefficients (similarity index).

27. To study the species composition of an area for analysing biological spectrum and comparison with Raunkiaer's normal biological spectrum.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Brown, T.A. (2006). *Gene cloning and DNA analysis* (5th ed.). Oxford, UK.: Blackwell Publishing.
2. Clark, D.P. &Pazdernik, N.J. (2009). *Biotechnology – applying the genetic revolution*. USA: Elsevier Academic Press.
3. Glick, B.R., Pasternak, J. J. (2010). *Molecular Biotechnology: Principles and Applications.* Washington, U.S.: ASM Press.
4. Majumdar, R and Kashyap, R (2019). *Practical Manual of Ecology and Environmental*
5. *Science*, New Delhi, India: Prestige Publishers
6. Odum, E.P. and Barrett, G.W.2005. *Fundamentals of Ecology*, Thomson Books Cole, U.S.A
7. Sambrook, J., Fritsch, E. F., & Maniatis, T. (2001). *Molecular cloning- a laboratory manual* (3rd ed.). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
8. Singh, B.D., 2007.*Biotechnology*: Expanding Horizon, Kalyani Publishers, New Delhi.
9. Stewart, C.N. Jr. (2008). *Plant Biotechnology and Genetics: Principles, Techniques and Applications.* New Jearsey, U.S.: John Wiley & Sons Inc.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/4/CC19

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2	1	2	2	1	2	3	1	2	2	2	2
CO 2	2	1	2	2	3	2	2	1	2	2	2	2
CO 3	3	1	2	3	2	2	3	1	3	2	2	2
CO 4	3	1	2	3	2	2	2	1	3	2	2	2
Average	2.50	1	2	2.50	2	2	2.50	1	2.50	2	2	2

M.Sc. (Botany) – 4th Semester

MSc/BOT/4/DSC4/A - Lab-XI– Pertaining to Theory Papers DSC3/A

Credit: 4 (Lectures: 120) **Marks: 100**

Duration of exam: **4 Hrs.**

Course Objective: The aim of this course is to give the students essential knowledge pertaining to make permanent slides of shoot apical meristem, examine L.S. of root apical meristem, study of phyllotaxy in different plants and study of V.S. & T.S. of leaves of dicots and monocots plants, induction of bolting under natural conditions as well as GA. treatment.and study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum* and *Hydrilla.*

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Develop ability to make permanent slides of shoot apical meristem, examine L.S. of root apical meristem, study of phyllotaxy in different plants and study of V.S. & T.S. of leaves of dicots and monocots plants.
CO2	Increase confidence to perform as examination of rosette plants and induction of bolting under natural conditions as well as GA treatment and study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum*and *Hydrilla.*
CO3	Enhance knowledge and ability to examine the shoot apices in a monocotyledon in both T.S. and L.S. to show the origin and arrangement of leaf primordia. Study of alternate and distichous; alternate and superposed; opposite and superposed; opposite and decussate leaf arrangement.
CO4	Demonstration of the effect of ABA on stomatal closure, study of whole roots in monocots and dicots. Examination of L.S. of root from a permanent preparation to understand the organization of root apical meristem and its derivatives

1. Study of cytohistological zonation in the shoot apical meristem in sectioned permanent slides.
2. Examination of L.S. of root apical meristem from a permanent slide preparation.
3. Study of phyllotaxy in different plants.
4. Study of V.S. & T.S. of leaves of dicots and monocots plants.
5. Study of epidermal peels of leaves of dicots & monocots to study the development and final structure of stomata and prepare stomatal index.

6. Study of T.S. of stem of various plants having primary and secondary anomalous structure.
7. Effect of gravity, unilateral light and plant growth regulators on the growth of young seedlings.
8. Study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum* and *Hydrilla.*
9. Examination of shoot apices in a monocotyledon in both T.S. and L.S. to show the origin and arrangement of leaf primordia.
10. Study of alternate and distichous; alternate and superposed; opposite and superposed; opposite and decussate leaf arrangement. Examination of rosette plants and induction of bolting under natural conditions as well as GA treatment.
11. Microscopic examination of vertical sections of leaves such as *Coccinia, Gaillardia, Tradescantia, Notonea,* etc.
12. To study the development and final structure of stomata and prepare stomatal index.
13. Demonstration of the effect of ABA on stomatal closure.
14. Study of whole roots in monocots and dicots. Examination of L.S. of root from a permanent preparation to understand the organization of root apical meristem and its derivatives (use maize, aerial roots of banyan, *Pistia, Jussieua,* etc.). Origin of lateral roots. Study of leguminous roots with different types of nodules.
15. Study of permanent tissues.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Bajracharya, D. (1999). *Experiments in Plant Physiology: A Laboratory Manual.* New Delhi, Delhi: Narosa Publishing House.
2. Esau, K. (1977). *Anatomy of Seed Plants.* New Delhi, Delhi: John Wiley & Sons, Inc.
3. Evert, R.F., Eichhorn, S. E. (2006). *Esau's Plant anatomy: Mersitems, Cells, and tissues of the Plant Body: their structure, function and development.* New Jersey, U.S.: Wiley- Liss.

4. Kochhar, S.L., Gujral, S.K. (2017). *Plant Physiology: Theory and Applications.* New Delhi, Delhi: Foundation Books, Cambridge University Press India Pvt, Ltd.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/4/DSC4/A

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2	2	2	2	1	2	1	1	2	2	2	2
CO 2	2	2	2	2	2	2	3	2	2	2	2	2
CO 3	2	1	2	3	1	1	2.50	2	2	2	3	3
CO 4	2	3	2	3	2	1	2.50	1	2	2	3	3
Average	2	2.25	2	2.50	1.50	1.50	2.25	1.50	2	2	2.50	2.50

M.Sc. (Botany) – 4th Semester

MSc/BOT/4/DSC4/B - Lab-XI– Pertaining to Theory Papers DSC3/B

Credit: 4 (Lectures: 120) **Marks: 100**

Duration of exam: **4 Hrs.**

Course Objective: The aim of this course is to give the students essential knowledge about Gene, genome and transcriptome sequence download and mining from various databases after that assemble and annotation of these standard sequences and basic sequences alignment and analysis using various available methods, designing of ZFN, TALENs and CRISPR-Cas targets for given sequences.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Gene, genome and transcriptome sequence download and mining from various databases after that assemble and annotation of these standard sequences.
CO2	Understand the basic sequences alignment and analysis using various available methods, In-Silico gene characterization and promoter mining.
CO3	Enhances knowledge about CRISPR-Cas, ZFN and TALENs targets.
CO4	Develops ability to perform designing of ZFN, TALENs and CRISPR-Cas targets for given sequences.

1. Gene, genome and transcriptome sequence download and mining from various databases.
2. Assembly and annotation of standard sequences.
3. Sequences alignment and analysis using various available methods.
4. In-Silico gene characterization and promoter mining and analysis.
5. Designing of RNAi targets and RNA fold and interaction analysis.
6. Analysis of given sequences for CRISPR-Cas, ZFN and TALENs targets.
7. Designing of ZFN, TALENs and CRISPR-Cas targets for given sequences.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Armstrong L.2013.*Epigenetics*. CRC Press.
2. Brown, T.A.2017. *Genomes 4*. CRC Press.
3. Dale J.W., Schantz M.V. and Plant N.2011.*From Genes to Genomes: Concepts and Applications of DNA Technology*. Third edition. John Wiley & Sons, UK.
4. Green M.R. and Sambrook J.2012.Molecular Cloning: A Laboratory Manual. Fourth edition, CSHL Press, USA.
5. Gupta, P.K. 2013.*Biotechnology and Genomics*. Rastogi Publications.
6. Wilson, K. and Walker, J., 2016.*Principles and techniques of Biochemistry and Molecular Biology*, Cambridge Press.

CO-PO-PSO MAPPING MATRIX FOR PAPER MSc/BOT/4/DSC4/B

No.	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO 1	2.50	1.50	2	2	1.50	2	1.50	1	1.50	2	2	2
CO 2	2	2.50	1.50	2	2	1.50	2	2	2	2	2.50	2
CO 3	3	1	2.50	2	2.50	2.50	1.50	1	2	2	2	3
CO 4	2.50	3	2	2	2	2	3	1	2.50	2	2.50	3
Average	2.50	2	2	2	2	2	2	1.25	2	2	2.25	2.50