Programme Bye-laws & Syllabus of M.Sc. Botany

based on
CHOICE-BASED CREDIT SYSTEM (CBCS) &
CREDIT TRANSFER SYSTEM
w.e.f. Academic Session (2021-22)
Course Code: 509

REVISED IN BOS MEETING HELD ON 24.08.2021 &
APPROVED IN THE 42ND MEETING OF ACADEMIC COUNCIL HELD ON 15TH DECEMBER 2021

Department of Botany
School of Chemical & Life Sciences
JAMIA HAMDARD (Deemed to be University)
NEW DELHI – 110 062

Department of Botany

The Department of Botany, which came into existence in the year 1989, has developed strong research programmes in the fields of stress physiology, structural & developmental botany, environmental botany, plant systematics, medicinal botany, plant biotechnology and plant molecular biology. The first registration for Ph.D. dates back to 1991 while the post-graduate and under-graduate teaching programme started in 1994 and 2017 respectively leading to the award of degrees of M.Sc. & B.Sc. (Hons.). The first Ph.D. from the department was awarded in 1995 and the first batches of students were awarded M.Sc. and B.Sc. (Hons.) in 1996 and 2020 respectively. An Advanced Diploma in Environmental Monitoring and Impact Assessment is also offered by the department through distance mode of learning.

During the last **31** years, as many as **114** students have received Ph.D. degrees. The alumni of the department are noted teachers and scientists occupying important positions in Indian universities, research institutions, colleges and non-governmental organizations. The department has been acknowledged for its excellence and creativity by various funding agencies of National/ International repute.

Twenty-three research projects from various funding agencies including DBT, DST, UGC, AYUSH, IPI, CCRUM, have been successfully completed in the department. The department has received generous funding DST-FIST & UGC-SAP (DRS-I) programmes. At present the department is receiving substantial funding from DST-SERB, UGC & SERB-NPDF.

The students of department have been successfully clearing the national level exams including NET/GATE/ICMR test for JRF and have been selected in reputed institutions such as JMI, Delhi University, AMU (Aligarh), Amity University, IGNOU, Kashmir University, NIOS, DRDO, Integral University (Lucknow) etc. Besides national institutions, students of the Botany department have been enrolled in Ph.D. programmes of international universities. Moreover, students of botany have been qualifying the highest level of civil services exams including IAS, IPS, KAS.

Research at our department ranges from fundamental discovery (through integrated physiological, biochemical and molecular biology approaches) to delivery of research-based information and new technology to end users.

Thrust Areas of Research

- Understanding the physiological and molecular mechanisms of abiotic and biotic stressors
- Identification and characterization of medicinal plants and their active ingredients
- Tissue culture studies for alkaloid production, clonal multiplication and preservation of endangered species
- Development of diagnostics and study of pathogenicity caused by plant viruses
- Deciphering the plant microbe interactions in response to both pathogenic and beneficial microbes

Research Facilities

The Department has well equipped laboratories for research. The available equipments include Growth chambers, BOD incubators, Refrigerated microfuges, Laminar air flow,

Shakers, Environmental shaker incubator, Double beam spectrophotometer, PCR, High speed cold centrifuge, Deep freezer (-20, -80,), IRGA (Photosynthesis System), Leaf area meters, Flame photometer, Sliding and rotary microtomes, Gel documentation system and Nikon Phase contrast microscope with photographic attachment, Weather station attached with gas monitoring sensors, Spectrophotometers, Chlorophyll Fluorometer, Plant Canopy Analyzer, Rotavapor, Sound level meter, Gas & dust analysing system and Inverted fluorescent microscope among others. A modest Green House and an environmentally controlled Glass House is also available.

Vision

The department aspires to be a *'centre-of-excellence'* with state-of-the-art facilities for promoting holistic study of plant sciences and realizing products and processes in alignment with sustainable development goals for the overall well-being of society.

Mission

The **mission** of the department of botany is to

MS 1: attain excellence in teaching and research in botany;

MS 2: address global issues intervened by plants through cutting-edge research, dynamic graduate and postgraduate education with exemplary outreach;

MS 3: train and develop human resources in botany by tapping their inherent potential and enriching their learning experience;

MS 4: address the global issues of food insecurity and climate change by way of translational research;

MS 5: effect *in-situ* conservation of medicinal and aromatic plants native to the NCR of Delhi in the herbal garden which is an integral part of the department;

MS 6: develop state-of-the-art facility for plant-based herbal drug identification and characterization;

MS 7: introduce relevant and tailor-made courses to address burning global issues such as climate change;

MS 8: promote public outreach programmes such as World Environment Day, World Ozone Day, Fascination of Plants Day etc;

MS 9: adopt sustainable development goals (SDGs) in teaching and research;

MS 10: develop and maintain *Green India* and promote sustainable healthy environment by adopting and implementing social programmes like *Haritha Haram;* and

MS 11: maximize the employability opportunities of the maximum number of students.

Qualification Descriptors

On completing M.Sc. in botany, the graduates will be able to	
QD 1	demonstrate comprehensive knowledge and skills in the area of botany and translate them when needed;
QD 2	use knowledge and skills required for identifying problems and issues, collection of relevant quantitative and/or qualitative data, designing strategies for minimizing resources such as water, fertilizers, insecticides, identifying plants that are resilient to abiotic stresses and resistant to pathogens and insects and for crop improvement;
QD 3	apply disciplinary knowledge and transferable skills to meet the challenges of climate changes using plant-based approach, such as (1) source of biomass and environment-friendly alternative fuel, fertilizer and insecticide resources, (2) affordable fibre-rich plant generation, and (3) post-harvest process of plant-based food;
QD 4	communicate the results of studies undertaken in the identification of plants, including herbs and trees, cultivation and management practices under different environmental conditions;
QD 5	demonstrate knowledge and transferable skills in the fields of Biodiversity, Genetics, Medicinal Botany, Plant Molecular Biology, Plant Biotechnology, Plant Pathology, Tissue Culture, etc., that are relevant in job trades and employment opportunities like Faculty/Scientists in academia and industrial jobs like Pharmaceuticals and Agro-based industries and meet one's own learning needs, based on research and development work and professional materials; and
QD 6	kindle inquisitiveness and creativity to develop innovative protocols for solving issues related to the environment and conservation and sustainable development through research.

	MS 1	**MS 2**	**MS 3**	**MS 4**	**MS 5**	**MS 6**	**MS 7**	**MS 8**	**MS 9**	**MS 10**	**MS 11**
QD 1	3	3	3	3	3	3	3	**2**	**1**	**2**	**3**
QD 2	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**3**
QD 3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**1**	**3**
QD 4	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**3**
QD 5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
QD 6	**2**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**3**

Programme Learning Outcomes (PLOs)

On completing the programme, the graduates will be able to	
PLO 1	apply the knowledge of basic, advanced and applied sciences to solve complex research and industrial problems;
PLO 2	identify, formulate and obtain solutions to the challenging problems in interdisciplinary fields using principles of chemical and life sciences;
PLO 3	design and develop materials or products or processes suitable for applications in agriculture, medicine and environment that will meet the needs of the stakeholders;
PLO 4	conduct investigation on materials and living organisms and execute novel research in chemical and life sciences with proper experimental design and suitable controls;
PLO 5	choose and apply appropriate, analytical techniques and resources to analyze and address complex problems and come up with logical reasoning through integrative problem-solving approaches;
PLO 6	apply reasoning informed by the contextual knowledge to assess day-to-day issues pertaining to agriculture, environment, medicine and society and the incumbent responsibilities relevant to the careers in chemical and life sciences;
PLO 7	evaluate the impact of chemical and life processes in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development;
PLO 8	commit and conform to professional ethics, responsibilities and norms in professional and societal interactions; and
PLO 9	function effectively as an individual, as a member or as a leader in diverse cross-functional teams and multi-disciplinary groups.
PLO 10	develop critical thinking and problem-solving skills, which helps students to grow as a scientist or scientifically literate citizen.

Programme Specific Outcomes (PSO's)

On completing M.Sc. in botany, the graduates will be able to	
PSO 1	apply the basic concepts learnt to utilize them for lifelong learning, communicative skills and imbibition of ethical values to create a better world;
PSO 2	materialize the knowledge gained about systematics, structure and functions of plants for effective management of cultivation practices for improved plant performance;
PSO 3	employ the laboratory skills gained to collect and process data to arrive at innovative scientific solutions;
PSO 4	apply the skills for the benefit of the society through teamwork and project management practices for employability and entrepreneurship; and
PSO 5	exploit the knowledge gained through various courses for sustainable environment and human welfare.

Programmes for human resource development offered by the department

B.Sc.-M.Sc. Dual Degree (Botany)

Duration: Three years [with exit option at the end of III year (Sixth semester) with B.Sc. (Hons.) in Botany]

Seats: 20

Eligibility: Senior Secondary (XII/Intermediate) with Biology/Mathematics from CBSE or any other Board recognized by JH as equivalent thereto, securing at least 50% marks or equivalent CGPA in aggregate

M.Sc. Botany

Duration: Two years (Four semesters)

Seats: 40

Eligibility: Pass in B.Sc. or equivalent examination of a recognized university with Botany/Plant Sciences as one of the subjects securing at least 50% marks in the aggregate.

Selection procedure: Selection for M.Sc. Program in Botany will be based on the merit in the qualifying examination. Qualifying exam takes into account the mean average of three years marks of B.Sc. programme. In case, where final year exam results are not declared, the average of last two years marks will be counted for provisional selection of candidates.

Ph.D. Botany

Duration: Minimum three years

Seats: As per the availability of the faculty mentors

Eligibility: As per the Ph.D. Ordinance

Selection procedure: Entrance test will be exempted for candidates who have secured fellowship. In case of candidates not possessing any fellowship, there will be entrance tests. Candidates (both with and without fellowship) will have to appear before a committee for a comprehensive interview. Admissions are held twice in a calendar year.

Faculty

Dr. Shahid Umar, M.Sc., M.Phil, Ph.D., Professor & Head
Dr. Abdul Mujib, M.Sc, Ph.D., Associate Professor
Dr. Md. Salik Noorani Khan, M.Sc., Ph.D., Assistant Professor
Dr. Mohd Ashraf Ashfaq, M.Sc., Ph.D., MBA, PGDIPR, Graduate Certificate in Scientific Writing, Assistant Professor
Dr. Md Iqbal Raja Khan, M.Sc., Ph.D., Assistant Professor
Dr. Naushina Iqbal, M.Sc., Ph.D., Assistant Professor (Contractual)
Dr. Peer Saffeullah, M.Sc., Ph.D., Assistant Professor (Contractual)

Structure of M.Sc. in Botany under CBCS

Core Courses
MBO-CC101: Plant Diversity and Systematics of Angiosperms
MBO-CC102: Cell and Molecular Biology
MBO-CC103: Plant Biochemistry and Metabolism
MBO-CC104: Microbiology and Plant Pathology
MBO-CC105: Lab Course (based on MBO-101, 102, 103 & 104)
MBO-CC201: Genetics and Cytogenetics
MBO-CC202: Plant Physiology
MBO-CC203: Lab Course (based on MBO-CC201 and 202)
MBO-CC301: Developmental and Structural Botany
MBO-CC302: Plant Ecology and Biodiversity
MBO-CC303: Plant Resource Utilization and Medicinal Botany
MBO-CC304: Lab Course (based on MBO-CC301,302 & 303)
MBO-CC401: Project Work

Discipline Centric Electives (*Any one*)
MBO- DCE301: Plant Tissue Culture and Genetic Engineering
MBO- DCE302: Plant Breeding
MBO- DCE303: Molecular Markers for Crop Improvement
MBO- DCE304: Lab Course (based on MBO-DCE301)
MBO- DCE305: Lab Course (based on MBO-DCE302)
MBO- DCE306: Lab Course (based on MBO-DCE303)
MBO-DCE401: Seminar

Generic Electives (*Any one*)
MBO-GE201: Tools and Techniques in Biology
MBO-GE202: Genomics and Transcriptomics
MBO-GE203: Proteomics and Metabolomics
MBO-GE204: Lab Course (based on MBO-GE201)
MBO-GE205: Lab Course I (based on MBO-GE202)
MBO-GE206: Lab Course (based on MBO-GE203)

Compulsory foundation course
MBO-CFC 201: Academic writing (MOOC through NPTL/SWAYAM)

CHOICE-BASED CREDIT SYSTEM (CBCS)

Scheme and course structure implemented w.e.f. academic session 2021

Course Code	Name of the Paper	Paper Category	Duration	Internal Marks	Semester Marks	Total Marks	Credits
SEMESTER–I							
MBO–CC101	Plant Diversity and Systematics of Angiosperms	Core Course	72 hrs	25	75	100	4
MBO-CC102	Cell and Molecular Biology	Core Course	72 hrs	25	75	100	4
MBO-CC103	Plant Biochemistry and Metabolism	Core Course	72 hrs	25	75	100	4
MBO-CC104	Microbiology and Plant Pathology	Core Course	72 hrs	25	75	100	4
MBO-CC105	Lab Course (based on MBO-101, 102, 103 & 104)	Core Course	288 hrs	50	150	200	8
			Total	**150**	**450**	**600**	**24**
SEMESTER–II							
MBO-CC201	Genetics and Cytogenetics	Core Course	72 hrs	25	75	100	4
MBO-CC202	Plant Physiology	Core Course	72 hrs	25	75	100	4
	Any one from GE201 to GE203						
MBO-GE201	Tools and Techniques in Biology	Generic Elective	72 hrs	25	75	100	4
MBO-GE202	Genomics and Transcriptomics						
MBO-GE203	Proteomics and Metabolomics						
	Any one from OE201 or OE201						
MBT-OE201	Biostatistics	Open Elective	72 hrs	25	75	100	4
MBT-OE202	Bioinformatics						
MBO-CC203	Lab Course (based on MBO-CC201 and 202)	Core Course	144 hrs	25	75	100	4
	Any one from GE201 to GE203						
MBO-GE204	Lab Course (based on MBO-GE201)	Generic Elective	36 hrs	13	37	50	2
MBO-GE205	Lab Course I (based on MBO-GE202)						
MBO-GE206	Lab Course (based on MBO-GE203)						
MBO-CFC201	Academic writing (MOOC through NPTL/SWAYAM)	Compulsory Foundation Course	72 hrs	25	75	100	4
			Total	**163**	**487**	**650**	**26**
SEMESTER–III							
MBO-CC301	Developmental and Structural Botany	Core Course	72 hrs	25	75	100	4
MBO-CC302	Plant Ecology and Biodiversity	Core Course	72 hrs	25	75	100	4
MBO-CC303	Plant Resource Utilization and Medicinal Botany	Core Course	72 hrs	25	75	100	4
	Any one from DCE301 to DCE303						
MBO-DCE301	Plant Tissue Culture and Genetic Engineering	Discipline Centric Elective	72 hrs	25	75	100	4
MBO-DCE302	Plant Breeding						
MBO-DCE303	Molecular Markers for Crop Improvement						
MBO-CC304	Lab Course (based on MBO-CC301,302 & 303)	Core Course	216 hrs	37	113	150	6
	Any one from DCE304 to DCE306						
MBO-DCE304	Lab Course (based on MBO-DCE301)	Discipline Centric Elective	36 hrs	13	37	50	2
MBO-DCE305	Lab Course (based on MBO-DCE302)						
MBO-DCE306	Lab Course (based on MBO-DCE303)						
			Total	**150**	**450**	**600**	**24**
SEMESTER–IV							
MBO-CC 401	Project Work	Core Course	324 hrs	113	337	450	18
MBO-DCE401	Seminar	Discipline Centric Elective	72 hrs	25	75	100	4
			Total	**138**	**412**	**550**	**22**
						2400	**96**

Definitions

(i) 'Academic Programme' refers to an entire discipline/faculty of study comprising its programme structure, course details, evaluation schemes etc., that is designed to be taught and evaluated in a teaching Department/Centre or jointly under more than one such Department/ Centre.

(ii) 'Course' is a segment of a subject that is part of an Academic Programme.

(iii) 'Programme Structure' is a list of courses (Core, Generic Elective, Open Elective, Discipline Specific Elective) that constitutes an Academic Programme, specifying the syllabus, credits, hours of teaching, evaluation and examination schemes, minimum number of credits required for successful completion of the programme etc. prepared in conformity to the University Rules and eligibility criteria for admission.

(iv) 'Core Course' is a course that all students admitted to a particular programme will have to study and successfully complete to receive the degree.

(v) 'Generic Elective Course' refers to an optional course that can be selected by a student out of a pool of such courses offered in the same or any other Department/Centre.

(vi) 'Open Elective' is an elective course, which is available for students of all programmes. Students of other departments will opt these courses subject to fulfilling eligibility criteria laid down by the Department offering the course.

(vii) 'Discipline Specific Elective (DSE) Course' is an elective course that may be offered by the main discipline/subject of study.

(viii) 'Credit' refers to the value assigned to a course, which indicates the level of instruction; One-hour lecture per week equals 1 Credit, 2 hours practical class per week equals 1 credit. Credit for a practical could be proposed as part of a course or as a separate practical course.

Rules and Regulations of the Programme

1. Programme: Master of Science (M. Sc.)

M.Sc. in the following subjects

i)	Biochemistry
ii)	Biotechnology
iii)	Botany
iv)	Chemistry
v)	Toxicology
vi)	Clinical Research

Each programme shall be denoted by three-digit code as follows

a)	Biochemistry	507
b)	Biotechnology	508
c)	Botany	509
d)	Chemistry	510

e) Toxicology 511
f) Clinical Research 540

Each course of programme shall be given a course number which shall be preceded by three abbreviation as follows

a) Biochemistry MBC
b) Biotechnology MBT
c) Botany MBO
d) Chemistry MCH
e) Toxicology MTX
f) Clinical Research MCR

It shall be a regular full-time programme.

A candidate who is enrolled in a M.Sc. Programme, shall not be allowed to enroll for any other full-time programme either of study and shall not appear in any other examination of a full-time course of this or any other university during an academic year.

2. Duration: Two Years of Four semesters (two semesters each year) designated as under:

I Semester - August - December
II Semester - January - May
III Semester - August - December
IV Semester - January - May

Teaching days in each semester shall normally be **90 days**.

Medium of instruction and examinations: English

3. Eligibility of Admission: Admission to any of the above M.Sc. programmes is based on merit in the qualifying examination. Further, the candidates should fulfil the following qualifications for admission to

M.Sc. Biochemistry: Must have passed B.Sc. from a recognized university under 10+2+3 system with Biochemistry or Chemistry as one of the subjects and secured at least 50% marks in the aggregate.

M.Sc. Biotechnology: Must have passed B.Sc. from a recognized university under 10+2+3 system with Biological Sciences and secured at least 50% marks in the aggregate. The candidates having passed B.Sc. (Agriculture) or B.V. Sc. are also eligible.

M.Sc. Botany: Must have passed B.Sc. or equivalent examination from a recognized university under 10+2+3 system with Botany/Plant Sciences/Agricultural Science/Life Sciences/Biological Sciences/Biosciences/Biology as one of the subjects and secured at least 50% marks in the aggregate

M.Sc. Chemistry: Must have passed B.Sc. or equivalent examination from a recognized university under 10+2+3 system with Chemistry as one of the subjects and secured at least 50% marks in the aggregate.

M.Sc. Toxicology: Must have passed B.Sc. from a recognized university/institute under 10+2+3 system with any three of the following subjects: Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology, Environmental Biology or a subject of Life Sciences and secured at least 50% marks in the aggregate. Candidates who have studied biology at 10+2 level and have B. Pharm./B.V.Sc./B.Sc.(Ag.) degree are also eligible to apply. The minimum required percentage will be 55% in aggregate.

M.Sc. Clinical Research: Must have passed B.Sc. from a recognized university under 10+2+3 system with Biochemistry or Chemistry as one of the subjects and secured at least 50% marks in the aggregate.

4. Course Structure

a) There shall not be less than **four theory courses** and **one lab course** in each of the semesters. The detailed contents of the courses of study shall be prescribed by the respective Board of Studies and shall be reviewed regularly.

b) There shall not be less than **20 credits** of courses in each of the semesters, e.g., there may be 4 theory courses of 4 credits each and a lab course of 4 credits or 5 theory courses of 3 credits each and a lab course of 5 credits or there can be 5 theory papers of 3 credits each and a practical of 10 credits, making up not more than 25 credits in each semester.

c) A project dissertation may be prescribed in the programme in IV semester in place of theory papers. The project work may involve experimental work/literature survey on a specified topic or review article on a specified topic.

d) Though for project work the topics shall be given in advance, the credits assigned for the project work shall be awarded at the end of IV semester. For project work, the Head of the Department shall call a meeting of all the teachers of the Department and assign an appropriate number of students to each teacher to act as supervisor for project work. The student in consultation with the supervisor shall select a topic for the project work and inform the Head of the Department.

e) The contents of each theory course shall be divided into four units. Equal weightage in terms of hours should be given for all the units.

f) At the end of II semester, a department may arrange, if possible, for summer training of students for 6-12 weeks in an industry/research organization/university.

5. Weightage

Each course comprising a M.Sc. programme will be allotted credits as per the

following criteria.

a) **Lectures/Tutorials (L/T):** A course that is allotted one lecture/tutorial hour per week per semester shall be assigned one credit**,** and so on**.**

b) **Practicals/Project (P):** Two lab hours per week per semester for lab course shall be assigned one credit

6. Attendance

a) All students must regularly attend every lecture and practical class. However, to account for unforeseen contingencies, the attendance requirement for appearing in the semester examinations shall be a minimum of 75% of the classes held for each course.

b) In order to maintain the attendance record of students in a particular course, a roll call will be taken by the teacher in every scheduled lecture and practical class. For the purpose of attendance, each practical class will count as one attendance unit, irrespective of the number of contact hours. Attendance on account of participation in the prescribed and notified activities such as NCC, NSS, Inter University sports, educational tours/field work shall be granted provided the participation of the student is duly verified by the officer-in-charge and is sent to the Head of the Department within two weeks of the function/activity, etc.

c) The teacher shall consolidate the attendance record for the lectures and practicals at the end of each month and submit to the Head of the Department. At the end of the semester, the teacher shall consolidate the attendance record for the whole semester and submit it to the Head of the Department. The statement of attendance of students shall be displayed by the Head of the Department on the Notice Board. A copy of the same shall be preserved as record. Attendance record displayed on the Notice Board shall deemed to be a proper Notification for the students and no individual notice shall be sent to any student.

d) If a student is found to be continuously absent from the classes without any information for a period of 30 days, the concerned teacher shall report the matter to the Head of the Department who will report the matter to the Registrar for appropriate action that will include striking off the name of such student(s) from the rolls. Such a student may, however, apply for re-admission within 7 days from the date of issue of the notice of striking off the name of such student(s) from the rolls. The request for re-admission may be considered by the Dean of the School. Such a student shall not be eligible for re-admission after the prescribed period of 7 days. The re-admission shall be effected only after the payment of prescribed re-admission fee.

e) **A student with less than 75% attendance in a course in a semester shall be detained from appearing in the semester examination of that course. The Head of the Department may consider application for condoning up to 5% of attendance on account of sickness, provided the medical certificate, duly certified by a Registered Medical Practitioner/Public Hospital had been submitted in the office of the Head of the Department at the time of rejoining the classes immediately after the recovery**

from illness. Condonation of attendance on account of any other extenuating circumstances may be considered by the Head after consultation with the teacher concerned.

f) A student detained on account of shortage of attendance in any semester shall be re-admitted to the same class in the subsequent academic year on payment of prescribed fees applicable in that year to complete the attendance requirement of that course.

7. Internal Assessment

The Internal Assessment marks will constitute 25% of the total marks allotted to a course. For awarding Internal Assessment marks, **there shall be three sessional tests** for each course in a semester. The final score is rounded off taking the **average marks of the two into account.** The test question paper will be of 25 marks and may have objective type and short answer questions. For the evaluation of lab work, laboratory notebook, practical test/viva voce shall be taken into account. The marks shall be awarded by the respective teachers conducting the practical course.

8. Semester Examination

a) There shall not be less than two theory courses and one lab course in each semester. The detailed contents of the courses of study shall be prescribed by the respective Board of Studies and shall be reviewed regularly.

b) There shall not be less than 20 credits or more than 25 credits of courses in each semester. Each theory course should not be less than 2 credits or more than 4 credits. Each laboratory course shall not exceed 10 credits. Similarly, there could be seminars, assignments and projects. In such cases credits to theory and practical papers are to be adjusted accordingly.

c) A project may be prescribed in the programme in the IV semester as per the requirement of specific programme. The project work may involve experimental work and review of literature on a specified topic.

d) Though for project work, the topics shall be given in advance, the credits assigned for the project work shall be awarded at the end of IV semester. For project work, the Head of the Department shall call a meeting of all the teachers of the Department and assign an appropriate number of students to each teacher to act as the Supervisor for project work. The student in consultation with the Supervisor shall select a topic for the project work and inform the Head of the Department.

e) The contents of each theory course shall be divided into four units. Each unit shall preferably have equal teaching hours.

f) At the end of II semester, the department may arrange, if possible, for summer training of students for 6-12 weeks in an industry/research organization/university. The Head of the Department in consultation with industry/research organization/university shall appoint respective supervisors and co-supervisors for each student.

g) The botanical tour/educational tour shall be organized for the final year students as per the University rules and regulations.

h) Semester examination shall be held at the end of each semester as per the schedule given in the Academic Calendar of the School.

i) Seven days preparatory holidays shall be given to the examinees before the start of the semester examinations.

j) Each theory/practical paper having four credits shall be of 100 marks out of which 75% marks shall be for semester examination and 25% marks for internal assessment.

k) The question paper for semester examinations, shall be set either by the external examiner or an internal examiner. The Board of Studies of a department shall draw a panel of names of examiners, both internal and external, for approval by the Vice chancellor. **If the external examiner is unable to send the question paper by the deadline set by the examination branch of the University, the Head of the Department after consultation with the examination branch shall get the paper set internally by the School.** The papers set by the examiners can be moderated in consultation with the teacher who taught that course. Teachers appointed on contractual basis with appointment of less than one academic session, and temporary as well as ad-hoc teachers may not ordinarily be appointed as examiners. All such teachers, however, will be expected to assist in the practical examination. ***50% of the examiners in a semester can be external and the other 50% can be internal.***

l) The question paper shall have five questions. There shall be one question from each of the 4 units of the course and one question shall contain objective type/short answer questions covering all the units of the course. The candidate shall have to answer all the five questions. There shall, however, be internal choice within a unit. The choice shall be given by setting alternative questions from the same unit. The question paper should be such that it covers all the topics of that course.

m) **The duration of the semester examination of a theory course shall be 3 hours in case of 4 credits course and 1 ½ hours in case of 2 credits course. Practical exams of a lab course shall be of at least 4 hours duration.** The practical examination shall be conducted by an external and an internal examiner and assisted by other teachers.

n) For projects, **each student shall submit three typed bound copies of his/her project work to the supervisor** by the end of the IV semester. A student shall not be entitled to submit the project report unless he/she has pursued project work during IV semester under the guidance of a duly appointed supervisor. The report shall embody the candidates own work or an up-to-date review of the subject area. The write-up shall detail a critical assessment of the subject area and indicate in what respect the work appears to advance the knowledge of the subject concerned and future course of investigation.

o) The project report shall be examined by a Board of Examiners and the student shall have

to appear for *viva-voce*. The Board of Examiners shall consist of the following

- An external examiner
- Head of the Department
- A senior teacher of the Department
- Supervisor

The Board shall examine the project report of all the students, **conduct the *viva-voce* and award marks accordingly. All other teachers of the department will also be invited by the Head of the Department to be present during the examination.** In case, a student fails to secure the minimum pass marks, he/she may be asked to appear in the *viva-voce* again, or he/she may be asked to revise the project report in the light of the suggestions of the examiners and re-submit. For this, he/she will have to enroll as an ex-student in the next session. A re-submitted project report will be examined as above and *viva voce* shall be conducted along with other students.

10. Earned Credits (EC)

The credits for the courses in which a student has obtained E (minimum passing grade for a course) or a higher grade in the semester exam shall be counted as credits earned by him/her. Any course in which a student has obtained 'F' or 'I' grade shall not be counted towards his/her earned credits.

11. Promotion

(a) A student will be required to clear minimum 40% of his/her papers in a semester examination to be eligible for promotion to the next semester. A student may appear in the supplementary examination after each semester and can have a choice to appear in the backlog papers in the supplementary examination or in the subsequent regular semester examination. A student detained due to shortage of attendance will repeat his/her paper in the subsequent semester concerned (even/odd)

(b) Candidates who are unable to appear in the examination because of serious illness at the time of examinations may be given another chance. The request has to be processed through the Head of the Department to the Vice Chancellor. The Vice chancellor may look into the merit of the case and decide accordingly.

12. Grading system and conversion formula from CGPA to percentage of Marks

The following grading system under 10 points scale will be adopted

Letter Grade*	**Grade Point****
O (Outstanding)	10
A+ (Excellent)	9
A (Very Good)	8
B+ (Good)	7
B (Above Average)	6
C (Average)	5
P (Pass)	4

F (Fail)	0
Ab (Absent)	0

*__Letter Grade__: It is an index of the performance of students in a said course. Grades are denoted by letters viz, O, A+, A, B+, B, C, P and F

**__Grade Point__: It is numerical weight allotted to each letter grade on a 10-point scale

Converting the marks into letter grades

Letter Grade	Grade Point	Range of Percentage of Marks
O (Outstanding)	10	90 and above 100 (90 -100)
A+ (Excellent)	9	80 and above and less than 90 (80<90)
A (Very Good)	8	70 and above and less than 80 (70<80)
B+ (Good)	7	65 and above and less than 70 (65<70)
B (Above Average)	6	55 and above and less than 65 (55<65)
C (Average)	5	50 and above and less than 55 (50<55)
P (Pass)	4	40 and above and less than 50 (40<50)
F (Fail)	0	00 and above and less than 40 (00<40)
Ab (Absent)	0	--

A student obtaining Grade 'F' shall be considered failed and will be required to reappear in the examinations.

Computation of SGPA and CGPA

As per UGC norms, the following procedure will be adopted to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA)

i. The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all courses taken by a student and the number of credits of all the courses undergone by a student.
SGPA (Si) = ∑ (Ci x Gi) / ∑Ci where Ci is the number of credits of the ith course and Gi is the Grade point scored by the student in the ith course.

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e. CGPA = ∑ (Ci x Si) / ∑Ci where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Formula for Conversion of CGPA into Marks percentage

The percentage equivalent to the CGPA shall be obtained by using the following formula:
Equivalent percentage of CGPA = CGPA x 10

14. Criteria for award of CGPA

The result of successful candidates who fulfill the criteria for the award of M. Sc. shall be categorized after the IV semester, on the basis of his/her CGPA.

Award of division/class shall be done on the basis of following criteria

Range of CGPA	**Division/Class**
CGPA of 7.50 and above and upto 10	1st Division with Distinction
CGPA of 6.00 and above and less than 7.50	I Division
CGPA of 5.00 and above and less than 6.0	II Division
CGPA of 4.00 and above and less than 5.00	III Division

15. Span Period

a) I and II Semester Exams: A maximum of 2 years to complete M.Sc. year I from the date of admission to the programme.

b) A maximum of 2+2 years is allowed for a candidate to complete all the requirements of the M.Sc. programme.

16. Supplementary/Improvement Examination

A candidate who wishes to improve the previous performance will be allowed to do so as per the following regulation

A student can have a choice to appear in the backlog papers in the supplementary examination or in the subsequent regular semester examination after depositing the prescribed fee.

A student who cleared all the papers of a semester examination will be eligible for improvement examination on the following conditions:

i. A student shall be eligible to appear at the improvement examination if he/she secures 'C' and 'P' grade in any course.

ii. For the purpose of determining the SGPA/CGPA, the better of the two performances (regular and improvement) in the examinations shall be taken into consideration

iii. The supplementary examination will be held within one month of declaration of results.

iv. The improvement examination will be allowed only once within 1 year of the date of the original examination.

v. The improvement examination shall be conducted along with the supplementary examination within one month of declaration of results.

vi. Appearance in the improvement examination for a course will be allowed only once within 1 year of the date of the original examination.

vii. *The marks/grades scored by the students in the improvement examination shall not be considered for award of ranks, medals, prizes etc.*

viii. *The students who will take repeat/supplementary examinations, will not be entitled to be considered for the award of medals, prizes, and ranks etc.*

Re-evaluation of answer books without any condition

A student may seek re-evaluation of his/her answer book by submitting a written application, along with necessary fee, within one week after declaration of results.

Provision of exhibiting/displaying answer books

Upon a written request by the candidate, the answer books of the candidate can be physically handed to him/her, within one week after declaration of the result. Towards this, a fee of Rs. 2000/- per paper will have to be paid in advance. Students will also be allowed to compare their marks with the highest scorer for which a fee of Rs. 4000/- will have to be paid.

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-CC101**

Title of the Course: **Plant Diversity and Systematics of Angiosperms**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: **L=72**, T=0, P=0 ,

Course Objectives

This course strives to highlight the origin and attempts a comparative study of algae, bryophytes, pteridophytes, gymnosperms and angiosperms. The course also attempts to simplify concepts of plant systematics and its components such as description, identification, classification, nomenclature and phylogeny of angiosperms.

Course Learning Outcomes (CLOs)

On completing this course, students should be able to
CLO1: interpret the morphological, anatomical and reproductive features of algae, bryophytes, pteridophytes, gymnosperms and angiosperms (apply);
CLO 2: recognize the origin and evolution of plants and concept, components and aims of plant systematics (understand);
CLO 3: explain the taxonomic hierarchy, interpret the principles and rules of ICN in botanical nomenclature (understand/evaluate); and
CLO 4: classify and predict the relationship among the plants based on molecular data (understand and evaluate).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	3	-	2	1	-	-	2	2	3	3	1	2
CLO 2	3	2	1	2	2	1	1	-	-	1	1	3	3	1	2
CLO 3	3	2	-	1	1	1	1	-	-	1	2	3	2	-	1
CLO 4	3	2	1	1	1	1	1	-	-	1	1	3	3	1	2

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

UNIT – I **(L=18)**

- General characteristics, outline classification, origin, evolution and comparative account based on morphology, anatomy and reproductive structures of Algae, Bryophytes, Pteridophytes and Gymnosperms.

UNIT-II **(L=18)**

- **Angiosperm:** Origin and evolution; **Systematics:** Concept, components, phases and aims; **Nomenclature:** History, principles, important rules (Rank and concept of taxa, nomenclatural types, priority of publication, effective and valid publication, author citation, name changes etc.), species concept; Major changes in the code for botanical nomenclature., Taxonomic evidence: structural and biochemical characters.

UNIT-III **(L=18)**

- **Systems of classification:** Historical background of angiosperm classification with special reference to Linnaeus and Bentham and Hooker's classification. A comparison of Pre-Darwinian and Post-Darwinian classifications. Salient features and outline of Angiosperms Phylogeny Group (APG) system of plant classification; Introduction to proposed phylocode and Biocode; Phenetics and Cladistics: Principles, methodology and uses.

UNIT-IV **(L=18)**

- **Molecular Systematics:** Plant genome (Nuclear, chloroplast and mitochondrial genome); Generating DNA sequence data, Types of molecular data, Sequence alignment, Phylogenetic analysis; concept and types of phylogenetic tree, major methods for estimation of phylogenetic tree (Distance-based and tree-searching approach); DNA barcoding: Concept, basic steps, applications and limitations.

Reference Books:

1. Morris J. ***An Introduction to the Algae***. Cambridge University Press, U.K.
2. Round FE. ***The Biology of Algae***. Cambridge University Press, U.K.
3. Alexopoulos CJ, Mims CW & Blackwell M. ***Introductory Mycology***. John Wiley & Sons.
4. Webster J. ***An Introduction to Fungi*** by Cambridge Univ. Press.
5. Parihar NS. ***The Biology and Morphology of Pteridophytes***. Central Book Depot, Allahabad.
6. Puri P. ***Bryophytes***. Atma Ram & Sons, New Delhi.
7. Sporne KR. ***The Morphology of Pteridophytes***. B.I. Publ. Pvt. Ltd.
8. Daniel, M. ***Taxonomy***: Evolution at Work. Narosa Publishing House, New Delhi
9. David, P.H. & Heywood, V.H. ***Principles of Angiosperm Taxonomy***: Oliver and Boyd
10. Jones, S.B. Jr. & Luchinger, A.E. ***Plant Systematics***. 2nd Ed. McGraw-Hill Book,
11. Judd, W.S. eds. ***Plant Systematics***: A Phylogenetic Approach. Ind. Sunderland, USA.
12. Naik, V.N. ***Taxonomy of Angiosperms***. Tata McGraw-Hill, New Delhi.
13. Simpson, M.G. ***Plant Systematics***. Elsevier Academic Press, New York.
14. Singh, Gurcharan. ***Plant Systematics***. Oxford & IBH Publishing Co, New Delhi.

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme:	**M.Sc. Botany**
Course Code:	**MBO-CC102**
Title of the Course:	**Cell and Molecular Biology**
Credits:	**4**
L=Lecture; T=Tutorial; P=Practical):	**L=72,** T=0, P=0

Course Objectives

The objective of this paper is to offer insights into the basic structure and function of a cell and its organelles. The course aims to impart understanding of cell cycle, its regulation and cell death processes. This paper also aims to provide a framework for understanding the molecular features of plant cells.

Course Learning Outcomes (CLOs)

On completing this course, students should be able to
CLO 1: relate the structure with the function of various cell organelles of plant cells (evaluate);
CLO 2: explain the nuclear, mitochondrial and chloroplast genomes (understand);
CLO 3: examine mechanisms of cell cycle regulation and cell death processes (analyze); and
CLO 4: describe replication and repair mechanism of DNA, synthesis and processing of RNA and protein, expression and regulation of genes at transcription, translation and post-translational level (understand/evaluate).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	2	3	3	-	-	-	2	3	3	2	-	1
CLO 2	3	1	-	1	2	2	2	-	-	1	3	3	2	-	1
CLO 3	3	2	-	2	2	2	2	-	-	2	2	3	3	-	1
CLO 4	3	3	-	-	1	2	2	-	-	2	2	3	-	-	2

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

SECTION-A: CELL BIOLOGY

UNIT – I **(L=18)**

- **An overview of cells; Membrane structure and function** (Structure of model membrane, lipid bilayer and electrical properties of membranes).
- **Structural organization and function of intracellular organelles** (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility).

UNIT – II **(L=18)**

- **Organization of genes and chromosomes** (unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes). Genomes of mitochondria and chloroplast
- **Cell division and cell cycle** (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle), Apoptosis

SECTION-B: MOLECULAR BIOLOGY

UNIT – III **(L=18)**

- **DNA replication and repair mechanism:** Prokaryotic nucleoids, eukaryotic DNA/ chromosome, Nucleosome etc.; Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, DNA damage and repair mechanisms.
- **RNA synthesis and processing** (RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNAs).

UNIT – IV **(L=18)**

- **Protein synthesis and processing**: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, aminoacyl tRNA synthetase, and translational proof-reading, post-translational modification of proteins.
- **Control of gene expression at transcription and translation level:** Regulation / expression of prokaryotic (lac - and trp operon) and eukaryotic genes, role of genetic

Reference Books:

1. Alberts B, Bray D, Lewis J, et al. ***Molecular Biology of the Cell***, Garland Publishing.
2. Lodish H, Berk A, et al. ***Molecular Cell Biology***. W.H. Freeman & Co., New York.
3. Richard M, Twyman & Wisden W. ***Advanced Molecular Biology***, Viva Books Pvt. Ltd.
4. Turner PC, Mclenann AG et al. ***Instant Notes on Molecular Biology***, Viva Books Pvt.
5. Benjamin Lewin. ***Genes IX***, Prentice Hall.
6. Brachet J & Mirsky AE. ***The Cell***, Academic Press, Vols. 16.
7. De Robertis EDP & De Robertis EMF. ***Cell and Molecular Biology***, Bombay.
8. Wolfe SL. ***Molecular and Cellular Biology***, Wordsworth Publ. Co., California, USA.

Teaching – Learning Strategies in brief (4 to 5 sentences)

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief (4 to 5 sentences)

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.
Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-CC103**

Title of the Course: **Plant Biochemistry and Metabolism**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: L=**72,** T=0, P=0

Course Objectives

The course attempts to make students understand and appreciate the importance of structure and function of various biomolecules and their role in metabolic pathways operating in a plant cell.

Course Learning Outcomes (CLOs)

On completing this course, students should be able to

CLO 1: explain the principles of bioenergetics and principles, kinetics and regulation of enzymes (understand);

CLO 2: interpret the composition, structure and function of carbohydrates, proteins, vitamins, lipids and nucleic acids (evaluate);

CLO 3: examine the conformation and stability of proteins and nucleic acids (analyze); and

CLO 4: recognize the metabolism of carbohydrates, lipids and nucleic acids (remember).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	2	-	-	2	2	2	-	-	2	3	2	-	-	1
CLO 2	3	1	-	-	1	2	2	-	-	1	2	3	-	-	1
CLO 3	3	2	1	-	2	2	2	-	-	2	1	3	1	-	1
CLO 4	2	2	-	-	1	3	1	-	-	1	2	2	-	-	1

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

UNIT-I **(L=18)**

- Principles of bioenergetics - Laws of thermodynamics, internal energy, entropy, enthalpy, Gibb's free energy, redox potential, spontaneous reactions, exothermic and endothermic reactions, energy rich compounds.
- Concept of phosphorylation, chemiosmotic hypothesis, biological energy transducers (chloroplast and mitochondria).
- Enzyme: principles and mechanism of action, kinetics and regulation, concept of isozymes.

UNIT -II **(L=18)**

- Composition, structure and function of carbohydrates.
- Metabolism of carbohydrates - glycolysis, TCA cycle, amphibolic pathways, anaplerotic reactions, Electron Transport System and oxidative phosphorylation.
- Structure and functions of vitamins.

UNIT-III **(L=18)**

- Concept of amino acids and peptide bonds.
- Composition, structure and function of proteins.
- Conformation and stability of proteins.

UNIT-IV **(L=18)**

- Composition, structure, function and metabolism of nucleic acids.
- Composition, structure and function of lipids.
- Metabolism of lipids - fatty acid synthesis and oxidation.

Reference Books:

1. Voet & Voet. ***Biochemistry 2nd Edn***, John Wiley & Sons, Inc., New York, USA.
2. Nelson DL & Cox MM. ***Lehninger Principles of Biochemistry*****.** Macmillan Worth Publishers, Madison Av., New York
3. White R et al. ***Principles of Biochemistry 2nd Edn,*** McGraw Hill Publications, NY.
4. Farago P & Lagnado J. ***Life in Action: An Introduction to Biochemistry***. Heinemann Publ, London.
5. Lehninger AL. ***Principle of Biochemistry***. CBS Publishers, New Delhi.
6. Cooper, A. ***Biophysical Chemistry***. Royal Society of Chemistry, Cambridge publication.
7. Hames, BD, Hooper NM & Houghton JD. ***Instant Notes in Biochemistry***. Viva Books, New Delhi.

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-CC104**

Title of the Course: **Microbiology and Plant Pathology**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: L=**72,** T=0, P=0

Course Objectives

This course is designed to appreciate the diversity of microbes and plant pathogens. It presents a vivid account of the general characteristics, habit and habitat, structure, function of microbes like viruses, bacteria, fungi, phytoplasma. It also attempts at presenting the negative side of the microbes as pathogens and details the causes and mechanisms of disease and control measures for the pathogens.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to

CLO1: recall history, characteristic features, classification and enumerate the economic importance of plant viruses, phytoplasma, bacteria and fungi (remember/ analyse);

CLO 2: relate disease epidemics and epidemiology with host pathogen interaction (create);

CLO 3: recognize innate and acquired immunity and disease resistance mechanisms of plants (understand); and

CLO 4: explain diseases of plants with reference to the causal agents, symptomatology, disease cycle, transmission and management (evaluate).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	1	-	-	-	2	2	-	-	1	2	2	-	-	1
CLO 2	3	3	2	2	3	2	3	-	-	2	2	3	2	-	1
CLO 3	2	2	1	1	2	2	1	-	-	1	1	3	-	-	1
CLO 4	2	2	2	2	2	3	2	-	-	2	1	3	1	-	1

3: ‘high level’ mapping; **2**: ‘medium level’ mapping; **1**: ‘low level’ mapping

Detailed Syllabus

SECTION-A: MICROBIOLOGY

UNIT-I **(L=18)**

Plant viruses: History, general characteristics, symptomatology, chemical nature, ultrastructure, sub viral agents, classification, replication, detection and transmission, economic importance.
Phytoplasma: General characteristics, symptomatology, ultrastructure, detection, transmission and pathology.

UNIT-II **(L=18)**

Bacteria: History, characterization, classification and identification, ultrastructure, nutrition, growth (Principles and kinetics), culture, reproduction and economic importance.
Fungi: History, general characteristics (true fungi, molds and yeasts), classification, ultrastructure, life-style – biotrophic, hemi-biotrophic and necrotrophic; economic importance, Mycorrhizae: general account.

SECTION-B: PLANT PATHOLOGY

UNIT-III **(L=18)**

Plant diseases: History, concept, classification, identification- Koch's postulates, Flor's hypothesis, disease triangle, surveillance, disease epidemics and epidemiology, Host pathogen interaction.
Plant immunity: Innate and acquired, disease resistance, classes of resistance genes, adapted host resistance, non-adapted host resistance, hypersensitive response, systemic acquired resistance, induced systemic acquired resistance.

UNIT-IV **(L=18)**
Study of plant diseases with reference to the causal agents, symptomatology, disease cycle, transmission and management: mosaic disease of tobacco, phyllody of sesame, bacterial leaf blight of rice, Late blight of potato, Rust and smut of wheat.

Reference Books:

1. Madigan Michael T.,Martinko John M., Bender Kelly S., Buckley Daniel H., Stahl David A. Brock. ***Biology of Microorganisms***. Pearson Publications.
2. Tortora, Funk, Case. ***Microbiology: An Introduction***. Pearson Publications.
3. Agrios. ***Plant Pathology***. Elsevier Publishers
4. Dickinson M. ***Molecular Plant Pathology***. Bios Scientific Publications. Taylor and Francis

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme:	**M.Sc. Botany**
Course Code:	**MBO-CC105**
Title of the Course:	**Lab Course (based on MBO-CC101, 102, 103 & 104)**
Credits:	**8**
L=Lecture; T=Tutorial; P=Practical:	L=0**,** T=0, **P=288**

SEMESTER – I

MBO-CC105: LAB COURSE (based on MBO-CC101, 102, 103 & 104)

(Credit: 8, Maximum Marks: 200 [Internal Marks: 50, Exam Marks: 150] Time: 288 hours

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Course Objectives

This course is broadly intended to include experiments from lower plants, cell biology, microbiology, plant pathology and plant biochemistry and metabolism. This course is envisioned to study morphological, anatomical and reproductive structures of algae, bryophytes, Pteridophytes, and gymnosperms. The course also attempts to study practical application of taxonomic keys in plant families. The course also deals with the preparation of herbarium sheets of local plant species. The course also includes experiments related to extraction of plant genomic DNA, gel electrophoresis and cell fractionation. The studies related to plant microbiology and phytopathology will also be performed in this course. In this course, students will also be able to perform different qualitative tests for determination of carbohydrates, proteins and nucleic acids.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to

CLO 1: describe an unknown sample or specimen from representative locally available families with the aid of key characters and preparation of keys at generic level;

CLO 2: isolate nucleic acids from a specimen and should be able to characterize them;

CLO 3: isolate and characterize microbes and plant pathogens and develop methods of cultivation of the same; and

CLO 4: test for the presence/absence of a carbohydrate/amino acid/nucleic acid in a mixture, qualitatively and quantitatively;

Detailed Syllabus

PLANT DIVERSITY & SYSTEMATICS OF ANGIOSPERMS

- Observation of morphological, anatomical (through CS, RLS & TLS) and reproductive structure of algae, bryophytes, Pteridophytes and gymnosperms
- Description of a specimen from representative (locally available) families.
- Description of a specimen to study intraspecific variation and a collection exercise.

- Description of various species of a genus, location of key characters and preparation of keys at generic level.
- Location of key characters and use of keys at family level.
- Field trips within and nearby areas in the campus, compilation of field notes and preparation of herbarium sheets of such wild or cultivated plants that are abundant.
- Training in using floras and herbarium for identification of specimens described in the class.

CELL AND MOLECULAR BIOLOGY

- Isolation of genomic DNA
- Gel electrophoresis for DNA analysis
- Cell fractionation: extraction, homogenization and centrifugation
- Description of different types of techniques for ultra-structure studies of the cell organelles
- Preparation of different types of stains for cell cycle studies

MICROBIOLOGY AND PLANT PATHOLOGY

- Preparation of media for cultivation of micro-organisms and plant pathogens
- Isolation of micro-organisms and plant pathogens from the environment
- Maintenance of cultures of micro-organisms and plant pathogens
- Determination of growth of *E.coli*
- Molecular based detection of virus, phytoplasma, bacteria and fungus

PLANT BIOCHEMISTRY AND METABOLISM

- Determination of reducing sugars of fruits by Nelson Somogyi's method
- Qualitative tests for carbohydrates (Iodine, Anthrone, Fehlings, Benedict etc.)
- Qualitative tests for proteins – Ninhydrin test, Biuret test, Xanthoproteic acid test
- Estimation of nucleic acids – DNA (diphenylamine (DPA) test) and RNA (Orcinol test)

Reference Books:

1. Bower, Vines, Dyer. A Course of Practical Instruction in Botany. Part 1 & 2. ***A Course of Practical Instruction in Botany***. Trieste Publishing.
2. Zhang S. Li P. ***Essential Experiments for Molecular Biology: A Student's Guide***. Medtech.
3. Aneja K.R. ***Laboratory Manual of Microbiology and Biotechnology***. Medtech.
4. Aneja K.R. ***Experiments in Microbiology, Plant Pathology and Biotechnology***. New Age International Publishers.
5. Plummer David. ***An Introduction to Practical Biochemistry***. McGraw Hill Publishers.

Teaching – Learning Strategies in brief

The teaching learning strategies followed are learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 50 marks. End semester exam is of 100 marks. Total Marks are 200 for the subject (Internal Assessment: 50 Marks and End Semester Examination: 150 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-CC201**

Title of the Course: **Genetic and Cytogenetics**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: L=**72,** T=0, P=0

Course Objectives

This course will equip students with the knowledge necessary to deduce the genetic basis of inheritance of plant traits, appreciation of the tools of cytogenetics and the role of mutations in causing the change in genotype.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to
CLO 1: explain the principles and extension of Mendelian inheritance and various concepts of genes (understand /evaluate);
CLO 2: recognize the molecular mechanisms of linkage, crossing over, recombination, extra-chromosomal and polygenic inheritance (understand);
CLO 3: estimate the importance of polyploidy in plants (evaluate); and
CLO 4: understand the role of mutations in plants for the betterment (understand/apply).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	1	-	-	1	2	-	-	-	1	2	3	-	-	1
CLO 2	1	1	-	-	1	2	-	-	-	1	2	2	-	-	1
CLO 3	2	1	-	-	1	2	-	-	-	1	1	2	-	-	-
CLO 4	2	3	-	1	1	3	-	1	-	1	2	3	-	-	1

3: ‘high level’ mapping; **2**: ‘medium level’ mapping; **1**: ‘low level’ mapping

Detailed Syllabus

UNIT – I **(L=18)**

- **Mendelian Inheritance**: Principle of Mendelian Inheritance, dominance, independent assortment, segregation
- **Concept of gene**: Allele, multiple alleles, pseudoallele/ pseudogene,
- **Extension of Mendelian principles**: Codominance, incomplete dominance, gene interactions, pleiotropy,
- Chromosomes / sex chromosome, sex determination, dosage compensation, Lyon hypothesis, sex linked characters.

UNIT – II **(L=18)**

- Linkage and crossing over, cytological basis, molecular mechanism of crossing over
- Linkage / Chromosomal maps, Chiasma / chromosome Interference
- Recombination (homologous, non-homologous), site specific recombination
- Extra chromosomal inheritance; mitochondrial and chloroplast genes, maternal inheritance
- Quantitative genetics: Polygenic inheritance, heritability and its measurements,

UNIT – III **(L=18)**

- Cytogenetics of Polyploids and Aneuploids; Autopolyploidy, origin, chromosome pairing and breeding behaviour, phenotypic effect
- Allopolyploids, origin, types, important allopolyploid plants, uses
- Aneuploids: monosomic, trisomic etc. and their uses
- Numerical alteration of ploidy and their implications.

UNIT – IV **(L=18)**

- **Mutation**: Mutation types, molecular basis of mutation, spontaneous and induced mutations, Somatic versus germinal mutants,
- Physical and chemical mutagens, effect of mutagens on chromosomes/ DNA (loss and gain of function)
- Transposons (insertional mutagenesis)
- Cancer at cellular level, protooncogenes/ oncogene, tumour suppressor genes
- Structural alterations of chromosomes; Deletion, duplication, inversion, translocation, karyotype, Importance of chromosomal aberration.
- Complementation tests

Reference Books:

1. Strickburger M. ***Genetics***. MacMillan Publishing Company, New York.
2. Gardner J. ***Principle of Genetics***. John Wiley & Sons, New York.
3. Klug WS & Cummings MR. ***Essential of Genetics***. Prentice Hall Publishing Co., New Jersy.
4. Brown T. ***Genetics: A Molecular Approach***. Chapman & Hall, London.
5. Lewin, B. ***Genes Vol. 9***. Oxford University Press.

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-CC202**

Title of the Course: **Plant Physiology**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: L=**72,** T=0, P=0

Course Objectives

This course will equip students with the knowledge necessary to understand the various physiological processes operating in plants.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to

CLO 1: explain plant-water relations, plant-nutrient interactions, fixation and assimilation of nitrogen and sulphur (understand/evaluate);

CLO 2: describe photobiology, CO_2 fixation and translocation of photosynthates and recognize the concept and importance of photoperiodism, vernalization and circadian rhythm (understand);

CLO 3: outline the importance of secondary metabolites in medicine/human welfare (apply);

CLO 4: access the physiological effects and mechanisms of action of plant growth regulators**;** the responses of plants to various biotic and abiotic stress (evaluate).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	2	-	-	3	3	2	-	-	2	2	3	-	-	2
CLO 2	2	2	-	-	2	3	2	-	-	1	2	2	-	-	1
CLO 3	3	2	3	-	2	3	2	-	-	2	2	3	-	-	2
CLO 4	2	2	-	-	2	2	1	-	-	2	2	2	-	-	1

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

UNIT – I **(L=18)**

- **Plant-water relations:** Water potential, uptake, transport and translocation of water by plants, mechanism and importance of stomatal movement.
- **Plant-nutrient interaction:** Essential and beneficial nutrients; deficiencies and importance, uptake, transport and translocation of nutrients.
- Biological nitrogen fixation and sulfur assimilation

UNIT – II **(L=18)**

- **Photobiology of plants:** Photosynthetic pigments, light harvesting complexes, general concepts of photosynthesis, mechanisms of photosynthetic electron transport (non cyclic and cyclic)
- **CO_2 fixation:** C3, C4 and CAM pathways , photorespiration and its significance
- **Translocation** of Photosynthates by phloem, phloem loading and unloading

UNIT – III **(L=18)**

- **Sensory photobiology:** Phytochromes; structure, function and responses in plants
- Cryptochrome and its role in photomorphogenesis
- **Photoperiodism, vernalization, circadian rhythm:** concept and importance

UNIT – IV **(L=18)**

- **Plant growth regulators:** Physiological effects and mechanisms of action
- **Secondary metabolites:** Meaning, classification and functions. Importance of secondary metabolites in medicine/human welfare.
- **Stress physiology:** Responses of plants to biotic and abiotic (water, temperature and salt) stresses; general mechanisms of resistance to biotic stress and tolerance to abiotic stresses.

Reference Books:

1. Devlin RM & Witham FH. ***Plant Physiology***. CBS Publs. and Distributors, New Delhi
2. Hopkins WG. ***Introduction to Plant Physiology***, John Wiley & Sons. Inc., NY, USA.
3. Moore TC. ***Biochemistry and Physiology of Plant Hormones***. Springer Verlag, NY
4. Singhal et al. ***Concepts in Photobiology***, ***Photosynthesis and Phytomorphognesis***, Narosa Pub. House, N. Delhi.
5. Taiz & Zeigler. ***Plant Physiology 4th Edn***, Publishers, Sunderland.
6. Mengel K & Kirkhy EA. ***Principles of Plant Nutrition***. Kluwer Academic Press
7. Salisbury FB & Celon W. ***Plant Physiology 3rd Edn***. CBS Publishers, New Delhi.

Teaching – Learning Strategies in brief

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Assessment methods and weightages in brief

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Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-GE201**

Title of the Course: **Tools and Techniques in Biology**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: L=**72,** T=0, P=0

Course Objectives

This course will equip students with the knowledge of modern tools and techniques in biology so as to instil in students the confidence for hands-on.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to

CLO 1: explain the concepts and principles of various analytical tools and techniques commonly employed in biology (understand/evaluate);

CLO 2: operate the instruments and manipulate the data obtained for their specific research purposes (apply);

CLO 3: analyze and examine the data obtained (analyze); and

CLO 4: enumerate the various applications of the tools and techniques (remember).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	-	3	2	2	-	-	2	2	3	2	-	2
CLO 2	2	3	3	2	3	2	2	-	-	2	3	3	2	-	3
CLO 3	3	3	2	2	3	2	2	-	-	2	3	3	2	-	2
CLO 4	3	1	-	-	2	2	2	-	-	1	2	3	1	-	1

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

UNIT – I **(L=18)**

- Electrophoresis: Principles, technique, operational procedure and applications, native vs denaturing, horizontal vs vertical; proteomics: isoelectric focusing, gel based and gel free.
- Centrifugation: Principles, technique, operational procedure and applications.

UNIT – II **(L=18)**

Chromatography: Principles, technique, operational procedure and applications of thin layer chromatography, high performance liquid chromatography, gas chromatography, gel filtration, ion exchange chromatography.

UNIT – III **(L=18)**

- Spectrophotometry: Principles, technique, operational procedure and applications of UV/visible, circular dichroism, atomic absorption
- Flame photometry: Principles, technique, operational procedure and applications
- Mass spectrometry: Principles, technique, operational procedure and applications
- Surface plasmon resonance: Principles, technique and applications

UNIT – IV **(L=18)**

- Microscopy: Basics concepts and principles
- Light microscopy: Principles, technique, operational procedure and applications
- Electron microscopy: Principles, technique, operational procedure and applications
- Micro-techniques: Fixation, mounting, microtomy, staining, freeze-etching and freeze-fracture.

Reference Books:

1. Snyder LR. ***Principles of Adsorption Chromatography: The Separation of Nonionic Organic Compound***. Marcel Dekker Publ, New York.
2. Wilson K & Walker J. ***Practical Biochemistry: Principles and Techniques 5th Edn***, Cambridge University Press.
3. Skoog, DA, Holler FJ & Timothy N. ***Principles of Instrumental Analysis 5th Edn***. Sauders College Publishing.
4. Wise DL. ***Bioinstrumentation and Biosensors***. Marcel Dekker, New York.
5. Clark BT, Frost T & Russell MA. ***UV Spectroscopy: Techniques, Instrumentation, Data Handling***. Chapman & Hall
6. Ewing, GW. ***Analytical Instrumentation Handbook*.** Marcel Dekker, New York.

Teaching – Learning Strategies in brief

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Assessment methods and weightages in brief

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DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-GE202**

Title of the Course: **Genomics and Transcriptomics**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: L=**72,** T=0, P=0

Course Objectives

This course will equip students with the structure, function, evolution, mapping and editing of genomes. Also, it provides information to find genes that are differentially expressed between distinct situations and thus provides new insights into the linked genes or pathways.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to

CLO 1: study about genome sequencing and various aspect of functional genomics (understand);

CLO 2: analyze the gene function and genome evolution (analyze);

CLO 3: access genes that are differentially expressed between distinct situations (evaluate); and

CLO 4: explain the principles of next generation sequencing, Yeast one-, two- and three hybrid systems (understand/evaluate).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	-	3	2	1	-	-	1	2	2	-	-	1
CLO 2	3	2	-	-	2	3	1	-	-	1	2	2	-	-	1
CLO 3	2	3	2	-	2	2	1	-	-	2	2	3	-	-	2
CLO 4	2	3	2	-	2	3	2	-	-	2	2	3	-	-	2

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

UNIT – I **(L=18)**

Genome sequencing and functional genomics; Genome projects; genome annotation; ab initio gene discovery; functional domains, functional annotation and gene family clusters; gene finding, promoter identification and transcription factor binding site (TFBS) analysis.

UNIT – II **(L=18)**

Functional analysis of genes; gene knockoffs; forward genetics and reverse genetics; allele/gene mining – TILLING and EcoTILLING; Comparative genomics – synteny and co-linearity; genome evolution - gene duplication, genome duplication, paralogous and orthologous genes, neofunctionalization, speciation and domestication.

UNIT – III **(L=18)**

Transcriptome; Transcript profiling – hybridization and PCR based methods, microarrays, ESTs, small RNAs and their biogenesis, role of small RNAs in heterochromatin formation and gene silencing, genomic tools to study methylome and histone modifications.

UNIT – IV **(L=18)**

Metagenomics, Principles of next generation sequencing, RNA sequencing, Yeast one-, two- and three hybrid systems bioinformatics for genomics and transcriptomics

Reference Books:

Saraswathy M and Ramalingam P. ***Concepts and Techniques in Genomics and Proteomics***. Woodhead Publishing Series in Biomedicine.

Teaching – Learning Strategies in brief

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Assessment methods and weightages in brief

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Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-GE203**

Title of the Course: **Proteomics and Metabolomics**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: L=**72,** T=0, P=0

Course Objectives

This course will equip students with the knowledge to identify and analyze the protein complement of a cell and its metabolite pool.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to
CLO 1: separate, identify and annotate protein by 2D PAGE and mass spectrometry (analyze);
CLO 2: determine and predict the structure of protein (evaluate);
CLO 3: develop an assay for extraction and identification of small biomolecules (create); and
CLO 4: predict structural confirmation of metabolites by various available software's (evaluate).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	2	-	2	3	2	-	-	-	2	2	3	2	-	2
CLO 2	2	-	-	2	3	2	-	-	-	2	2	3	1	-	1
CLO 3	3	3	2	-	2	2	-	-	-	2	2	3	2	-	2
CLO 4	3	2	2	-	2	2	-	-	-	2	2	2	2	-	2

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

UNIT – I **(L=18)**

Proteomics: protein annotation; protein separation and 2D PAGE; mass spectrometry - modes of data acquisition, data repositories

UNIT – II **(L=18)**

Protein microarrays; protein interactive maps; structural proteomics: protein structure determination, prediction and threading, software and data analysis/ management

UNIT – III **(L=18)**

Metabolomics -an overview, basic sample preparation strategies - extraction, derivatization, Workflow for lipidomics;. Targeted Vs Untargeted metabolomics; development of targeted assays for small molecules

UNIT – IV **(L=18)**

Metabolomic Data Analysis: Peak detection, retention time alignment; identification of molecular features and metabolites; structural confirmation of metabolites. Software- Multiquant, MZmine, XCMS, MarkerView, LipidSearch

Reference Books:

1. Twyman R. ***Principles of Proteomics***. Bios Scientific. Taylor and Francis.
2. Metabolomics Perspectives: From Theory to Practical Applications. Academic Press.

Teaching – Learning Strategies in brief

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DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-OE201**

Title of the Course: **Biostatistics**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: L=**72,** T=0, P=0

Course Objectives

This course will equip students with the knowledge about the principles and applications of statistics in biological science, especially when it comes to analyzing and interpreting research data.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to
CLO 1: understand the basics of descriptive and inferential biostatistics (understand);
CLO 2: develop skills in data tabulation, analysis, interpretation and the presentation of data in charts and graphs (create);
CLO 3: analyze the biological consequences of inferential statistics (analyze); and
CLO 4: develop their ability to test and interpret hypotheses (create).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	-	2	3	1	-	-	2	2	2	1	-	2
CLO 2	3	3	3	2	2	2	2	-	-	2	2	3	2	-	2
CLO 3	3	2	-	-	2	2	1	-	-	2	3	2	1	-	2
CLO 4	3	3	-	2	2	3	2	-	-	2	2	3	2	-	2

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

UNIT – I **(L=18)**

- Arithmetic mean, Median and Mode (Theory and simple numerical problem)
- **Measure of variation**: Standard deviation, variance, coefficient of variation, properties (Theory and simple numerical problems)
- **Correlation**: Types of correlation, methods of correlation, simple, multiple and linear and nonlinear correlation, spearman's correlation coefficient, Rank correlation (Theory and simple numerical problems)

UNIT – II **(L=18)**

Regression: Linear regression, curvilinear regression (for two variables X and Y only), Regression lines by least square methods, Regression equations of X and Y and Y on X only (Theory and simple numerical problems)

UNIT – III **(L=18)**

Tests of significance: Null hypothesis, standard error, level of significance, degrees of freedom, significance in mean for large samples, significance in means for small samples (student t-test)/Significance in ratio of two samples. F-test (for difference between variance of two samples), chi square test (simple numerical examples and theory), analysis of variance test (ANOVA) for one- and two-way classification. Signed rank test, Dunnet's t-test (Theory and numerical examples)

UNIT – IV **(L=18)**

Representation of statistical data: Softwares used in plotting and representation of data (Excel, SPSS, Sigma Plot, R).

Diagrams and graphs: simple bar, multiple bars, component bar, pie diagram, histogram.

Reference Books:

1. Daniel W. ***Biostatistics***, John Wiley, New York.
2. Gupta SP. ***Statistical Methods***, Sultan Chand & Sons, New Delhi.
3. Sundar Rao PSS & Richard J. ***An Introduction to Biostatistics. A Manual for Students in Health Sciences***, Prentice Hall of India Pvt. Ltd., New Delhi.
4. Khan, IA & Khanum, A. ***Fundamentals of Biostatistics***. Ukaaz Publications, Hyderabad.
5. Rangaswamy R. A textbook of Agricultural Statistics. New Age International Publishers.

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DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-OE202**

Title of the Course: **Bioinformatics**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: L=**72,** T=0, P=0

Course Objectives

This course will equip students with the knowledge to generate, organize, analyze and interpret large amounts of molecular biology data using computer-assisted devices and their associated software.

Course Learning Outcomes (CLOs)

On completing this course, students should be able to
CLO 1: understand the components, generations and characteristics of computer; concept of hardware, software and internet (understand);
CLO 2: recognize concept of bioinformatics and types of biological data bases (understand);
CLO 3: analyze and develop various tools of bioinformatics (analyze/create); and
CLO 4: develop programs related to bioinformatics (create).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	2	-	-	2	2	1	-	-	2	2	3	-	-	2
CLO 2	3	2	-	-	2	2	-	-	-	1	2	2	-	-	2
CLO 3	3	3	3	2	2	3	2	-	-	2	2	3	2	-	2
CLO 4	3	3	3	2	2	3	2	-	-	3	2	3	3	-	2

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Detailed Syllabus

UNIT – I: Requirements for Bioinformatics-Computer, Internet, and Database (L=18)

Computer: Computer and its peripheral devices, generations of computer and their Characteristics, Types of Digital Computers, Microcomputer, Main Frame, Workstation, and Supercomputer.
Hardware: Processor, Memory, Motherboard, various storage devices, bus parallel and serial ports,
Software: Operating system (LINUX, and Windows), Application softwares (MS-Word, Excel, and PowerPoint)
Database: fundamentals, Data Abstraction, Data Models, Instances & Schemes, E-R Diagram, DBMS, MS-Access, My SQL
Internet: Internet and its application, LAN WAN, MAN, Client-Server concepts, WWW, Web browsers and Search Engines, Web server, Internet Protocols, Internet service provider (ISP) and types of internet connection, HTML

UNIT – II: Introduction to Bioinformatics and Biological Databases (L=18)

Bioinformatics: Concept, Emerging research areas, and Applications
Knowledge of various databases: Primary, secondary, and Specialized
Nucleic acid sequence databases: GenBank, EMBL, DDBJ
Protein sequence databases: SWISS-PROT, TrEMBL, PIR
Viral, Bacterial and Archeal Genome Databases: NCBI, EBI, TIGR, SANGER
Genomics of model eukaryotic organisms: Yeast, *Drosophila*, *C. elegans*, and *Arabidopsis thaliana*
Bibliographic databases and searching of literature: PubMed, PubMed Central, Google Scholar
Databases of metabolic pathways: MetaCyc and KEGG
Nucleic acid and protein structure database: PDB, CSD, and NDB
Gene Expression database and Atlas: GXD-MGI, GEO-NCBI, and EMBL-EBI

UNIT – III: Bioinformatics Tools and Techniques (L=18)

DNA and Protein sequence alignment and database searching tools: Sequence file formats, PAM, BLOSUM matrices, BLAST, and FAST-Alignment
Pairwise sequence alignments: Needleman-Wuncsh, Smith-Waterman, Dynamic Programming (DP) and Hidden Markov Model (HMM) algorithms.
Multiple sequence alignments: Various approaches for MSA, MEGA, CLUSTAL-X and Omega,
Molecular phylogeny: Basic concepts in systematics, molecular evolution, nature of molecular data, various types of phylogenetic trees, concept of cladogram/dendrograms and its interpretation.

UNIT – IV: Bioinformatics Programming (L=18)

Various concepts of programming language: C, JAVA, and Perl
Basic Perl for Bioinformatics: Numbers, Strings, Scalar, Operators, Scalar Variables, Operators and Functions, Control Structure, Loop, Array, Variable, Array operators, Hash variables,
Regular Expression: Patterns, File handles and File Tests, Directory Access, File and Directory Manipulation
BioPerl: Introduction, Installation, Architecture, and Uses

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DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-CC203**

Title of the Course: **Lab Course (based on MBO-CC201 & 202)**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: L=0, T=0, **P=72**

Course Objectives

This course seeks to equip students with practical aspects related to plant physiology, inheritance biology and cytogenetics.

Course Learning Outcomes (CLOs)

On completing this course, students should be able to

CLO 1: estimate the content of photosynthetic pigments and determine water potential of a leaf sample;

CLO 2: assay nitrate reductase in a given sample;

CLO 3: apply tests of significance for analysis of complex genetic data and describe stages of meiosis in *Rhoeo* sp.; and

CLO 4: delineate the phases of cell cycle in a model plant such as *Allium cepa* and effect of mutagens on chromosomes.

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	3	-	2	1	-	-	2	2	3	3	1	2
CLO 2	3	2	1	2	2	1	1	-	-	1	1	3	3	1	2
CLO 3	3	2	-	1	1	1	1	-	-	1	2	3	2	-	1
CLO 4	3	2	1	1	1	1	1	-	-	1	1	3	3	1	2

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

PLANT PHYSIOLOGY

- Estimation of chlorophyll ‘a’, chlorophyll ‘b’, carotenoid and total chlorophyll content in leaves
- Determination of water potential of plant leaves
- Determination of osmotic potential of cell sap by plasmolytic method
- In vitro assay of nitrate reductase enzyme

GENETICS AND CYTOGENETICS

- Introduction and applications of chi-square test in Mendelian Genetics.
- Use of chi-square test to analyze Monohybrid and Dihybrid experiments of Mendel
- Genetic interactions and chi square test.
- Cell cycle phases study of model plant, *Allium cepa.*
- Study of meiosis (translocation) - a case study in *Rhoeo* sp.
- Effect of mutagen on chromosomes.

Reference Books:

1. Sadasivam. ***Biochemical Methods***. New Age International Publishers.
2. Devlin, Witham, Blaydes. ***Exercises in Plant Physiology***. Medtech.
3. Phad DS. ***Practical Manual of Fundamental Genetics***. Lambert Academic Publishing.

Teaching – Learning Strategies in brief

The teaching learning strategies followed are learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 50 marks. End semester exam is of 100 marks. Total Marks are 200 for the subject (Internal Assessment: 50 Marks and End Semester Examination: 150 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-GE204**

Title of the Course: **Lab Course (based on MBO-GE201)**

Credits: **2**

L=Lecture; T=Tutorial; P=Practical: L=0, T=0, **P=36**

Course Objectives

The present practical attempts to impart hands-on sessions in modern analytical tools and techniques in biology.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to

CLO 1: analyze physicochemical properties of nucleic acids by subjecting them to electrophoresis;

CLO 2: demonstrate the utility of gel filtration in separation of biomacromolecules;

CLO 3: employ TLC for separation and identification of amino acids;

CLO 4: determine absorption spectrum of a given metabolite using UV-Visible spectrophotometer

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	3	-	2	1	-	-	2	2	3	3	1	2
CLO 2	3	2	1	2	2	1	1	-	-	1	1	3	3	1	2
CLO 3	3	2	-	1	1	1	1	-	-	1	2	3	2	-	1
CLO 4	3	2	1	1	1	1	1	-	-	1	1	3	3	1	2

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

TOOLS AND TECHNIQUES IN BIOLOGY

- Agarose gel electrophoresis of genomic and plasmid DNA
- Demonstration of gel filtration
- Separation and identification of amino acids by TLC
- Determination of λ-max of a given metabolite by UV-Visible spectrophotometer and preparation of its standard curve

Reference Books:

1. Wilson and Walker. ***Principles and Applications of Biochemistry and Molecular Biology***. Cambridge University Press.
2. Verma AS, Das, S. and Singh A. ***Laboratory Manual in Biotechnology***. S. Chand & Company Pvt.Ltd.

Teaching – Learning Strategies in brief

The teaching learning strategies followed are learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 50 marks. End semester exam is of 100 marks. Total Marks are 200 for the subject (Internal Assessment: 50 Marks and End Semester Examination: 150 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-GE205**

Title of the Course: **Lab Course (based on MBO-GE202)**

Credits: **2**

L=Lecture; T=Tutorial; P=Practical: L=0, T=0, **P=36**

Course Objectives

The course aims to impart practical knowledge with regard to analysing genomes and transcriptomes of organisms and attempts to carve out meaningful data out of the relationship between sequence, structure and function.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to

CLO 1: derive relationship between sequence, structure and function of nucleic acids and proteins;

CLO 2: carry out functional analysis of a gene and transcript;

CLO 3: clone and characterize a given gene/transcript of interest; and

CLO 4: apply methods for detailed analysis of genes and transcripts.

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	3	-	2	1	-	-	2	2	3	3	1	2
CLO 2	3	2	1	2	2	1	1	-	-	1	1	3	3	1	2
CLO 3	3	2	-	1	1	1	1	-	-	1	2	3	2	-	1
CLO 4	3	2	1	1	1	1	1	-	-	1	1	3	3	1	2

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

GENOMICS AND TRANSCRIPTOMICS

- Cloning of a chosen gene
- Expression profiling by semi-quantitative reverse transcription-polymerase chain reaction (RT-PCR)
- Determination of native molecular weight by PAGE
- Southern and Northern blotting and hybridization.

Reference Books:

1. Wilson and Walker. ***Principles and Applications of Biochemistry and Molecular Biology***. Cambridge University Press
2. Verma AS, Das, S. and Singh A. ***Laboratory Manual in Biotechnology***. S. Chand & Company Pvt.Ltd.

Teaching – Learning Strategies in brief

The teaching learning strategies followed are learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 50 marks. End semester exam is of 100 marks. Total Marks are 200 for the subject (Internal Assessment: 50 Marks and End Semester Examination: 150 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-GE206**

Title of the Course: **Lab Course (based on MBO-GE203)**

Credits: **2**

L=Lecture; T=Tutorial; P=Practical: L=0, T=0, **P=36**

Course Objectives

The course looks at the tools use for analysis of the protein complement and metabolite pool of a haploid cell.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to

CLO 1: analyze a mixture of proteins by subjecting them to native polyacrylamide gel electrophoresis;
CLO 2: deduce molecular weight of proteins by subjecting them to denaturing polyacrylamide gel electrophoresis;

CLO 3: detect presence or expression of expressed proteins by Western blotting and hybridization; and

CLO 4: detect presence of a particular metabolite in a cell using any of the appropriate tools and techniques.

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	3	-	2	1	-	-	2	2	3	3	1	2
CLO 2	3	2	1	2	2	1	1	-	-	1	1	3	3	1	2
CLO 3	3	2	-	1	1	1	1	-	-	1	2	3	2	-	1
CLO 4	3	2	1	1	1	1	1	-	-	1	1	3	3	1	2

3: ‘high level’ mapping; **2**: ‘medium level’ mapping; **1**: ‘low level’ mapping

Detailed Syllabus

PROTEOMICS AND METABOLOMICS

- Determination of native molecular weight by PAGE
- Determination of denaturing molecular weight by PAGE
- Western blotting and hybridization.

Reference Books:

1. Wilson and Walker. ***Principles and Applications of Biochemistry and Molecular Biology***. Cambridge University Press.
2. Verma AS, Das, S. and Singh A. ***Laboratory Manual in Biotechnology***. S. Chand & Company Pvt.Ltd.

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-CFC2-1**

Title of the Course: **Academic Writing (MOOCS through NPTEL/SWAYAM)**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: **L=72, T=0, P=0**

Course Objectives

The course attempts to teach the basics of academic writing and is targeted at PG students, research scholars, young scientists and faculty members (of any discipline or subject) for their career growth. It takes into consideration the academic needs of students and researchers who wish to improve their writing and thus make an impact.

Course Learning Outcomes (CLOs)

On completing the course, the students will be able to
CLO 1: differentiate between various kinds of academic writing (analyze);
CLO 2: identify and avoid plagiarism (understand);
CLO 3: practice the basic skills involved in quality literature review (apply);
CLO 4: practice the basic skills involved in writing research paper, review paper and thesis writing (apply);
CLO 5: target research work to suitable journal and communicate for publication (apply);
CLO 6: practice time and team management (apply);
CLO 7: practice digital writing or develop Open Educational Resources (OER) (apply); and
CLO 8: write research proposals, conference abstracts and book chapters/ book proposals (create).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	-	2	2	1	-	-	-	2	2	-	-	-
CLO 2	2	3	-	-	2	2	-	3	-	-	2	3	-	-	-
CLO 3	2	2	-	-	2	2	-	-	-	-	2	3	-	-	-
CLO 4	2	3	-	-	2	2	-	-	-	-	2	3	-	-	-
CLO 5	2	3	-	-	2	-	2	-	-	-	2	2	-	-	-
CLO 6	-	-	-	-	-	-	-	2	3	-	2	2	-	3	-

CLO 7	**2**	**2**	**3**	**-**	**2**	**-**	**2**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**-**
CLO 8	**3**	**3**	**3**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**3**	**-**	**-**	**-**	**2**

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

Course layout

Course Duration 15 week
Credits: 04
Week 1
Academic & research writing: Introduction; Importance of academic writing; Basic rules of academic writing
Week 2
English in academic writing I & II; Styles of research writing
Week 3*
Plagiarism: Introduction; Tools for the detection of plagiarism; Avoiding plagiarism
Week 4*
Journal Metrics
Week 5*
Author Metrics
Week 6*
Literature review: Introduction, Source of literature; Process of literature review
Week 7*
Online literature databases; Literature management tools
Week 8
Review Paper Writing, I & II
Week 9
Research paper writing I, II, III
Week 10
Referencing and citation; Submission and; Post submission
Week 11
Thesis Writing I, II & III
Week 12
Empirical Study I, II & III
Week 13*
Challenges in Indian research & writing; Team management (mentor and collaborators); Time Management
Week 14*
Research proposal writing; Abstract/ Conference Paper/ Book/ Book Chapter writing; OERs: basic concept and licenses
Week 15*
Open Educational Resources (OERs) for learning & Research; OERs development I & II

Additional Week*
Ethics in Research: Research fraud, competing interest, authorship, slicing research, FFP, COPE guidelines.

More details may be obtained from SWAYAM website:

https://swayam.gov.in

Teaching – Learning Strategies in brief

This course is outsourced to learning via the SWAYAM portal. Accordingly, teaching-learning strategies include weekly video based self-paced lectures and assignments. The course is spread over 15 weeks and it includes weekly video-based lectures and assignments. Also, the students are encouraged to post their queries and the same are addressed in virtual sessions.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-CC301**

Title of the Course: **Developmental and Structural Botany**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: **L=72**, T=0, P=0

Course Objectives

This course will equip students with the knowledge of various stages of plant developmental biology; origin and development of lateral meristem and their derivatives, comparative account of gymnospermous and angiospermous secondary xylem and phloem in plants.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to

CLO 1: recognize the structure and development of male and female gametophytes, pollination, fertilization, embryogeny and seed (understand);

CLO 2: describe the origin and development of apical meristem; morphogenesis and organogenesis in plants (understand);

CLO 3: discuss origin, development, differentiation and periodicity of vascular cambium and predict the age of plants (understand/create); and

CLO 4: differentiate between gymnospermous and angiospermous secondary xylem and phloem (analyze).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	3	-	2	1	-	-	2	2	3	3	1	2
CLO 2	3	2	1	2	2	1	1	-	-	1	1	3	3	1	2
CLO 3	3	2	-	1	1	1	1	-	-	1	2	3	2	-	1
CLO 4	3	2	1	1	1	1	1	-	-	1	1	3	3	1	2

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

UNIT – I **(L=18)**

- **Male and Female gametophyte**: Structure, organization and development.
- **Pollen-pistil interaction and fertilization**: Pollen germination, pollen tube growth and guidance, Double fertilization; Self incompatibility mechanism.
- **Embryogenesis and seed development**: *In vitro* fertilization, endosperm development apomixis, polyembryony, somatic embryogenesis.

UNIT – II **(L=18)**

- **Shoot and root apical meristem:** Organization, development, cytological and molecular analysis.
- **Morphogenesis and organogenesis in plants:** Leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in plants (*Arabidopsis/ Antirrhinum*)

UNIT – III **(L=18)**

- Origin and development of vascular cambium; Cambial cytology, Cell division patterns: pericliny, anticliny, transverse segmentation; Cambial ontogeny: size and relative proportions of cambial initials; Environmental factors influencing cambial periodicity; External regulation of cambial growth: role of hormones, sugar and water potential; Differentiation of young derivatives of the cambium

UNIT – IV **(L=18)**

- Comparative features of gymnospermous and angiospermous secondary phloem
- Differentiation of secondary phloem with special emphasis on sieve tube elements; Morphology and chemistry of P-proteins
- Differentiation of secondary xylem with special reference to vessel segments; Sapwood and heartwood: physical, structural and chemical properties; Reaction wood: tension wood and compression wood; periderm.

Reference Books:

1. Mahswari P. ***An Introduction to Embryology of Angiosperms***.
2. Bhojwani SS & Bhatnagar SP. ***Embryology of Angiosperms*** (4th edition).
3. Burgess J. ***An Introduction to Plant Cell Development***, Cambridge Univ Press, Oxford.
4. Fahn A. ***Plant Anatomy 3rd Edn***, Pergamon Press, Oxford.
5. Esau, K. ***Plant Anatomy***, Wiley Eastern Ltd.
6. Steeve TA & Sussex IM. ***Patterns in Plant Development, 2nd Edn***, Cambridge Univ.
7. Iqbal M. ***The Cambial Derivatives***, Gebruder Borntraeger, Stuttgart, Germany.
8. Iqbal M. ***Growth Patterns in Vascular Plants***, Dioscorides Press, Portland, USA.
9. Iqbal M. ***The Vascular Cambium***, R.S.P., Taunton, UK.
10. Larson PR. ***The Vascular Cambium***, Springer Verlag, Heidelberg, Germany.

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-CC302**

Title of the Course: **Plant Ecology and Biodiversity**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: **L=72**, T=0, P=0

Course Objectives

This course will equip students with the knowledge of nature of ecology, habitat and niche, population ecology, community and succession and key features of ecosystems, biome and phytogeography. Further it presents the importance of biodiversity and need for its conservation and management.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to

CLO 1: explain the various environmental factors and their interactions, develop concept of habitat and niche and population and community (understand)

CLO 2: analyze the major terrestrial biomes and phytogeographical division of India (analyze)

CLO 3: evaluate energy sources of ecological systems (evaluate); and

CLO 4: analyze importance and explain conservation and management of biodiversity (analyze and evaluate).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	3	-	2	1	-	-	2	2	3	3	1	2
CLO 2	3	2	1	2	2	1	1	-	-	1	1	3	3	1	2
CLO 3	3	2	-	1	1	1	1	-	-	1	2	3	2	-	1
CLO 4	3	2	1	1	1	1	1	-	-	1	1	3	3	1	2

3: ‘high level’ mapping; **2**: ‘medium level’ mapping; **1**: ‘low level’ mapping

Detailed Syllabus

UNIT – I **(L=18)**

- **The nature of ecology**: Physical environmental, Biotic and abiotic components of environment and their interactions
- **Habitat and niche**: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement
- **Population ecology**: Characteristics of a population; population growth curver; population regulation; life history strategies (r and k selection), concept of metapopulation: demes and dispersal, interdemic extinctions, age structured populations.

UNIT – II **(L=18)**

- **Community Ecology:** Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
- **Ecological succession**: Types, mechanism, changes involved in succession. Sere (hydrosere, xerosere, mesosere) concept of climax; Ecological adaptations
- **Biome**: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India

UNIT – III **(L=18)**

Ecosystem: Concept, trophic structure, food chain and energy flow, Structure and function terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).
Biogeochemical cycle: carbon, nitrogen and phosphorus; water cycle; Bio-geocenoses.

UNIT – IV **(L=18)**

- **Biodiversity**: Types and threats; The biosphere as man's environment
- **Conservation of Biodiversity**: ***In situ*** **conservation:** Indian initiatives; protected areas in India – sanctuaries, national parks, biosphere reserves, wetlands and mangroves; **Ex situ conservation**: botanical garden, field gene bank, seed bank; Cryopreservation;
- General account of the activities of Botanical Survey of India (BSI); National Bureau of Plant Genetic Resources (NBPGR); Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves)

Reference Books:

1. Pierzynski GM, Sims JT & Vance GF. ***Soils and Environmental Quality***. CRC, London.
2. Coley D. ***Energy & Climate Change***. John Wiley & Sons, London.
3. Itanez JG, et al. ***Environmental Chemistry, Fundamentals***. Springer.
4. Suresh G. Environmental Studies and Ethics. IK International, New Delhi.
5. Odum EP & Barrett GW. ***Fundamentals of Ecology***. V Edn, Thomson Asia, Pvt. Ltd.
6. Chapman JL & Reiss MJ. ***Ecology Principles & Applications***. Cambridge Univ Press.

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-CC303**

Title of the Course: **Plant Resource Utilization and Medicinal Botany**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: **L=72**, T=0, P=0

Course Objectives

This course attempts to inform the students with the knowledge about the origins, evolution, conservation, and applications of various cultivated crops as well as medicinal and aromatic plants.

Course Learning Outcomes (CLOs)

On completing this course, students should be able to

CLO 1: describe origin, domestication, evolution and development strategies to improve agricultural crops through conventional plant breeding and genetic engineering (understand);

CLO 2: analyze botanical description, cultivation and uses of major economically important crops (analyze);

CLO 3: recall history of Indian system of medicine and evaluate chemical constituents from the various medicinally important plants (remember/evaluate) and;

CLO 4: access role of medicinal plants in modern medicine (evaluate).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	3	-	2	1	-	-	2	2	3	3	1	2
CLO 2	3	2	1	2	2	1	1	-	-	1	1	3	3	1	2
CLO 3	3	2	-	1	1	1	1	-	-	1	2	3	2	-	1
CLO 4	3	2	1	1	1	1	1	-	-	1	1	3	3	1	2

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

UNIT – I **(L=18)**

Origin of cultivated plants; Vavilovian concept of centers of origin crop plants; domestication and evolution of crop plants, development of improved agricultural crops through conventional plant breeding and genetic engineering.

UNIT – II **(L=18)**

Botanical description, cultivation and uses: rice, maize, lentil, soybean, potato, tomato, flax, ramie, sal, shisham**,** sesame, safflower, castor, tea, coffee, rubber.

UNIT – III **(L=18)**

History of genesis of herbal medicine; Indian systems of medicine.

Drugs yielding plants: Origin, history, distribution, classification, botanical description, part(s) used, chemical constituents, adulteration, identification and uses: *Aloe vera, Artemesia spp, Atropa belladonna, Caesalpina spinosa, Catharanthus roseus, Digitalis purpurea, Ginkgo biloba, Plantago ovata, Podophyllum hexandrum, Rauwolfia serpentina, Stevia,Taxus baccata, Withania somnifera, Zingiber officinale.*

UNIT – IV **(L=18)**

Important controversial medicinal plants and substitute drugs.
Medicinal plants (Indian origin) as listed in IUCN Red list.
Ethnobotany and medicinal plants.

Role of medicinal plants in modern medicine.

Reference Books:

1. Jain SK, Sinha BK & Gupta RC. ***Notable Plants in Ethnomedicine of India***. Deep Publications, New Delhi.
2. Chowdhery HJ & Murti SK. ***Plant Biodiversity and Conservation in India: An Overview***. Bishen Singh, Mahendrapal Singh, Dehradun.
3. Jain SK. ***Contribution of Indian Ethnobotany***. Scientific Publishers, Jodhpur.
4. Singh VK & Abrar MK. ***Medicinal Plants and Folkories***. Today & Tomorrows Printers & Publishers, New Delhi.
5. Ghosh, AK. ***A Comprehensive Handbook on Biodiversity***, TERI, New Delhi.
6. Ghosh, AK. ***Simplifying Climate Change***. TERI, New Delhi.
7. Sampson, Garey P (2005). ***The WTO and Sustainable Development***, TERI, New Delhi.
8. Somayaji S & Somayaji G. ***Environmental Concerns and Sustainable Development***. TERI, New Delhi.
9. Saikia, Ranjane. ***Making Sense of Climate Change***. TERI, New Delhi.
10. Lovejoy TE & Hannah L. ***Climate Change and Biodiversity***, TERI, New Delhi.

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-DCE301**

Title of the Course: **Plant Tissue Culture and Genetic Engineering**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: **L=72**, T=0, P=0

Course Objectives

This course strives to equip students with the knowledge about plant tissue culture, genetic transformation of plants and development of transgenic plants as well as the major concerns and applications of transgenic technology.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to
CLO 1: relate basic concepts of plant tissue culture with their applications (understand);
CLO 2: improve their knowledge of various forms of plant tissue culture (understand);
CLO 3: analyze principles, tools and techniques of genetic engineering (analyze); and
CLO 4: summarize various application of genetic engineering (evaluate).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	3	-	2	1	-	-	2	2	3	3	1	2
CLO 2	3	2	1	2	2	1	1	-	-	1	1	3	3	1	2
CLO 3	3	2	-	1	1	1	1	-	-	1	2	3	2	-	1
CLO 4	3	2	1	1	1	1	1	-	-	1	1	3	3	1	2

3: ‘high level’ mapping; **2**: ‘medium level’ mapping; **1**: ‘low level’ mapping

Detailed Syllabus

SECTION-A: PLANT TISSUE CULTURE

UNIT – I **(L=18)**

- General introduction, history, basic concept of cellular totipotency
- Tissue culture media – preparation and sterilization
- Micropropagation /clonal propagation: types and applications
- Somatic embryogenesis and artificial seeds

UNIT – II **(L=18)**

- Haploidy and its importance in plant breeding
- Callus, suspension and shoot meristem culture and their applications
- Somaclonal variation, origin, molecular aspects and utility
- Protoplast isolation, fusion and culture, production of hybrids, hybrid selection and regeneration, possibilities, achievement and limitations of protoplast research, cybrids

SECTION–B: GENETIC ENGINEERING

UNIT – III **(L=18)**

Principles, tools and techniques of genetic engineering: Cloning vectors; enzymes: restriction and modification; construction of recombinant DNA; genetic transformation of bacteria, fungi and plants (direct and indirect methods); components of a typical gene construct; genetic and molecular analyses of transgenics; gene libraries; PCR (variants), DNA sequencing, microarray; gene silencing; molecular markers-hybridization vs. PCR based, dominant vs. codominant.

UNIT –IV **(L=18)**

Applications of genetic engineering:

Marker assisted selection; structural and functional genomics in relation to crop improvement; target traits and transgenic crops - insect, fungal, bacterial disease and herbicide resistance, male sterility, abiotic stress tolerance, biofortification, molecular farming and pharming, status of transgenic plants in India, biosafety issues, regulatory procedures for commercial approval, biofertilizers, biopesticides, single cell protein and biodiesel.

Reference Books:

1. Razdan MK. ***An Introduction of Plant Tissue Culture***. Oxford & IBH, New Delhi.
2. Evans DA, Sharp WR & Amirato PY . ***Handbook of Plant Tissue Culture***. Macmillan
3. Primrose SB. ***Principles of Gene Manipulation and Genomics***. Wiley Blackwell.
4. Slater. ***Plant Biotechnology: The Genetic Manipulation of Plants***. Oxford University Press.

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-DCE302**

Title of the Course: **Plant Breeding**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: **L=72**, T=0, P=0

Course Objectives

This course will equip students with the knowledge to breed traits that might result in high yielding, biotic and abiotic stress resistant plants.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to
CLO 1: recognize aims and basic concepts of plant breeding (understand);
CLO 2: evaluate the various methods of crop improvement (evaluate);
CLO 3: produce new hybrids with desirable traits (create); and
CLO 4: access the role of molecular markers in crop improvement (evaluate).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	3	-	2	1	-	-	2	2	3	3	1	2
CLO 2	3	2	1	2	2	1	1	-	-	1	1	3	3	1	2
CLO 3	3	2	-	1	1	1	1	-	-	1	2	3	2	-	1
CLO 4	3	2	1	1	1	1	1	-	-	1	1	3	3	1	2

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

UNIT – I **(L=18)**

- Aim and objective of plant breeding; Conventional methods of crop improvement of sexually, asexually and clonal plants
- The concept of center of origin of plant; Introduction (primary and secondary introduction, Agencies of introduction; Domestication. Selection method.
- Hybridization, inter and intra specific hybridation, achievement, merits and demerits, Some important released varieties through hybridization.
- Mutation breeding methods; Different sources of mutation; Merits and demerits, achievement,

UNIT – II **(L=18)**

- Numerical changes in chromosomes: Aneuploidy: monosomy, nullisomy, trisomy, tetrasomy. Monoploidy and Haploidy, origin, production, morphology, cytology, uses of haploids
- Karyotype: evolution, molecular basis of chromosome pairing, molecular organization of centromere and telomere; ribosomal RNA (rRNA) genes, banding pattern.

UNIT – III **(L=18)**

- Polyploidy: Autopolyploids, origin and production of autopolyploids, induced autopolyploids, effects of chromosome doubling, uses of induced polyploids, allopolyploids, synthesized allopolyploids, evolution of major crop plants, segmental allopolyploids.
- Heterosis, Polyploid based breeding

UNIT -IV **(L=18)**

Molecular markers and crop improvement: Morphological, biochemical and molecular markers, non-PCR based marker (construction and uses), PCR based markers, molecular maps, structural and functional genomics in relation to crop improvement, DNA fingerprinting, marker assisted selection.

Reference Books:

1. Singh BD. ***Plant Breeding: Principles and Methods***. Kalyani Publishers
2. Singh P. ***Essentials of Plant Breeding***. Kalyani Publishers

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

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DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-DCE302**

Title of the Course: **Molecular Markers in Crop Improvement**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: **L=72**, T=0, P=0

Course Objectives

This course attempts to introduce the importance of molecular markers in realizing plants with the desired trait(s). Knowledge of molecular markers is helpful in redesigning crops using that can withstand diseases and other biotic and abiotic stressors.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to
CLO 1: discuss various DNA marker techniques used in crop improvement (understand);
CLO 2: develop sequence based molecular markers (create);
CLO 3: enumerate the uses of markers in plant breeding (remember); and
CLO 4: recognize the marker assisted selection (MAS) in backcross and heterosis breeding (understand).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	3	-	2	1	-	-	2	2	3	3	1	2
CLO 2	3	2	1	2	2	1	1	-	-	1	1	3	3	1	2
CLO 3	3	2	-	1	1	1	1	-	-	1	2	3	2	-	1
CLO 4	3	2	1	1	1	1	1	-	-	1	1	3	3	1	2

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

UNIT – I **(L=18)**

DNA marker techniques, PCR and hybridization-based methods, Methods of physical mapping – Restriction mapping, DNA fingerprinting and foot printing methods, Southern, Northern and Western Hybridizations, ESTs

Unit II **(L=18)**

Development of sequence based molecular markers - SSRs and SNPs; Advanced methods of genotyping; Mapping genes for qualitative and quantitative traits. Principles of Genetic linkage map construction, Relation between Genetic maps and physical maps

Unit III **(L=18)**

QTL mapping using structured populations; AB-QTL analysis; Association mapping of QTL; Fine mapping of genes/QTL; Map based gene/QTL isolation and development of gene-based markers; Allele mining by TILLING and Eco-TILLING; Use of markers in plant breeding.

Unit IV **(L=18)**

Marker assisted selection (MAS) in backcross and heterosis breeding; transgenic breeding; Foreground and background selection; MAS for gene introgression and pyramiding: MAS for specific traits with examples.

Reference Books:

Lörz H and Wenzel G. ***Molecular Marker Systems in Plant Breeding and Crop Improvement***. Springer.

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-CC304**

Title of the Course: **Lab Course (based on MBO-CC301, 302 & 303)**

Credits: **6**

L=Lecture; T=Tutorial; P=Practical: L=72, T=0, **P=216**

Course Objectives

The course aims to provide students with the experimental knowledge of various aspects of plant developmental biology, structural botany, plant ecology, biodiversity, plant resource utilization and medicinal botany.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to

CLO 1: dissect and differentiate specific plant tissues or tissue systems and enable visualization and appreciation of their structure;

CLO 2: identify stages in the development of a plant with regard to a particular tissue;

CLO 3: devise experiments to study different facets of plant ecology; and

CLO 4: identify plant parts which are of economic importance and have direct bearing on their demand for utilization.

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	3	-	2	1	-	-	2	2	3	3	1	2
CLO 2	3	2	1	2	2	1	1	-	-	1	1	3	3	1	2
CLO 3	3	2	-	1	1	1	1	-	-	1	2	3	2	-	1
CLO 4	3	2	1	1	1	1	1	-	-	1	1	3	3	1	2

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

DEVELOPMENTAL AND STRUCTURAL BOTANY

- Demonstration of slides showing embryological peculiarities (male and female gametophytes, endosperm, embryo)
- Training in paraffin wax method for preparation of serial sections from fixation to mounting of permanent slides.
- Sectioning and staining, Slide preparation
- Study of cambium, Study of angiospermous and gymnospermous wood (T.S., R.L.S. & T.L.S.)
- Study of anomalous structure

PLANT ECOLOGY

- Determination of maximum and minimum size of quadrate (areaspecies curve) of the grassland ecosystem
- Determination of frequency, density and cover
- Analysis of soil texture, moisture content and water holding capacity
- Vulnerability factor and associated variables and measurement/calculation of vulnerability factor

PLANT RESOURCE UTILIZATION AND MEDICINAL BOTANY

- Field survey of important plants of the region for biodiversity.
- Morphology, anatomy and economic important parts of the food and vegetable crops included in the theory.
- Study of the characters and medicinal properties of the plants included in the theory.
- Mapping of Hotspots and Biosphere Reserves

Reference Books:

1. Sundararajan. ***Practical Manual of Plant Anatomy and Embryology***. Anmol Publications Pvt. Ltd.
2. Sundararajan. ***Practical Manual of Plant Ecology and Plant Physiology***. Anmol Publications Pvt. Ltd
3. Daniel D. and Mammen M. ***Analytical Methods for medicinal plants and economic botany***. Scientific Publishers.

Teaching – Learning Strategies in brief

The teaching learning strategies followed are learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 37 marks. End semester exam is of 113 marks. Total Marks are 150 for the subject (Internal Assessment: 37 Marks and End Semester Examination: 113 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-DCE304**

Title of the Course: **Lab Course (based on MBO-DCE301)**

Credits: **2**

L=Lecture; T=Tutorial; P=Practical: L=72, T=0, **P=36**

Course Objectives

This course takes through the various experiments in the area of *in vitro* plant biology and plant biotechnology and assumes a thorough hands-on them.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to
CLO 1: understand the importance of sterile techniques in manipulation of plants *in vitro;*
CLO 2: devise composition of media for sustaining growth of plants *in vitro;*
CLO 3: assemble component sequences to develop gene construct harboring gene(s) of interest; and
CLO 4: deploy gene construct in subject plants and characterize their transgenicity.

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	3	-	2	1	-	-	2	2	3	3	1	2
CLO 2	3	2	1	2	2	1	1	-	-	1	1	3	3	1	2
CLO 3	3	2	-	1	1	1	1	-	-	1	2	3	2	-	1
CLO 4	3	2	1	1	1	1	1	-	-	1	1	3	3	1	2

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

PLANT TISSUE CULTURE & GENETIC ENGINEERING

- Preparation of stock solution for Murashige and Skoog (MS) medium
- MS basal medium preparation
- Inoculation of seeds on agar medium for germination
- Induction of callus and determination of biomass (fresh and dry weight) of cultivated tissues
- Demonstration of organogenesis and somatic embryogenesis using appropriate explants
- Liquid medium preparation and establishment of suspension culture
- Demonstration and preparation of artificial seed
- Demonstration of androgenesis in plant like *Datura*
- Development of gene construct
- Genetic transformation of tobacco
- Confirmation of plant transgenics

Reference Books:

1. E. Pullaiah, T.,Rao, M.V. Subba, Sreedevi. ***Plant Tissue Culture: Theory and Practicals***. Scientific Publishers.

2. Potrykus I. and Spangenberg. ***Gene transfer to plants: A laboratory manual***. Springer Lab Manuals.

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-DCE305**

Title of the Course: **Lab Course (based on MBO-DCE302)**

Credits: **2**

L=Lecture; T=Tutorial; P=Practical: L=72, T=0, **P=36**

Course Objectives

The aim of this course is to impart practical exposure to experiments which are directly connected with crop yield. Further, it seeks to teach raising plants with desired characteristics such as disease resistance and tolerance to extreme environmental stresses.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to

CLO 1: understand the importance of field layout of experiments, field trials and importance of maintenance of plant breeding records;

CLO 2: compare and contrast the karyotypes of selected plants;

CLO 3: explain the effect of a chosen mutagen on the performance of plant function; and

CLO 4: analyze the data generated by employing various tools including some software.

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	3	-	2	1	-	-	2	2	3	3	1	2
CLO 2	3	2	1	2	2	1	1	-	-	1	1	3	3	1	2
CLO 3	3	2	-	1	1	1	1	-	-	1	2	3	2	-	1
CLO 4	3	2	1	1	1	1	1	-	-	1	1	3	3	1	2

3: ‘high level’ mapping; **2**: ‘medium level’ mapping; **1**: ‘low level’ mapping

Detailed Syllabus

PLANT BREEDING

1. Field layout of experiments, field trials and maintenance of records.
2. Effect of mutagenic agents on a plant system to record chromosomal abnormalities.
3. Comparative study of karyotypes of selected plants
4. Data analysis using various methods in plant breeding.

Reference Books:

Tomar. *Practical manual on fundamentals of plant breeding*. Scholar's Press.

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-DCE306**

Title of the Course: **Lab Course (based on MBO-DCE303)**

Credits: **2**

L=Lecture; T=Tutorial; P=Practical: L=72, T=0, **P=36**

Course Objectives

The course aims at exploiting the potential and application of molecular markers in the improvement of plants.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to
CLO 1: differentiate between mutation and polymorphism;
CLO 2: differentiate between dominant and co-dominant molecular markers;
CLO 3: differentiate between random and genic markers and PCR based and hybridization based molecular markers; and
CLO 4: execute amplification of a desired loci in a genome using appropriate marker.

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	3	-	2	1	-	-	2	2	3	3	1	2
CLO 2	3	2	1	2	2	1	1	-	-	1	1	3	3	1	2
CLO 3	3	2	-	1	1	1	1	-	-	1	2	3	2	-	1
CLO 4	3	2	1	1	1	1	1	-	-	1	1	3	3	1	2

3: ‘high level’ mapping; **2**: ‘medium level’ mapping; **1**: ‘low level’ mapping

MOLECULAR MARKERS FOR CROP IMPROVEMENT

1. PCR amplification of insert DNA for using as RFLP probe
2. RAPDs with two arbitrary primers
3. Set up the PCR reaction with SSR primers
4. Purity testing of hybrids with molecular markers
5. MAS for BLB resistance
6. Genotyping and phenotyping data collection
7. Use of various software like NTSys for data analysis

Reference Books:

1. Caetano-Anolles G and Gresshoff PM. ***DNA Markers***. Wiley.
2. Philips RL and Vasil IK. ***DNA-based markers in plants***. Kluwer.
3. Weising K, Nybom H, Wolff K. and Meyer W. ***DNA Fingerprinting in plants and fungi***.

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-CC401**

Title of the Course: **Project Work**

Credits: **18**

L=Lecture; T=Tutorial; P=Practical: L=72, T=0, **P=324**

Course Objectives

The purpose of this course is to engage students in active learning through minor projects and to develop their analytical thinking and problem-solving abilities under the guidance of a mentor. This course will instruct students how to carry out scientific research so that they can go on to get professional training or venture into research and development in any field of botany.

Course Learning Outcomes (CLOs)

On completing this course, the students should be able to
CLO 1: think critically, plan and carry out a research project independently (apply);
CLO 2: gather, analyze and execute data in the right manner (analyze);
CLO 3: acquire proficiency in handling instruments (understand); and
CLO 4: enhance scientific writing skill (create);

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	3	-	2	1	-	-	2	2	3	3	1	2
CLO 2	3	2	1	2	2	1	1	-	-	1	1	3	3	1	2
CLO 3	3	2	-	1	1	1	1	-	-	1	2	3	2	-	1
CLO 4	3	2	1	1	1	1	1	-	-	1	1	3	3	1	2

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Detailed Syllabus

The students will be allotted topics for project work in the beginning of the academic session, under the supervision of the concerned teacher(s) as decided by the Head of the Department, keeping in view the student's desire and the teacher's consent. The students will complete the assigned work in the department or at any other laboratory/institute identified and arranged for this purpose. **They will submit a dissertation which will contain some original experimental data and their interpretation, in addition to the survey of relevant literature**. The student may deliver a seminar lecturer or face the *viva voce* by a panel of teachers appointed by the Head of the Department. The dissertations will be examined by a panel of examiners including the external examiner(s) who will also conduct oral examination of the students.

Teaching – Learning Strategies in brief

Learning by doing is the major teaching-learning strategy for realizing the objectives envisaged in work related to research project.

Assessment methods and weightages in brief

There will be periodic assessment of the progress of research work carried out under the mentorship of a faculty member. A total of 450 marks are earmarked for the project work out of which 113 marks are allotted for internal assessment and the external *viva-voce* examination will be conducted for 337 marks.

DEPARTMENT OF BOTANY

Name of the Academic Programme: **M.Sc. Botany**

Course Code: **MBO-DCE401**

Title of the Course: **Seminar**

Credits: **4**

L=Lecture; T=Tutorial; P=Practical: **L=72, T=0, P=36**

Course Objectives

The aim of this course is to encourage, promote and enhance the presentation and oral skills of individual students. Primarily, it seeks to prepare a student to gather facts in a particular scientific area.

Course Learning Outcomes (CLOs)

On completing this course, the students will be able to
CLO 1: hone one's presentation skills (create);
CLO 2: enhance the depth of knowledge in a particular subject (apply);
CLO 3: sharpen oral communication skills (apply);
CLO 4: sustain engaging discussions arising out of the seminar (create) and;
CLO 5: break barriers of communication by facilitating smooth flow of information (apply).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	2	2	-	3	-	2	1	-	-	2	2	3	3	1	2
CLO 2	3	2	1	2	2	1	1	-	-	1	1	3	3	1	2
CLO 3	3	2	-	1	1	1	1	-	-	1	2	3	2	-	1
CLO 4	3	2	1	1	1	1	1	-	-	1	1	3	3	1	2

3: 'high level' mapping; **2**: 'medium level' mapping; **1**: 'low level' mapping

Seminars, according to Wikipedia, are courses that feature intense study of one topic. They include discussions but may also involve term papers, exams, oral presentations and other assignments. Seminars can be used to introduce other topics that are related to the course, and serve to help students transition to new ideas.

The students are expected to present an in-depth seminar and a write-up on a topic of interest assigned by the mentor. The students should collect sufficient literature and draw an outline of topics to be presented during the seminar and also for the write-up. The seminar will have to be presented before the entire department including the teachers and class fellows as this may expose students to new concepts and ideas, highlight new perspectives in the area, teach vital skills like listening, negotiating, leadership, time management conflict resolution and foster critical learning.

Teaching – Learning Strategies in brief

The students are encouraged to choose a topic of interest in consultation with their mentors towards the seminar. The students are expected to explore for literature extensively on the internet before finalizing the sub-topics of the seminar.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment will consist of evaluation of a critical write-up on the chosen topic of seminar which will have to be submitted by the student much before the presentation of seminar. Internal assessment is conducted and computed for 25 marks. End semester exam is of 75 marks and consists of a powerpoint presentation of the chosen topic in front of the faculty members of the department followed by a *viva-voce* on the presented topic.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).