POST-GRADUATION IN BOTANY

The Department offers a two- year integrated program leading to Masters (M. Sc.) degree in Botany. From the academic year 2017- 18, the Department is offering to students Choice Based Credit System (CBCS) with semesterization of the examination pattern.

GUIDELINES FOR CHOICE BASED CREDIT SYSTEM

Definitions of Key Words:

1. **Academic Year**: Two consecutive (one odd + one even) semesters constitute one academic year.
2. **Choice Based Credit System (CBCS):** The CBCS provides choice for students to select from the prescribed elective and skill courses. Each student has to select **one special/ elective paper** offered by the Department in which he/she is doing core course.This shall be part of core program during third and fourth semester. Each student has to complete **four skill courses**: two within the Department and two from other Department within the college.
3. **Course**: Usually referred to, as 'papers' is a component of a program. All courses need not carry the same weight. The courses should define learning objectives and learning outcomes. A course may be designed to comprise lectures/ tutorials/laboratory work/ field work/ project work/ self-study etc. or a combination of some of these.
4. **Credit Based Semester System (CBSS)**: Under the CBSS, the requirement for awarding a degree is prescribed in terms of number of credits to be completed by the students.
5. **Credit Point**: It is the product of grade point and number of credits for a course.
6. **Credit**: A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one period of teaching (lecture or tutorial) or two periods of practical work/field work per week.
7. **Cumulative Grade Point Average (CGPA)**: It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.
8. **Grade Point**: It is a numerical weight allotted to each letter grade on a 10-point scale.
9. **Letter Grade:** It is an index of the performance of students in a said course. Grades are denoted by letters O, A+, A, B+, B, C, P and F.
10. **Programme**: An educational programme leading to award of the Postgraduate Degree in the Core subject in which he/she is admitted.
11. **Semester Grade Point Average (SGPA)**: It is a measure of performance of work done in a semester. It is ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.
12. **Semester**: Each semester will consist of 15-18 weeks of academic work equivalent to 90 actual teaching days. The odd semester may be scheduled from July to November/ December and even semester from December/January to May.
13. **Transcript or Grade Card or Certificate:** Based on the grades earned, a statement of grades obtained shall be issued to all the registered students after every semester. This statement will display the course details (code, title, number of credits, grade secured) along with SGPA of that semester and CGPA earned till that semester.

Fairness in Assessment:

Assessment is an integral part of system of education as it is instrumental in identifying and certifying the academic standards accomplished by a student and projecting them far and wide as an objective and impartial indicator of a student's performance. Accordingly the BOS resolves the following:

a. All internal assessments shall be open assessment system only and that are based on test/ seminar.
b. Attendance shall carry the prescribed marks in all papers and Practical examination CCA.
c. In each semester two out of four theoretical component End Semester Examination shall be undertaken by external examiners from outside the college, who may be appointed by the competent authority.

Grievances and Redressal Mechanism

a) The students will have the right to make an appeal against any component of evaluation. Such appeal has to be made to the Head of the Department concerned as the case may be clearly stating in writing the reason(s) for the complaint / appeal.
b) The appeal will be assessed by the Principal as the Chairman and heshall place it before the **Grievance Redressal Committee (GRC)** comprising all HODs of the Faculty and if need be Course Teacher(s) be called for suitable explanation; GRC shall meet at least once in a semester and prior to CCA finalization.
c) The Committee will consider the case and may give a personal hearing to the appellant before deciding the case. The decision of the Committee will be final.

Table 1: Grades and Grade Points

S.No.	Letter Grade	Meaning	Grade Point
1	'O'	Outstanding	10
2	'A+'	Excellent	9
3	'A'	Very Good	8
4	'B+'	Good	7
5	'B'	Above Average	6
6	'C'	Average	5
7	'P'	Pass	4
8	'F'	Fail	0
9	'Ab'	Absent	0

i. A student obtaining Grade 'F' in a paper shall be considered failed and will be required to reappear in the University End Semester examination.
ii. For noncredit courses (Skill Courses) 'Satisfactory' or "Unsatisfactory' shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA.

Grade Point assignment

=and> 95 % marks Grade Point 10.0
90 to less than 95 % marks Grade Point 9.5
85 to less than 90 % marks Grade Point 9.0
80 to less than 85 % marks Grade Point 8.5
75 to less than 80 % marks Grade Point 8.0
70 to less than 75 % marks Grade Point 7.5
65 to less than 70 % marks Grade Point 7.0
60 to less than 65 % marks Grade Point 6.5
55 to less than 60 % marks Grade Point 6.0
50 to less than 55 % marks Grade Point 5.5
45to less than 50 % marks Grade Point 5.0
41 to less than 45 % marks Grade Point 4.5
= 40 % marks Grade Point 4.0

Computation of SGPA and 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 the courses taken by a student and the sum of the number of credits of all the courses undergone by a student,
i.e.

$$\textbf{SGPA}\ (Si) = \Sigma\ (Ci \times Gi) / \Sigma Ci$$

WhereCi 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 program,
i.e.
CGPA = Σ (Ci x Si) / Σ 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.

***Illustration* for SGPA:**

S.No.	Course	Credit	Grade letter	Grade point	Credit Point (Credit x Grade)
1	Course 1	**4**	**B**	**6**	**4 x 6 =24**
2	Course 2	**4**	**B+**	**7**	**4 X 7 =28**
3	Course 3	**4**	**B**	**6**	**4X 6 = 24**
4	Course 4	**4**	**O**	**10**	**4 X 10 =40**
5	Course 5 Practical I	**4**	**C**	**5**	**4 X 5 =20**
6	Course 6 Practical II	**4**	**B**	**6**	**4 X 6 = 24**
	Total	**24**			**24+28+24+40+20+24 =160**

Thus, **SGPA =160/24 =6.67**

***Illustration* for CGPA:**

	Semester- I	Semester-II	Semester-III	Semester-IV
Credit	**24**	**24**	**24**	**24**
SGPA	**6.67**	**7.25**	**7**	**6.25**

CGPA = (24X6.67+ 24X 7.25 + 24X7 + 24 X 6.25)/ 96
652.08/96 = 6.79

Semester-wise Theory Papers/Practical / Skill component

Type of course	Course code	Title of the Course	L-T-P*/Week	NC#	CCA$	ESE£	Total
Semester I							
Core course 1	MSBO111	Biology and Diversity of Microbes	4-0-0	4	30	70	100
Core course 2	MSBO112	Systematics of Angiosperms	4-0-0	4	30	70	100
Core course practical 1	MSBO121	Board I covering theory papers MSBO 111 and MSBO112	0-0-16(8+8)	4	30	70	100
Core course 3	MSBO113	Cell Biology	4-0-0	4	30	70	100
Core course 4	MSBO114	Plant Physiology	4-0-0	4	30	70	100
Core course practical 2	MSBO122	Board II covering theory papers MSBO 113 and MSBO114	0-0-16(8+8)	4	30	70	100
Skill Course I	MSBOSC131 As per the list		2-0-4				
Total				24	180	420	600
Semester II							
Core course 5	MSBO211	Biology and Diversity of Archegoniatae	4-0-0	4	30	70	100
Core course 6	MSBO212	Molecular Biology	4-0-0	4	30	70	100
Core course practical 3	MSBO221	Board I covering theory papers MSBO 211 and MSBO 212	0-0-16(8+8)	4	30	70	100
Core course 7	MSBO213	Cytology and Genetics	4-0-0	4	30	70	100
Core course 8	MSBO214	Plant Biochemistry and Metabolism	4-0-0	4	30	70	100
Core course practical 4	MSBO222	Board II covering theory papers MSBO 213 and MSBO214	0-0-16(8+8)	4	30	70	100
Skill course II	MSBOSC231 As per the list		2-0-4				
Total				24	180	420	600
Semester III							
Core course 9	MSBO311	Plant Development	4-0-0	4	30	70	100
Core course 10	MSBO312	Plant Reproductive Biology	4-0-0	4	30	70	100
Core course practical 5	MSBO321	Board I covering theory papers MSBO311 and MSBO312	0-0-16(8+8)	4	30	70	100
Core course 11	MSBO313	Fundamentals of Ecology	4-0-0	4	30	70	100
Core course practical 6	MSBO322	Board II covering theory paper MSBO313	0-0-8	2	15	35	50
Discipline Specific Special Paper/Elective 1	MSBO314A/B/C One paper from the list of elective papers		4-0-0	4	30	70	100
Discipline Specific Special Paper/Elective practical 1	MSBO323	Board III covering elective theory paper MSBO314 A/B/C	0-0-8	2	15	35	50
Skill course III	MSBOSC331 As per the list		2-0-4				
Total				24	180	420	600
Semester IV							
Core course 12	MSBO411	Biodiversity and Resource Utilization	4-0-0	4	30	70	100
Core course 13	MSBO412	Genetic Engineering	4-0-0	4	30	70	100

Core course practical 7	MSBO421	Board I covering theory papers MSBO411 and MSBO412	0-0-16(8+8)	4	30	70	100
Core course 14	MSBO413	Applied Ecology	4-0-0	4	30	70	100
Core course practical 8	MSBO422	Board II covering theory paper MSBO413	0-0-8	2	15	35	50
Discipline Specific Special Paper/Elective 2	MSBO414A/B/C One paper from the list of Elective papers		4-0-0	4	30	70	100
Discipline Specific Special Paper/Elective practical 2	MSBO423	Board III covering elective theory paper MSBO414 A/B/C	0-0-8	2	15	35	50
Skill course IV	MSBOSC431 As per the list		2-0-4				
Total				24	180	420	600

* Lecture – Tutorial -- Practical

#Number of Credits

$ Continuous Comprehensive Assessment

£ End- Semester Examination

In view of the course content, the Department of Botany and Biotechnology distributed the Periods (**per paper**) for Lecture/Tutorial/Practical as under:

- 4 : 0 : 0 (four lectures only (no tutorial and no practical) per week) – For Theory
- 0 : 0 : 8 (no lecture, no tutorial, and eight practical only per week) – For Practical
- 2 : 0 : 4 (two lectures, no tutorial and four practical/field experimentations) – For Skill course

Course Evaluation:

I. Evaluation of the Students for Core/ Special (Elective) courses:

All courses (Core/ Elective) involve an evaluation system of students that has the following two components:-

A. **Continuous Comprehensive Assessment (CCA)** accounting for 30% of the final grade that a student gets in a course; and

B. **End-Semester Examination (ESE)** accounting for the remaining 70% of the final grade that the student gets in a course.

A. **Continuous Comprehensive Assessment (CCA)**:

(i) For Theory Paper:

This would have the following components:

a. **Test**: Two tests, each of 1 hour duration, having a maximum of 20 marks shall be arranged for each theory paper during the semester course period. The question paper will consist of Part A, B & C. The Part B & C may have internal choice.

Types of question	Number of Questions	Marks per question	Total marks per type
Part A Very Short Answer (up to 30 words)	3	2	6
Part B Short Answer (up to 250 words)	1	4	4
Part C Long answer (500 words)	1	10	10
Total	5		20

b. **Seminar:** A seminar having a maximum of 10 marks shall be arranged for each theory paper during the semester course period. The student will prepare slides and give presentation on topics allotted to them based on theory papers. The marks shall be awarded on the following basis:

i. Slide Presentation = 4 marks

ii. Viva Voce = 3 marks
iii. Hand written literature = 3 marks

c. **Classroom Attendance:** Each student will have to attend a minimum of 75% Lectures / Tutorials / Practical. A student having less than 75% attendance will not be allowed to appear in the End-Semester Examination (ESE). Attendance shall have 10 marks and will be awarded by following the system proposed below:

Those having greater than 75% attendance (for those participating in Co-curricular activities, 25% will be added to per cent attendance) will be awarded CCA marks as follows:-

75% to less than 80%	=	2 marks
80% to less than 85%	=	4 marks
85 to less than 90%	=	6 marks
90% to less than 95%	=	8 marks
= and > 95%	=	10 marks

II. **For Practical Paper:**

In laboratory courses (having only practical (*P*) component), the CCA marks will be awarded as follows:

a. Attendance : 10 marks
b. Others* : 20 marks

* Practical records, hands on Practical, attending educational tour, preparation and submission of tour report etc, (as applicable).

Each component marks will be added without rounding and the total thus obtained is ratio by a factor of two. This value shall be rounded.

Illustration:

Test 1	– Marks obtained = 10.5
Test 2	– Marks obtained = 15.5
Seminar	– Marks obtained = 4.5
Attendance	-- Marks obtained = 8
Total	= 38.5
Conversion	= 38.5/2 = 19.25
Award	= 19.00

B. End Semester Examination (ESE) :

(i) For Theory Paper:

Part A

Ten short type questions (Definitions, illustrations, functions, short explanations, etc; 25-50 words) for two marks each. 10 × 2= 20 marks; two questions from each Unit; no choice in this part.

Part B

Five short answer (250 words) type questions for four marks each. 5 × 4 = 20 marks; one question from each Unit with internal choice.

Part C

Five questions of long/explanatory answer (500 words) type, one drawn from each Unit; student need to answer any three; ten marks each; 3 × 10 = 30 marks.

20+20+30 = 70 marks

(ii) For Practical Paper:

Semester I & Semester II shall have Board I and Board II only. However, Semester III & Semester IV shall have Board I, Board II and Board III.

BOARD I:

Maximum Marks: 100 (including 30% CCA).
Duration: Six hours in a single day.
In Semester I, Semester II & Semester III, it includes course work of two theory papers (Paper I & Paper II).

BOARD II:
For Semester I & Semester II - Maximum Marks: 100 (including 30% CCA).
Duration: Six hours in a single day
It includes course work of next two theory papers (Paper III & Paper IV).
For Semester III & Semester IV –Maximum Marks: 50 (including 30% CCA).
Duration: Four hours in a single day
It includes course work of one theory paper (Paper III).

BOARD III:
Maximum Marks: 50 (including 30% CCA). It includes course work of special / elective paper (Paper IV)
Duration: Four hours in a single day.
In fourth Semester, Board III shall also evaluate the dissertation submitted by the student that is the part of Practical examination. Each student shall submit one dissertation allotted by lottery based on the special/ elective paper.

III. **Evaluation of the students for Skill Course:**

At the end of the semester, performance of the student shall be evaluated. Each student has to submit a hand written literature on the topic assigned by the teacher. Based on his/her performance, hands - on practice and attendance (minimum 75%), the respective Department shall declare the result as "Satisfactory" or "Non-Satisfactory"; each student need to get a minimum of three "Satisfactory" declaration for the course completion.

TEACHING AND EXAMINATION SCHEME

Per Semester*

Course	Periods/Week	Examination hours	CCA	ESE	Total
Core Course					
Theory Paper I	4	3	30	70	100
Theory Paper II	4	3	30	70	100
Theory Paper III	4	3	30	70	100
Theory Paper IV	4	3	30	70	100
Practical Courses In SEM I & SEM II					
Board I	8 per paper	6	30	70	100
Board II	8 per paper	6	30	70	100
Practical Courses In SEM III & SEM IV					
Board I	8 per paper	6	30	70	100
Board II	8 per paper	4	15	35	50
Board III	8 per paper	4	15	35	50

***Students are required to pass in Theory and Practical examination individually in each semester.**

Qualifying for Next semester:

a. A student acquiring minimum of 40% in total of the CCA is eligible to join next semester.
b. A student who does not pass the examination (CCA+ESE) in any course(s) (or due to some reason as he/she not able to appear in the ESE, other conditions being fulfilled, and so is considered as 'Fail'), shall be permitted to appear in such failed course(s) in the subsequent ESE to be held in the following October / November or April / May, or when the course is offered next, as the case may be.

c. A student who fails in one or more papers in a semester shall get three more chances to complete the same; if he/she fails to complete the same within the prescribed time, i.e. three additional chances for each paper; the student is ineligible for the Postgraduate degree in the Subject in which he/she is admitted.

Students Failed in CCA:

Any student declared "Not Eligible" by the Department based on CCA in Semester I, II, III or IV and accordingly did not appear in ESE; can be readmitted as an additional student in that Semester in the **following year only**. Such student need to deposit the annual fee as prescribed for that academic year.

The full course is of FOUR SEMESTERS spread for TWO YEARS duration. A semester-wise list of courses to be offered is given below:

CODE & NOMENCLATURE OF PAPERS IN M.Sc. BOTANY

SEMESTER I

MSBO111: Biology and Diversity of Microbes
MSBO112: Systematics of Angiosperms
MSBO121: Practical I (Covering MSBO 111 and 112)
MSBO113: Cell Biology
MSBO114: Plant Physiology
MSBO122: Practical II (Covering MSBO 113 and 114)
MSBOSC131: Skill course I (for students of M. Sc. Botany only)

SEMESTER II

MSBO211: Biology and Diversity of Archegoniatae
MSBO212: Molecular Biology
MSBO221: Practical I (Covering MSBO 211 and 212)
MSBO213: Cytology and Genetics
MSBO214: Plant Biochemistry and Metabolism
MSBO222: Practical II (Covering MSBO 213 and 214)
MSBOSC231: Skill course II (for students of other PG programme)

SEMESTER III

MSBO311: Plant Development
MSBO312: Plant Reproductive Biology
MSBO321: Practical I (Covering MSBO 311 and 312)
MSBO313: Fundamentals of Ecology
MSBO322: Practical II (Covering MSBO 313)
MSBO314: Special/ Elective Paper I¥
MSBO323: Practical III (Covering MSBO 314)
MSBOSC331: Skill course III (for students of M. Sc. Botany only)

SEMESTER IV

MSBO411: Biodiversity and Resource Utilization
MSBO412: Genetic Engineering
MSBO421: Practical I (Covering MSBO 411 and 412)
MSBO413: Applied Ecology
MSBO422: Practical II (Covering MSBO 413)
MSBO414: Special/ Elective Paper II¥
MSBO423: Practical III (Covering MSBO 414)

MSBOSC431: Skill course IV (for students of other PG programme)

Special/ Elective paper group – Semester III
MSBO314A: Fundamentals of Plant Tissue Culture
MSBO314B: Industrial Microbiology- I
MSBO314C: Biostatistics & Bioinformatics

Special/ Elective paper group –Semester IV
MSBO414A: Applied Plant Tissue Culture
MSBO414B: Industrial Microbiology- II
MSBO414C: Genomics & Proteomics

¥ Number of Special/ Elective to be taught in a particular year shall be decided by the Department. Special/ Elective offered will be announced at the beginning of the academic session. Each student shall be assigned one Special/ Elective paper on merit-cum-choice basis with equal number (minimum 5) of students in each paper.

Skill Courses in Botany*:

1 Intellectual Property Rights
2-Data Analysis and Presentation
3-Micropropagation
4-Mushroom Cultivation

*The Department shall offer two skill courses per semester from the list of skill courses that will have 2 lectures and 4 practical/ field experimentations per week

MSC BOTANY I SEMESTER

Semester I							
Core course 1	MSBO111	Biology and Diversity of Microbes	4-0-0	4	30	70	100
Core course 2	MSBO112	Systematics of Angiosperms	4-0-0	4	30	70	100
Core course practical 1	MSBO121	Board I covering theory papers MSBO 111 and MSBO112	0-0-16(8+8)	4	30	70	100
Core course 3	MSBO113	Cell Biology	4-0-0	4	30	70	100
Core course 4	MSBO114	Plant Physiology	4-0-0	4	30	70	100
Core course practical 2	MSBO122	Board II covering theory papers MSBO 113 and MSBO114	0-0-16(8+8)	4	30	70	100
Skill Course I	MSBOSC131 As per the list		2-0-4				
Total				24	180	420	600

MSBO111: BIOLOGY AND DIVERSITY OF MICROBES	
UNIT - 1	Microbial diversity: Classical and modern methods and concepts. Domain and Kingdom concept in classification of microorganisms: criteria for classification, Recent trends in the classification of bacteria. Bacteria: structure, nutrition, Genetic recombination in Bacteria -transformation, transduction and conjugation; General account of Cyanobacteria, Archaebacteria, Actinomycetes, L- forms, Mycoplasma, Spiroplasma and Phytoplasma
UNIT - 2	Structure, classification and replication of viruses. Transmission of plant viruses, General account of Prions and Viroids. Phycology: Algae in diversified habitats (terrestrial, fresh water & marine); thallus organization: cell ultrastructure; reproduction; criteria for classification of algae; Schemes of algal classification, Outline of Fritsch's & Smith's classification
UNIT - 3	Salient features of Prochlorophyta, Chlorophyta (*Coleochaete, Hydrodictyon, Ulva, Cladophora*), Charophyta (*Chara*), Xanthophyta (*Vaucheria*), Phaeophyta (*Ectocarpus, Sargassum*) and Rhodophyta (*Batrachospermum, Polysiphonia*); algal blooms, algal biofertilizers; algae as food, feed and uses in industry
UNIT - 4	Mycology: General characters and classification of fungi; substrate relationship in fungi; cell ultrastructure, unicellular and multicellular organization; cell wall composition; nutrition (necrotrophic, biotrophic and symbiotic); reproduction; heterothallism; heterokaryosis; parasexuality
UNIT - 5	Phylogeny of fungi: general account of Mastigomycotina (*Synchytrium, Albugo, Peronospora*), Zygomycotina (*Rhizopus, Mucor, Pilobolus*), Ascomycotina (*Saccharomyces, Penicillium, Erysiphe, Phyllactinia, Morchella*); Basidiomycotina (*Polyporus, Puccinia, Ustilago, Uromyces, Melampsora*) and Deuteromycotina (*Curvularia, Drechslera, Alternaria, Phoma, Fusarium, Colletotrichum*); fungi in industry, medicine and as food; Mycorrhizae; fungi as biocontrol agents

SUGGESTED READINGS

1. Agrios, GN 2005, *Plant Pathology*, 5th edn, Elsevier, Academic Press.
2. Alexopoulos, CJ, Mims, CW & Blackwell, MM 2007, *Introductory Mycology*, 4th edn, John Wiley and Sons Inc.
3. Deacon, JW 2013, *Modern Mycology*, John Wiley and sons.
4. Dubey, HC 2012, *An Introduction to Fungi*, 4th edn, Scientific Publishers.
5. Dubey, RC & Maheswari, DK 2014, *A Textbook of Microbiology*, S. Chand and Co., New Delhi.
6. Mandahar, CL 1990, *Introduction to Plant Viruses*, CRC Press.
7. Mehrotra, RS & Aneja, KR 2015, *An Introduction to Mycology*, New Age International Publishers.
8. Vashishta, BR & Sinha, AK 2016, *Botany for Degree Students: Fungi*, S. Chand and Co., New Delhi.
9. Vashishta, BR, Singh, VP & Sinha, AK 2014, *Botany for degree students: Algae,* S. Chand and Co. Ltd., Delhi.

10. Webster, J & Weber, R 2007, *Introduction to Fungi*, Cambridge University Press.

MSBO112: SYSTEMATICS OF ANGIOSPERMS	
UNIT - 1	Fundamentals and importance of Plant Systematics and Taxonomy: Basic concepts and practices of plant taxonomy- Identification, nomenclature, salient features of International Code of Nomenclature. Taxonomic hierarchy; The concept of species, genus, family and other categories. Principles used in assessing relationship, delimitation of taxa and attribution of rank
UNIT - 2	Classification systems: Phenetic versus Phylogenetic systems; Taximetrics and Cladistic methods in taxonomy; merits and demerits of system of Bentham and Hooker. The Angiosperm Phylogeny Group (IV) system of classification of flowering plants
UNIT - 3	Taxonomic tools and evidences: Taxonomic literature, herbarium techniques, Digital and e-herbaria; morphological, anatomical, palynological, cytological, phytochemical, serological, biochemical and molecular techniques - genome analysis, nucleic acid hybridization and DNA bar-coding
UNIT - 4	Phylogeny of angiosperms: Ancestors of Angiosperms, Time of origin and Habit of Angiosperms, Primitive living Angiosperms, Inter-relationship among the major groups of angiosperms
UNIT - 5	Origin of intra-population variations: Phenotypic plasticity, Plant Invasions and Introductions, Ecads and ecotypes. Speciation - various models. Hybridization and taxonomy - methods of analysis, hybrid complexes, taxonomic treatment of hybrids

SUGGESTED READINGS

1. Besse, P 2014, *Molecular Plant Taxonomy: Methods and Protocols*, Humana Press.
2. Davis, PH & Heywood, VH 2011, *Principles of Angiosperm Taxonomy*, Scientific Publishers, Jodhpur.
3. Heywood, VH & Moore, DM 1984, *Current Concepts in Plant Taxonomy*, Academic Press, London.
4. Judd, WS, Campbell, CS, Kellogg, EA, Stevens, PF & Donoghue, MJ 2015, *Plant Systematics: A Phylogenetic Approach*, 4th edn, Sinauer Associates, Inc., Massachusetts.
5. Mondal, AK 2016, *Advanced Plant Taxonomy*, New Central Book Agency (P) Limited.
6. Radford, AE 1986, *Fundamentals of Plant Systematics*, Harper & Row Publications, USA.
7. Sharma, OP 2009, *Plant Taxonomy,* Tata McGraw Hill Education Pvt. Ltd., New Delhi.
8. Simpson, MG, 2010, *Plant Systematics*, Elsevier, Amsterdam.
9. Singh, G (ed.) 2010, *Plant Systematics: An Integrated Approach*, 3rd edn, Science Publishers, Enfield, NH, USA.
10. Stace, CA 1991, *Plant Taxonomy and Biosystematics*, Edward Arnold Ltd., London.
11. Stebbins, GL 1974, *Flowering Plant-Evolution above Species Level*, Edward Arnold Ltd., London.
12. Stuessy, TF 2009, *Plant Taxonomy: The Systematic Evaluation of Comparative Data*, Columbia University Press, New York.
13. Verma, BK 2011, *Introduction to Taxonomy of Angiosperms*, PHI Learning Pvt. Ltd

MSBO121: PRACTICAL I (COVERING MSBO 111 AND 112)

PART-A

SUGGESTED LABORATORY EXERCISES:

Material A: Gram Staining of Bacteria, Study of Cyanobacteria (*Nostoc, Oscillatoria, Microcystis, Lyngbya, Scytonema*)

Material B: Algae - *Coleochaete, Hydrodictyon, Ulva, Cladophora, Chara, Stigeoclonium, Vaucheria, Pithophora, Closterium, Cosmarium, Polysiphonia, Batrachospermum, Ectocarpus, Sargassum*

Material C: Fungi - Morphological study of representative members: *Peronospora, Albugo, Mucor, Rhizopus, Saccharomyces, Chaetomium, Erysiphe, Phyllactinia, Melampsora, Polyporus, Penicillium, Aspergillus, Curvularia, Drechslera, Phoma, Colletotrichum, Alternaria* and *Fusarium.*

Preparation of stains.

Media preparation and sterilization.

Identification of fungal cultures: *Mucor, Rhizopus, Chaetomium, Penicillium, Aspergillus, Curvularia, Drechslera, Phoma, Colletotrichum, Alternaria* and *Fusarium.*

SPOTS:

1. Study of morphology of bacteria, viruses, phytoplasma and cyanobacteria (photographs /slides): TMV, Bacteriophage, *Lactobacillus, Scytonema, Oscillatoria, Nostoc, Anabaena, Microcystis, Spiroplasma,* L- forms and *Phytoplasma* (in Sieve Cells).
2. Study of symptoms of the following diseases(Specimens / Photographs) :

a. Loose smut of Wheat
b. Covered smut of Barley
c. Black Rust of Wheat
d. White rust of Crucifers
e. Red rot of Sugarcane
f. Powdery mildew of Pea
g. Citrus Canker
h. Little leaf of Brinjal
i. Mosaic of Tobacco

PART-B

TAXONOMY

SUGGESTED LABORATORY EXERCISES:

1. **Material D:** Description of a specimen from representative, locally available families.

List of Locally Available Families:

(1) Ranunculaceae, (2) Capparidaceae, (3) Papaveraceae (4) Caryophyllaceae,
(5) Fabaceaeae, (6) Cucurbitaceae, (7) Apiaceae, (8) Rubiaceae,
(9) Asteraceae, (10) Primulaceae, (11) Plumbaginaceae, (12) Asclepiadaceae,
(13) Convolvulaceae, (14) Zygophyllaceae (15) Portulacaceae, (16) Phytollacaceae,
(17) Bignoniaceae, (18) Lamiaceae, (19) Nyctaginaceae, (20) Malvaceae,
(21) Tiliaceae, (22) Sterculiaceae, (23) Zygophyllaceae, (24) Rhamnaceae,
(25) Molluginaceae, (26) Euphorbiaceae, (27) Cyperaceae (28) Poaceae
(29) Polygonaceae, (30) Chenopodiaceae, (31)Amaranthaceae, (32) Aizoaceae,
(33) Solanaceae, (34) Boraginaceae, (35) Meliaceae(36) Acanthaceae, (37) Pedaliaceae.

2. Description of a species based on various specimens to study intra-specific variation: a collective exercise.
3. Description of various species of a genus; location of key characters and preparation of keys at generic level.
4. Location of key characters and use of keys at family level.
5. Study of relationship: UPGMA phylogenetic tree.
6. Field trips within and around the campus; compilation of field notes and preparation of herbarium sheets of such plants, wild or cultivated, as are abundant.
6. Training in using floras and herbaria for identification of specimens described in the class.
7. Educational Visit*.

***** The students shall prepare a brief illustrated narrative of the Educational Visit.

After evaluation, the marks will be added to the CIA of the practical examination.

SPOTS:

a. Vasculum
b. Secateur
c. Plant Press
d. Drier
e. Flora
f. Types of inflorescence
g. Types of leaf
h. Types of placentation
i. GISH
j. FISH
k. DNA Barcoding

l. TEM
m. SEM
n. *Amborella trichopoda*
o. Sympatric & Allopatric speciation
p. *Triticale*

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - I
M. Sc Botany
SEMESTER I
MSBO 121 (covering MSBO 111 and 112)

Time: 6 Hours **Max. Marks: 70**

PART – A

Q.1 Prepare a temporary mount of **material A**. Identify and give reasons. **03**

Q.2 Examine the **material B**. Prepare temporary glycerin mount and identify giving reasons. Draw suitable labeled diagrams. **06**

Q.3 Make temporary preparation of **material C**. Identify and classify giving reasons and place in its systematic position. Draw suitable labeled diagrams. **05**

Q.4 Identify and comment upon spots from 'a' to 'd' **4 X 4 =16**

(a) _____ (b) _____

(c) _____ (d) _____

PART-B

Q.5 Describe the given flowering plant **(Material D)** in semi-technical language and identify it up to the species level giving reasons. (Flora will be given only after identification of the family). **06**

Q.6 a. Construction of taxonomic key **02**
b. Phylogenetic tree **03**

Q. 7 Solve the given nomenclature exercise. Select the correct name giving reasons. **03**

Q.8 Identify and comment upon spots from 'a' to 'd': **4 X 4 =16**

(a) _____ (b) _____

(c) _____ (d) _____

Q. 8 Viva-Voce **10**

MSBO113: CELL BIOLOGY	
UNIT - 1	The dynamic cell: Structural organization of the plant cell; Specialized plant cell types; Chemical foundation: Atoms and Molecules, Covalent and Non-covalent interactions (Van der Waals, electrostatic, hydrogen bonding & hydrophobic interactions) Composition, structure and function of biomolecules: carbohydrates, lipids, proteins, nucleic acids and vitamins
UNIT - 2	Cell wall: Structure and functions; biogenesis; growth; Plasma membrane: Structure of model membrane and functions; Active and Passive transport, Sites for ATPases, ion carriers, channels and types of pumps; receptors and electrical properties of membranes; Plant vacuole: Tonoplast membrane; ATPases; transporters; as storage organelle; Plasmodesmata: Structure, role in movement of micromolecules and macromolecules; comparison with gap junctions.
UNIT - 3	Plastid and Mitochondria: Structure and function; division and biogenesis; Plastome and Chondriome. Hydrogenosome; Ribosome, Endoplasmic reticulum, Golgi apparatus: Structure and function; Protein sorting and targeting
UNIT - 4	Cell shape and mobility: The cytoskeleton; organization and role of microtubule and microfilament, motor movements; implication in flagellar and other movements; Other cellular organelles: Structure and function of microbodies, lysosome, Peroxisome; Nucleus: Structure; nuclear pores; chromatin organization, nucleolus; DNA polymorphism: A, B and Z forms and non-canonical forms of DNA; RNA polymorphism-mRNA, rRNA, tRNA and other regulatory RNAs
UNIT - 5	Microscopic techniques: Visualization of cells and sub-cellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, Scanning and Transmission Electron Microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy; Flow cytometry and FACS; Centrifugation: Velocity gradient and Buoyant Density centrifugation; Chromatography: Paper, Thin layer and Column Chromatography (Gel permeation, Ion exchange, Affinity and HPLC)

SUGGESTED READINGS

1. Alberts, B, Johnson, A, Lewis, J, Raff, M., Roberts, K & Walter, P 2007, *Molecular Biology of the Cell*, 5th edn, Garland Publishing Inc, New York.
2. Buchanan, BB, Gruissem, W, & Jones, RL (eds.) 2015, *Biochemistry and Molecular Biology of Plants*, American Society of Plant Physiologists, Maryland, USA and Wiley Blackwell.
3. Cooper, GM & Robert EH 2007, *The Cell: A Molecular Approach*, 4th edn, ASM Press and Sinauer Associates Inc, USA.
4. De, DN 2000, *Plant Cell Vacuoles: An Introduction*, CSIRO Publication, Collingwood, Australia.
5. Jocelyn, EK, Stephen TK, Elliott, SG & Lewin, B 2014, *Genes XI*, Jones & Bartlett Learning, Burlington, Massachusetts.
6. Iwasa, J & Marshall, W 2016, *Karp's Cell and Molecular Biology: Concepts and Experiments,* 8thedn, John Wiley & Sons Inc, USA.
7. Lodish, H, Berk, A, Kaiser, CA, Kreiger, M, Bretscher, A, Ploegh, H, Amon, A & Martin, K 2016, *Molecular Cell Biology,* 8th edn, W.H. Freeman and Company, New York.
8. Verma, PS & Agarwal VK 2015, *Cell Biology (Cytology, Biomolecules and Molecular Biology),* S. Chand & Company Ltd

MSBO114: PLANT PHYSIOLOGY	
UNIT - 1	Transport of Water - Components of water potential, water absorption by roots, pathways of movement of water in the root, mechanism of water transport through the xylem, transpiration and stomatal regulation; Mineral Nutrition - Essential nutrient elements, their functions and deficiency symptoms in plants; Solute Transport - Passive and active transport, root-microbe interactions in facilitating nutrient uptake; Transport of Organic Solutes - Pathway, the pressure-flow model, phloem loading and unloading
UNIT - 2	Phytochrome - Discovery, photochemical and biochemical properties, characteristics of VLF, LF and HI responses, phytochrome-mediated responses including shade-avoidance response, mode of action; Cryptochrome - Discovery, chemistry, cryptochrome-mediated responses, mode of action; a brief account of phototropins; Photoperiodism - Discovery, critical day length, site of signal perception, circadian clock

	and photoperiodic time measurement, photoreceptors in flowering; Vernalization - Discovery, site of signal perception, vernalized (induced) and devernalized state
UNIT - 3	Plant growth regulators: Discovery, chemical structure, occurrence, biosynthesis, physiological effects, commercial applications and signal transduction pathways of Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic acid and Brassinosteroids; abrief account of Strigolactones
UNIT - 4	Stress: Definition, types & plant responses (susceptibility, avoidance & tolerance); constitutive & induced responses; Biotic Stress: Production of physical barriers (cutin, suberin & wax) and secondary metabolites (terpenes, phenolics & N-containing compounds); induced plant defense against insect herbivores; plant defense against pathogens - elicitors, receptors & signaling, hypersensitive response & systemic acquired resistance; role of Salicylic acid & Jasmonic acid
UNIT - 5	Abiotic Stress: Water deficit stress & drought tolerance, role of compatible solutes and ABA; Salt stress & biochemical determinants, SOS signaling; Heat stress & HSPs; Cold (chilling and freezing) stress & antifreeze proteins; Oxidative stress & scavenging mechanisms (enzymatic and non-enzymatic antioxidants); Heavy metal stress & role of transporters and chelators

SUGGESTED READINGS

1. Buchanan, BB, Gruissem, W, & Jones, RL (eds.) 2015, *Biochemistry and Molecular Biology of Plants*, American Society of Plant Physiologists, Maryland, USA and Wiley Blackwell.
2. Davies, PJ (ed.) 2004, *Plant Hormones: Biosynthesis, Signal Transduction*, 3rd edn. Kluwer Academic Publishers, Dordrecht.
3. Devlin, RM 1983, *Plant Physiology*, (Witham, FH ed.), 4th edn, PWS.
4. Hopkins, WG & Huner, NPA 2008, *Introduction to Plant Physiology*, 4th edn, John Wiley and Sons, Inc., New York, USA.
5. Jenks, MA & Hasegawa, P (eds.) 2005, *Plant Abiotic Stress,* Blackwell Publishing Ltd. Oxford, UK.
6. Nobel, PS 2009, *Physicochemical and Environmental Plant Physiology*, 4th edn. Academic Press, San Diego, USA.
7. Ricardo, A (ed.) 2012, *Plant Responses to Drought Stress- From Morphological to Molecular Features*, Springer.
8. Singhal, GS, Renger, G, Govindjee, Irrgang, KD & Sopory, SK 1999, *Concepts in Photobiology: Photosynthesis and Photomorphogenesis*, Kluwer Academic Publishers.
9. Taiz, L., Zeiger, E, Moller, IM & Murphy, A 2015, *Plant Physiology and Development*, 6th edn, Sinauer Associates, Inc. USA

MSBO122: PRACTICAL II (COVERING MSBO 113 AND 114)

SUGGESTED LABORATORY EXERCISES:

1. Study of cell wall using specific stains.
2. Determination of stomatal index (quantitative).
3. Quantitative estimation of SOD activity in plant samples.
4. Demonstration of continuity of water column by the use of mercury in *Cucurbita* /*Tinospora* stem.
5. Separation of Turmeric Alkaloids by TLC.
6. Separation of amino acids by TLC.
7. Separation of biomolecules using gel permeation chromatography.
8. Quantitative estimation of phenol contents in the given plant samples.
9. Quantitative estimation of soluble protein in the given plant samples.
10. Quantitative estimation of carbohydrate contents in the given plant samples.
11. Quantitative estimation of proline by Bates et al. method in the given plant sample.
12. Studies on the effects of plant growth regulators in plant samples.
13. Quantitative estimation of antioxidants in plant samples.
14. Study of photoperiodism in *Petunia*.

SPOTS:

a. Cell membrane
b. Plasmodesmata
c. Secondary structure of protein
d. Flow cytometry

e. TEM
f. SEM
g. Plastome
h. Chondriome
i. Active transport
j. Phloem loading and unloading
k. Photomorphogenesis
l. Phytochrome
m. Cryptochrome
n. Effect of auxins on rooting
o. Elicitors
1. Reactive Oxygen Species

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - II
M.Sc. BOTANY
SEMESTER- I
(MSBO122: Covering Papers -MSBO113 and 114)

Time: 6 hours **Max. Marks: 70**

1. Perform the given Cell Biology experiment. 18

2. Perform the given Plant Physiology experiment 18

3. Identify and comment upon spots from'a' to 'f' : 6x 4= 24

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

   f. _____

Viva-voce 10

MSC BOTANY II SEMESTER

Semester II							
Core course 5	MSBO211	Biology and Diversity of Archegoniatae	4-0-0	4	30	70	100
Core course 6	MSBO212	Molecular Biology	4-0-0	4	30	70	100
Core course practical 3	MSBO221	Board I covering theory papers MSBO 211 and MSBO 212	0-0-16(8+8)	4	30	70	100
Core course 7	MSBO213	Cytology and Genetics	4-0-0	4	30	70	100
Core course 8	MSBO214	Plant Biochemistry and Metabolism	4-0-0	4	30	70	100
Core course practical 4	MSBO222	Board II covering theory papers MSBO 213 and MSBO214	0-0-16(8+8)	4	30	70	100
Skill Course II	MSBOSC231 As per the list		2-0-4	2-0-4			
Total				24	180	420	600

MSBO211: BIOLOGY AND DIVERSITY OF ARCHEGONIATAE	
UNIT - 1	General characters and classification of Bryophytes. General account of morphology, anatomy, reproduction of marchantiales (*Marchantia, Plagiochasma, Astrella & Targionia*), Jungermanniales (*Pellia & Porella*), Anthocerotales (*Anthoceros*), Sphagnales (*Sphagnum*), Funariales (*Funaria*) and Polytrichales (*Polytrichum & Physcomitrella*); economic and ecological importance
UNIT - 2	General characters and classification of Pteridophytes. Stelar system in Pteridophytes. General account of morphology, anatomy and reproduction of Pteridophytes with special reference to Psilopsida (*Psilotum*) and Lycopsida (*Lycopodium, Selaginella & Isoetes*), Heterospory and origin of seed habit
UNIT - 3	General account of morphology, anatomy and reproduction of pteridophytes with special reference to Sphenopsida (*Equisetum*) and Pteropsida (*Ophioglossum, Osmunda, Gleichenia & Pteris*), Soral evolution, Alternation of generation, Apospory and apogamy; General account of fossil pteridophyta
UNIT - 4	General characters, classification, evolution and economic importance of Gymnosperms. Paleobotany: Geological Time Scale; Process of fossilization, types and age of fossils, Paleopalynological techniques – Coal and Lignite maceration
UNIT - 5	General account of structure, reproduction and evolutionary relationship of Pteridospermales- (Lyginopteridaceae, Medullosaceae, Glossopteridaceae & Caytoniaceae), Cycadales- (Cycadaceae), Ginkgoales- (Ginkgoaceae), Coniferales (Pinaceae, Taxodiaceae, Cephalotaxaceae, Cupressaceae, Podocarpaceae, Araucariaceae & Taxaceae), Ephedrales (Ephedraceae), Welwitschiales (Welwischiaceae) and Gnetales (Gnetaceae).

SUGGESTED READINGS

1. Bhatnagar, SP & Moitra, A 2013, *Gymnosperms,* New Age International (P) Ltd., Publishers, New Delhi.
2. Biswas, C & Johri, BM 2004, *Gymnosperms,* Narosa Publishing House, New Delhi.
3. Govil, CM 2014, *Gymnosperms: Extinct and Extant*, Krishna Prakashan Media (P) Ltd., Meerut.
4. Parihar, NS 1991, *Bryophyta*. Central Book Depot, Allahabad.
5. Parihar, NS 1996, *Biology and Morphology of Pteridophytes,* Central Book Depot, Allahabad.
6. Sharma, OP 2014, *Gymnosperms,* Pragati Prakashan, Meerut, India.
7. Smith, GM 1955, *Crytogamic Botany Vol 1 and Vol 2,* McGraw Hill Book Company, London.
8. Sporne, KR 2018, *The Morphology of Pteridophytes*, B. I. Publishing Pvt. Ltd., Bombay.
9. Stewart, WN & Rothwell, GW 2010, *Paleobotany and the Evolution of Plants: The Structure of Ferns & Allied Plants,* Creative Media Partners LLC.
10. Taylor, TN 1981, *Palaeobotany: An Introduction to Fossil Plant Biology*, McGraw-Hill Book Co. Inc. New York
11. Vashishta, BR, Sinha, AK & Kumar, A 2014, *Botany for Degree Students: Bryophyta,* S.Chand and Co. Ltd., Delhi.
12. Vashishta, PC, Sinha, AK & Kumar, A 2014, *Botany for Degree Students: Pteridophyta*, S. Chand and Co. Ltd., Delhi.

13. Vashishta, PC, Sinha, AK & Kumar, A 2009, *Botany for Degree Students – Gymnosperms*, S. Chand and company Ltd., New Delhi.

MSBO212: MOLECULAR BIOLOGY	
UNIT - 1	Nature of genetic material, DNA replication: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication; DNA damage and repair: Direct repair, Excision repair, Recombination repair and other repair mechanisms in plants; Organization of genes: Operons and interrupted genes, gene families, r-RNA, protein coding and t-RNA genes
UNIT - 2	Transcription in plants: Transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination; RNA processing: 5'capping, splicing, polyadenylation, RNA editing and Alternative processing mechanisms; Structure and function of different types of RNA and RNA transport; Transcription of plastid and mitochondrial genes and post-transcriptional processing
UNIT - 3	Ribosome, Genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl-tRNA synthetase; Translation in plants: Formation of initiation complex, initiation factors, elongation and elongation factors, termination; Translational proof-reading, translational inhibitors; Translation in plastids and mitochondria
UNIT - 4	Regulation of gene expression in plastids and mitochondria; Regulation of gene expression in plants at genomic level and genomic imprinting; Regulation of transcription and post transcriptional events in plants; Regulation of translation and post translational events in plants
UNIT - 5	Mechanism of signal transduction in plants: Receptors, effectors, adaptors and secondary messengers; two component regulatory system in bacteria and plants, molecular mechanism of sucrose sensing

SUGGESTED READINGS

1. Alberts, B, Johnson, A, Lewis, J, Raff, M., Roberts, K & Walter, P 2007, *Molecular Biology of the Cell*, 5th edn, Garland Publishing Inc, New York.
2. Buchanan, BB, Gruissem, W, & Jones, RL (eds.) 2015, *Biochemistry and Molecular Biology of Plants*, American Society of Plant Physiologists, Maryland, USA and Wiley Blackwell.
3. Cooper, GM & Hausman, RE 2016, *The Cell: A Molecular Approach*, 7th edn, ASM Press and Sinauer Associates Inc, USA.
4. Iwasa, J & Marshall, W 2016, *Karp's Cell and Molecular Biology: Concepts and Experiments,*8th edn, John Wiley & Sons Inc, USA.
5. Krebs, JE, Goldstein, ES & Kilparick ST 2014, *Lewin's Genes XI*, Jones & Bartlett Learning, Burlington, Massachusetts.
6. Lodish, H, Berk, A, Kaiser, CA, Kreiger, M, Bretscher, A, Ploegh, H, Amon, A & Martin, K 2016 *Molecular Cell Biology,* 8th edn, W.H. Freeman and Company, New York.
7. Malacinski, GM & Freifelder, D 1998, *Essentials of Molecular Biology*, Jones and Bartlett Publishers Inc., London.
8. Verma, PS & Agarwal VK 2015, *Cell Biology (Cytology, Biomolecules and Molecular Biology),* S. Chand & Company Ltd

MSBO221: PRACTICAL I (COVERING MSBO 211 AND 212)

SUGGESTED LABORATORY EXERCISES:

Biology and Diversity of Archegoniatae (MSBO 211)

Microscopic preparation and study of the following:

Material A- Bryophyta- *Marchantia, Plagiochasma*, *Targionia, Astrella, Pellia, Porella, Dumortiera,, Anthoceros, Sphagnum, Funaria & Polytrichum*

Material B- Pteridophyta- *Lycopodium, Selaginella, Isoetes, Equisetum, Ophioglossum, Osmunda*, *Gleichenia & Pteris.*

Psilotum (only as spot)

Material C- Gymnosperms- Comparative study of the anatomy of (i) vegetative and (ii) reproductive parts of:

Cycas, Ginkgo, Pinus, Cedrus, Abies, Picea, Cupressus, Araucaria, Cryptomeria, Taxodium, Podocarpus, Agathis, Taxus, Ephedra and *Gnetum*

Molecular Biology (MSBO 212)

Experiments:

1. Isolation of genomic DNA from given plant tissue using CTAB method.
2. Gel casting, loading &visualization of isolated genomic DNA from plant sample by agarose gel electrophoresis.
3. Quantitative estimation of genomic DNA by DPA method.
4. DNA sequencing from the given data/ photograph by Sanger's method
5. Extraction and quantitative estimation of RNA from given plant tissue by orcinol method.

SPOTS:

Biology and Diversity of Archegoniate (MSBO 211):

Spot (a), (b) & (c) -Slides/ Specimens/ Photographs of the following**:**

a. Material A- Bryophyta
b. Material B- Pteridophyta
c. Material C- Gymnosperms

Spot (d) - Paleobotany - Slides/ Specimens/ Photographs of the following**:**

a) *Rhynia*
b) *Horneophyton*
c) *Williamsonia*
d) *Ptilophyllum*
e) *Bucklandia*
f) *Weltrichia*

Molecular Biology (MSBO 212):

a. DNA replication
b. Structure of t- RNA
c. RNA polymerase
d. *Lac* operon
e. Genetic code
f. Bacterial two component system
g. Eukaryotic promoter
q. GPCR

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - I
M. Sc Botany
SEMESTER II
MSBO 221 (covering MSBO 211 and 212)

Time: 6 Hours **Max. Marks:70**

PART – A: Biology and Diversity of Archegoniate

Q.1 Make temporary preparation of **material A**. Identify and classify giving reasons and place in its systematic position. Draw suitable labeled diagrams. **04**

Q.2 Cut transverse section (T.S.) of **material B.** Make double stained permanent mount for examination. Identify the material giving reasons. Draw suitable labeled diagrams. **05**

Q.3 Cut transverse section (T.S.) of **material C.** Make double stained permanent mount for examination. Identify the material giving reasons. Draw suitable labeled diagrams. **05**

Q.4 Identify and comment upon spots from 'a' to 'd': **4 X 4=16**

(a) _____

(b) _____

(c)_____

(d) _____

PART-B: Molecular Biology

Q.5 Perform the given Molecular Biology experiment. **14**

Q.6 Identify and comment upon spots from 'a' to 'd': **4X4 =16**

(a) _____
(b) _____

(c)_____

(d) _____

Q. 7 Viva-Voce **10**

MSBO213: CYTOLOGY AND GENETICS	
UNIT - 1	Cell Division: Mitosis and Meiosis, their regulation, cell cycle and its regulation. Stability and variability of DNA: The amount of DNA in nuclei and the C-value paradox. Unique and Repetitive DNA. The chromosomes in interphase: Euchromatin and Heterochromatin. Chromosome organization: Nucleosome, Solenoid and higher order structure
UNIT - 2	Molecular organization of telomere and centromere, Chromosome banding Patterns: G banding, C banding, R banding and Q banding, Molecular basis of chromosome pairing, Specialized types of chromosomes: Polytene, Lampbrush and B-form chromosomes, Transposable elements in Bacteria and Plants
UNIT - 3	Mutation: Types, causes and detection; mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Structural alteration in chromosome: Deletion, Duplication, Inversion, Translocation and Robertsonian translocation. Recombination: Homologous and non-homologous recombination, including transposition, site-specific recombination
UNIT - 4	Numerical alteration in chromosomes: Aneuploidy and Euploidy. Polyploidy: Auto and Allopolyploid, their origin and genetic implications. Mendelian principles: Dominance, segregation, independent assortment, Deviation from Mendelian inheritance. Concept of gene: Allele, multiple alleles, pseudoalleles, complementation tests. Linkage and crossing over, Linkage maps, tetrad analysis
UNIT - 5	Extensions of Mendelian principles: Codominance, incomplete dominance, Gene interactions: Domianant and recessive epistasis, Complementary, Supplementary and duplicate genes. Pleiotropy, Penetrance and expressivity, phenocopy, Sex linkage

SUGGESTED READINGS

1. Alberts, B, Johnson, A, Lewis, J, Raff, M., Roberts, K & Walter, P 2007, *Molecular Biology of the Cell*, 5th edn, Garland Publishing Inc, New York.
2. Brooker, RJ 2009, *Genetics: Analysis and Principles* 3rd edn, McGraw-Hill Companies Inc., New York, USA.
3. Cooper, GM & Hausman, RE 2016, *The Cell: A Molecular Approach*, 7th edn, ASM Press and Sinauer Associates Inc, USA.
4. Hardin, J, Bertoni, G & Kleinsmith, LJ 2012, *Becker's-World of Cell*, Pearson Benjamin Cummings, San Francisco, CA, USA
5. Hartl, DL & Jones, EW 1998, *Genetics: Principles and Analysis,* 4th edn, Jones and Bartlett Publishers, Boston, Massachusetts, USA.
6. Karp G & Vander GP 2005, *Cell and Molecular Biology: Concepts and Experiments,* 4th edn, John Wiley & Sons Inc, USA.
7. Lodish, H, Berk, A, Kaiser, CA, Kreiger, M, Bretscher, A, Ploegh, H, Amon, A & Martin, K 2016 *Molecular Cell Biology,* 8th edn, W.H. Freeman and Company, New York.
8. Pierce, BA 2016, *Genetics: A Conceptual Approach,* 6th edn, WH Freeman & Company, New York, USA.
9. Snustad, DP & Simmons, MJ 2012, *Principles of Genetics*, 6th edn, John Wiley & Sons Inc, Hoboken, NJ, USA.
10. Sumner, AT 2003, *Chromosome: Organization and Function*. Blackwell Publishing, Oxford, UK.
11. Tamarin, RH 2001, *Principles of Genetics*, 7th edn, McGraw-Hill Companies Inc., New York, USA

MSBO214: PLANT BIOCHEMISTRY AND METABOLISM	
UNIT - 1	**Bioenergetics**: Laws of thermodynamics, Concept of Entropy, Enthalpy and Free energy. **Enzymes:** Characteristics, mechanism of action, reversible and irreversible inhibition, Regulation of enzyme activity; Allosteric enzymes; Isoenzymes; Steady – state enzyme kinetics for single substrate, Michaelis - Menten Equation; Line weaver-Burk plot and determination of Km and Vmax, Effects of reversible inhibitors on apparent Km and Vmax
UNIT - 2	**Photosynthesis:** General concepts and historical background; Photosynthetic pigments, Organization of light – absorbing antenna systems; Photo-oxidation of water, mechanism of electron and proton transport, Photophosphorylation; Repair and Regulation of photosynthetic machinery. Carbon assimilation: Calvin cycle and its regulation, Photorespiration and its significance
UNIT - 3	**Carbon dioxide-Concentrating Mechanisms**: C_4 cycle, Characteristics of C_4 plants, C_4 Variants -NAD-ME, NADP-ME and PEP-CK type, C_3-C_4 intermediates; CAM pathway, Characteristics of CAM plants.

	Allocation of photo assimilates: Biosynthesis of starch and sucrose. **Starch degradation:** Hydrolytic and Phosphorolytic
UNIT - 4	**Respiration**: Glycolysis and bottom-up regulation, TCA cycle, Pentose phosphate pathway and glyoxylate cycle, Mitochondrial Electron transport and ATP synthesis, Alternative oxidase system and its significance. **Lipid metabolism**: Biosynthesis of saturated fatty acids–*de novo* biosynthesis and further modifications; Synthesis of membrane and storage lipids; β-oxidation of saturated fatty acids, unsaturated fatty acids and fatty acids with odd– number of carbons
UNIT - 5	**Assimilation of nutrients:** Mechanism of nitrate uptake, transport and assimilation; Ammonium assimilation; Symbiotic Nitrogen fixation: Plant-microbe interactions, nodule formation, nod factors; Nitrogenase enzyme complex and Energetics; Sulphur uptake, transport and assimilation

SUGGESTED READINGS

1. Buchanan, BB, Gruissem, W, & Jones, RL (eds.) 2015, *Biochemistry and Molecular Biology of Plants*, American Society of Plant Physiologists, Maryland, USA and Wiley Blackwell.
2. Govindjee (ed) 1982, *Photosynthesis: Energy Conversion in Plants and Bacteria*, Vol 1, Academic Press, New York
3. Heldt, HW & Piechulla, B 2011, *Plant Biochemistry,* 4th edn Elsevier.
4. Hopkins, WG & Huner, NPA 2009, *Introduction to Plant Physiology*, 4th edn, John Wiley and Sons, Inc., New York, USA.
5. Jain, VK 2017, *Fundamentals of Plant Physiology*, 19th edn, S. Chand and Co. Ltd., New Delhi.
6. Lea, PJ & Leegood, RC 1998, *Plant Biochemistry and Molecular Biology*, 2nd edn, Wiley – Blackwell.
7. Singhal, GS, Renger, G, Govindjee, Irrgang, KD & Sopory, SK 1999, *Concepts in Photobiology: Photosynthesis and Photomorphogenesis*, Kluwer Academic Publishers.
8. Taiz, L., Zeiger, E, Moller, IM & Murphy, A 2015, *Plant Physiology and Development*, 6th edn, Sinauer Associates, Inc., USA

MSBO222: Practical II (Covering MSBO 213 and 214)

SUGGESTED LABORATORY EXERCISES:

1. Extraction and Visualization of plant proteins using SDS-PAGE.
2. Plotting Maximum Absorption spectrum of chlorophyll a and b.
3. Quantitative estimation of chlorophyll a and b in C_3 and C_4 plants.
4. Extraction and quantification of lipids by soxhlet method.
5. Determination of the activity of peroxidase enzyme in the given plant samples.
6. Determination of the activity of polyphenol oxidase enzyme in the given plant samples.
7. Kinetic Studies- Effect of pH, Temperature, enzyme and substrate concentration on peroxidase activity.
8. Demonstration of fluorescence in isolated plant pigments.
9. Extraction and Visualization of Isoenzymes by Electrophoresis.
10. Study of Mendelian and non- Mendelian inheritance with the help of seed samples.
11. Smear preparations in *Allium cepa* or any other suitable material for mitotic studies.
12. Meiotic studies in plants by slide preparation and/ or photographs.
13. Determination of mitotic index.
14. Karyotyping and preparation of photoidiogram.

SPOTS:

1 Polytene Chromosomes
2 Lampbrush Chromosomes
3 Chromosomal Aberrations - Structural
4 Chromosomal Aberrations - Numerical
5 Chromosome organization
6 Transposable elements
7 Linkage maps
8 C-value paradox.
9 Robertsonian translocation
10 Structure of Chlorophyll a

11 RubisCO
12 Isoenzymes
13 Allosteric enzymes
14 Photosystems
15 ETC in chloroplast
16 ETC in mitochondria
17 Nitrogenase enzyme complex
r. CAM pathway

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - II
M.Sc. BOTANY
SEMESTER- II
(MSBO222: Covering Papers –MSBO213 and 214)

Time: 6 hours **Max. Marks: 70**

1. Perform the given Cytology and Genetics experiment 18
2. Perform the given Biochemistry experiment 18
3. Identify and comment upon the spots from 'a' to 'f' : 6x 4= 24

   a. _____
   b. _____
   c. _____
   d. _____
   e. _____
   f. _____

Viva-voce 10

MSC BOTANY III SEMESTER

Semester III							
Core course 9	MSBO311	Plant Development	4-0-0	4	30	70	100
Core course 10	MSBO312	Plant Reproductive Biology	4-0-0	4	30	70	100
Core course practical 5	MSBO321	Board I covering theory papers MSBO311 and MSBO312	0-0-16(8+8)	4	30	70	100
Core course 11	MSBO313	Fundamentals of Ecology	4-0-0	4	30	70	100
Core course practical 6	MSBO322	Board II covering theory paper MSBO313	0-0-8	2	15	35	50
Discipline Specific Special Paper/Elective 1	MSBO314A/B/C One paper from the list of elective papers		4-0-0	4	30	70	100
Discipline Specific Special Paper/Elective practical 1	MSBO323	Board III covering elective theory paper MSBO314 A/B/C	0-0-8	2	15	35	50
Skill course III	MSBOSC331 As per the list		2-0-4				
Total				24	180	420	600

MSBO311: PLANT DEVELOPMENT	
UNIT - 1	Introduction: Unique features of plant development, differences between animal and plant development. Seed germination and seedling development. Plant body architecture; primary and secondary thickening; Concept of stem cell in plants
UNIT - 2	Shoot development: Organization of the shoot apical meristem (SAM); cytological and molecular analysis of SAM; control of cell division and cell to cell communication; control of tissue differentiation, especially xylem and phloem; secretory ducts and laticifers; wood development in relation to environmental factors; cellulose factorie
UNIT - 3	Nodal and floral anatomy of angiosperms; Leaf growth and differentiation: Determination; phyllotaxy; control of leaf form; differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll
UNIT - 4	Root development: Organization of root apical meristem (RAM); cell fates and lineages; vascular tissue differentiation; lateral roots; root hairs-development and function; root-microbe interactions
UNIT - 5	Reproduction: Vegetative options and sexual reproduction; flower development; genetics of floral organ differentiation; homeotic mutants in *Arabidopsis* and *Antirrhinum*; mechanism of sex determination in plants

SUGGESTED READINGS

1. Beck, CB 2010, *An Introduction to Plant Structure and Development: Plant Anatomy of the Twenty-First Century*, Cambridge University Press, Cambridge.
2. Beeckman T 2010, Root development, Willey Blackwell, UK.
3. Bewley, JD & Black, M 1994, *Seeds: Physiology of Development and Germination*, 2nd ed. Plenum Press, New York.
4. Burgess, J 1985, *An Introduction to Plant Cell Development*, Cambridge University Press, Cambridge.
5. Cutler, DF, Botha T and Stevenson DW 2007, *Plant Anatomy: An applied approach*, Blackwell.
6. Esau, K 2006, *Anatomy of Seed Plants*, 3rd edn, John Wiley & Sons, New York.
7. Fahn, A 1982, *Plant Anatomy*, 3rd edn, Pergamon Press, Oxford.
8. Galun, E 2007, *Plant Patterning: Structural and Molecular Genetic Aspects*, World scientific publisher, Singapore.
9. Gregory, P 2006, *Plant roots: Growth, Activity and interaction with Soils*, Blackwell.
10. Howell, SH 1998, *Molecular Genetics of Plant Development*, Cambridge University Press, Cambridge.
11. Lyndon, R 1990, *Plant Development: The Cellular Basis*, Springer.

12. Murphy, TM & Thompson, WF 1988, *Molecular Plant Development*, Prentice Hall, New Jersey.
13. Raghavan, V 1999, *Developmental Biology of Flowering Plants,* Springer-Verlag, New York.
14. Romberger JA, Hill JF & Hejnowicz Z 2005, *Plant Structure: Function and Development*, Springer Verlag.
15. Steeves, TA & Sussex IM 1996, *Patterns in Plant Development,* 2nd edn, Cambridge University Press, Cambridge.
16. Timmermans, M 2010, *Plant Development*, Vol. 91, 1st edn, Elsevier.
17. Waisel, Y, Eshel, A & Kafkaki, U (eds.) 1997, *Plant Roots*: *The Hidden Hall,* 2nd edn, Marcel Dekker, New York

MSBO312: PLANT REPRODUCTIVE BIOLOGY	
UNIT - 1	Floral characteristics, Microsporangium & Male gametophyte: Structure of anthers; microsporogenesis, role of tapetum; pollen development and gene expression; sperm dimorphism and hybrid seed production; pollen germination, pollen tube growth and guidance; pollen storage; pollen allergy; pollen embryos
UNIT - 2	Megasporangium & Female gametophyte: Ovule-structure, types and development; megasporogenesis; organization of the embryo sac, structure of the embryo sac cells. Functional role of accessory cells in embryo sac
UNIT - 3	Pollination mechanisms and pollination vectors; breeding systems; commercial considerations; structure of the pistil; pollen- stigma interactions, sporophytic and gametophytic self- incompatibility (cytological, biochemical and molecular aspects); double fertilization and triple fusion; *in vitro* fertilization, embryo culture, molecular mechanism of *in vitro* differentiation
UNIT - 4	Seed development and fruit growth: Endosperm development during early maturation and desiccation stages; embryogenesis, ultrastructure and nuclear cytology; cell lineages during late embryo development; storage proteins of endosperm and embryo
UNIT - 5	Polyembryony; apomixis and apospory; dynamics of fruit growth; biochemistry and molecular biology of fruit maturation. Dormancy: Importance and types (seed and bud); Metabolic changes associated with senescence and its regulation; influence of hormones and environmental factors on senescence, PCD/apoptosis in plants

SUGGESTED READINGS

1. Bhojwani, SS & Bhatnagar, SP 2009, The *Embryology of Angiosperms*, Vikas Publishing House, New Delhi.
2. Burgess, J 1985, *An Introduction to Plant Cell Development,* Cambridge University Press, Cambridge.
3. Galun, E 2007, *Plant Patterning: Structural and Molecular Genetic Aspects*, World scientific publisher, Singapore.
4. Larkins BA and Vasil IK 1997, *Cellular and Molecular Biology of Plant seed development*, Springer.
5. Olsen, OA 2007, *Endosperm, Developmental and Molecular Biology*, Springer-Verlag, Berlin.
6. Raghavan, V 1999, *Developmental Biology of Flowering Plants,* Springer-Verlag, New York.
7. Raghavan, V 2010, *Molecular Embryology of Flowering Plants,* Cambridge University Press, Cambridge.
8. Rose RJ 2016, *Molecular Cell Biology of the Growth and Differentiation of Plant Cells*, CRC press, Taylor and Francis Group, New York.
9. Evert, RF & Eichhorn, SE 2012, *Raven's Biology of Plants*, 8th edn, WH Freeman & Co., New York.
10. Shivanna, KR & Johri, BM 1986, *The Angiosperm Pollen: Structure and Function*, Wiley Eastern Ltd., New York.
11. Shivanna, KR & Rangaswamy, NS 1992, *Pollen Biology: A Laboratory Manual*, Springer-Verlag, Berlin.
12. Shivanna, KR & Sawhney, VK (eds) 1997, *Pollen Biotechnology for Crop Production and Improvement*, Cambridge University Press, Cambridge

MSBO321: PRACTICAL I (COVERING MSBO 311 & 312)

SUGGESTED LABORATORY EXERCISES:

Plant Development:

1. Dissection of shoot apical meristem (SAM) to observe different zones in shoot apex of *Hydrilla*.
2. Study of root morphology and root apical meristem (RAM) in *Eichhornia*.

3. Study of anatomy of stem and leaf to observe the growth due to environmental conditions (*Bignonia* & *Salvadora* stem & *Nerium* leaf).
4. Study of anatomical structure of C_3 & C_4 plant leaves (*Triticum* & *Zea mays*).
5. Study of origin of lateral roots.

Plant reproductive biology:

1 Study of pollen germination under different conditions of solution.
2 Study of Trichomes (*Hibiscus rosa- sinensis /Althea rosea*).
3 Testing the viability of given seed sample.
4 Determination of pollen stainability & percentage pollen stainability (to test pollen viability).
5 Study of various types of placentation (T.S. of ovary of given flower).
6 Dissection and mounting of translator.
7 Study of T.S. of mature anther.

SPOTS:

1. T.S. Stem (*Bignonia* & *Salvadora*)
2. T.S. Leaves (*Nerium*, *Triticum* & *Zea mays*)
3. Kranz anatomy
4. Types of Stomata
5. Mycorrhiza
6. Root Nodules
7. Sex determination in plants
8. T.S of mature anther
9. Types of placentation (Axile, Parietal, Marginal, Free central & Basal)
10. Translator
11. Ruminate endosperm
12. Types of ovules
13. Fruit ripening
14. Senescence
15. Apomixis

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - I
M.Sc. BOTANY
SEMESTER- III
(MSBO321: Covering Papers – MSBO311& 312)

Time: 6 hours **Max. Marks: 70**

1. Perform the given Plant development exercise. 18

2. Perform the given Plant reproductive biology exercise. 18

3. Identify and Comment upon the spot from 'a' to 'f': 6x 4= 24

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

4. Viva Voce 10

MSBO313: FUNDAMENTALS OF ECOLOGY	
UNIT - 1	Climate & Vegetation: Introduction to concept and development of ecology, experimentations & models. Atmosphere, hydrosphere and biosphere; microclimate
UNIT - 2	Vegetation Organization, Soil biology and Fertility: Life zones; Major biomes; Adaptation, Tolerance and Homeostasis; Vegetation types of the world. Major soil types of the world; Biological Management of soil fertility; litter fall and decomposition, litter quality and climatic factors affecting C, N, P and S mineralization, nutrient synchronization
UNIT - 3	Population Ecology: Concept of population, regulation. Competition and Life history patterns. r- selection and k-selection. Population genetics
UNIT - 4	Community Ecology: Concept of community; Analytical and Synthetic characters. Community coefficients. Inter-specific associations; Basic concepts of Ordination, Concept of habitat, Coexistence and Niche
UNIT - 5	Ecosystem Structure and Functions: Primary productivity, measurements, global patterns and controlling factors. Succession: concept, types, mechanism and models, changes in ecosystem properties during succession. Energy attenuation in atmosphere and vegetation. Energy flow models and efficiency. Biogeochemical cycles of C, N, P and S

SUGGESTED READINGS

1. Barbour, MG, Burk, JH & Pitts, WD 1998, *Terrestrial Plant Ecology*, Benjamin /Cummings Publication Company, California.
2. Begon, M, Harper, JL &Townsend, CR 2005, *Ecology*, 4th edn, Blackwell Science, Cambridge, U.S.A.
3. Chapman, JL, & Reiss MJ 2005, *Ecology: Principles and Applications*, Cambridge University Press.
4. Kormondy, EJ 2017, *Concepts of Ecology*, 4th edn, Pearson Education.
5. Kumar, P 2017, *Fundamentals of Ecology & Environment*, 2nd edn, Pathfinder Publications.
6. Ludwig, J &Reynolds, JF 1988, *Statistical Ecology*, John Wiley & Sons New York.
7. Odum, EP 2004, *Fundamentals of Ecology*, Saunders, Philadelphia.
8. Odum, EP 1983, *Basic Ecology*, Saunders, Philadelphia.
9. Rana, SVS 2005, *Essentials of Ecology and Environmental Science,* Prentice Hall of India.
10. Singh, JS, Singh, SP & Gupta, SR 2015, *Ecology, Environmental Science and Conservation*, S. Chand & Co. Pvt. Ltd.
11. Smith, RL & Smith, TM 2001, *Ecology & Field Biology*, 6th edn, Benjamin /Cummings Publication Company, California.
12. Smith, TM & Smith, RL 2014 *Elements of Ecology*, 9th edn, Pearson Education

MSBO322: PRACTICAL I1 (COVERING MSBO 313)

ECOLOGY:

SUGGESTED LABORATORY EXERCISES:

1. Determination of minimum size and number of quadrats required for reliable estimate of biomass in a natural field.
2. Comparison of protected and gochar land vegetation using similarity indices.
3. Analysis of plant communities using Bray-Curtis/Twin span ordination method.
4. Determination of diversity indices (concentration of dominance, Shannon-Wiener, species richness, equitability and diversity) for protected and gochar land vegetation.
5. Estimation of IVI of the species in protected and gochar land vegetation
6. Determination of productivity in terrestrial (Harvest method) and aquatic (Light and dark bottle method) systems.
7. Determination of organic carbon content in protected and gochar land soils.
8. Calculation of mean, variance, standard deviation, standard error, coefficient of variation and to use t-test for comparing two means related to ecological data.
9. Finding out the relationship between two ecological variables using correlation and regression analysis.
10. Finding the association between important species using chi- square test.
11. Estimation of rate of soil respiration by alkali absorption method

JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION -II
M.Sc. BOTANY
SEMESTER- III
(MSBO322: Covering Paper –MSBO313)

Time: 4 hours **Max. Marks: 35**

1. Perform the given major exercise	20
2. Perform the given minor exercise	10
3. Viva Voce	05

MSBO314: MSBO314: SPECIAL/ ELECTIVE PAPER I MSBO314A: FUNDAMENTALS OF PLANT TISSUE CULTURE	
UNIT - 1	Plant Tissue Culture: General introduction; Concept of totipotency, Historical Background; Concept of asepsis and methods of sterilization, Laboratory planning and design, Basic tools and techniques of *in vitro* culture, Explant selection and surface sterilization, Composition and preparation of tissue culture media
UNIT - 2	Micropropagation: Pathways (Axillary bud proliferation, adventitious shoot bud differentiation, callus organogenesis and somatic embryogenesis), meristem tip culture, Applications and limitations.
UNIT - 3	**Somaclonal Variations:** Isolation of somaclonal variants-with and without *in vitro* selection, molecular basis of somaclonal variations, Applications and limitations. Haploid production through androgenesis and gynogenesis; *In vitro* fertilization and ovary culture, Production of triploids through endosperm culture - advantages and limitations
UNIT - 4	Protoplast Culture: Isolation, purification and regeneration of protoplast; Testing of viability of isolated protoplast; Somatic hybridization and methods of protoplast fusion; Selection of hybrids, Practical applications of somatic hybridization (hybrids/cybrids)
UNIT - 5	Slow growth and cryopreservation technique – importance of cryopreservation, pretreatment, freezing methods, cryoprotectants; Application of plant tissue culture in plant pathology; Production of virus - free plants-thermotherapy, chemotherapy, virus indexing; Culture of obligate parasites

SUGGESTED READINGS

1. Barbara, MR 2007, *Plant Cryopreservation: A Practical Guide*. Springer Verlag, Berlin, Heidelberg.
2. Bhojwani, SS & Razdan, MK 1996, *Plant Tissue Culture: Theory and Practice (revised edition)*, Elsevier Science, Netherlands.
3. Davey, MR & Anthony, P 2010, *Plant Cell Culture: Essential Methods*, Wiley-Blackwell Ltd.
4. De, KK 2013, *An Introduction to Plant Tissue Culture*, New Central Book Agency, Kolkata.
5. Endress, R 2014, *Plant Cell Biotechnology*, Springer India Pvt. Ltd.
6. Pauline, MD 1997, *Hairy Roots: Culture and Applications*, Harwood Academic Publishers.
7. Purohit, SD 2013, *Introduction to Plant Cell, Tissue and Organ Culture*, PHI Learning Private Limited, Delhi.
8. Razdan, MK 2012, *An Introduction to Plant Tissue Culture*, Oxford & IBH Publ. Ltd., New Delhi.
9. Slater, A, Scott, N & Fowler, M 2003, *Plant Biotechnology: The Genetic Manipulation of Plants*, Oxford University Press, UK.
10. Thorpe, TA & Edward CY (eds) 2011, *Plant Embryo Culture: Methods and Protocols*, Springer Verlag, Berlin, Heidelberg.
11. Vasil, IK & Thorpe, TA (eds) 2005, *Plant Cell and Tissue Culture,* Springer India Pvt. Limited, New Delhi

MSBO323A: PRACTICAL II1 (COVERING MSBO 314A)

SUGGESTED LABORATORY EXERCISES:

1. Preparation of the stock solutions for MS medium.
2. Preparation of MS medium from stock solutions.
3. Isolation, preparation, surface sterilization and inoculation of different explants.
4. Effect of auxins and cytokinins on callus growth and organogenesis.
5. Effect of auxins and cytokinins on shoot multiplication.
6. Experiments on multiple shoot induction from mature nodal shoot segments of economically important plant species.
7. Differentiation of tissues through organogenesis/ somatic embryogenesis.

Spots:

1 Multiple shoot
2 Callus culture
3 Somatic embryogenesis
4 Protoplast
5 Synthetic seed
6 Somatic hybridization
7 Cryopreservation
1. *in vitro* rooting

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION -III
M.Sc. BOTANY
SEMESTER- III
(MSBO323A: Covering Paper –MSBO314A)

Time: 4 hours **Max. Marks: 35**

1 Perform the plant tissue culture experiment allotted by lots.

a. Preparation of nutrient medium & reporting the constituents in mg/L 08

b. Pre-treatment, surface sterilization and inoculation of explant. 10

2. Identify and Comment upon the spot from 'a' to 'c': 3 x 4= 12

a. _____

b. _____

c. _____

3. Viva Voce 5

MSBO314: SPECIAL/ ELECTIVE PAPER I MSBO314B: INDUSTRIAL MICROBIOLOGY I	
UNIT - 1	Definition, scope and historical development of Industrial microbiology. Fermentors: (Bioreactor) construction, Type, operation and basic functions
UNIT - 2	Development of Industrial fermentation process: Screening–Primary and Secondary. Fermentation Products, Stock Cultures, Fermentation media, Biological waste treatment
UNIT - 3	Dairy Microbiology: Milk (composition and constituents), Processing and Pathogens, Pasteurization and grading of milk. Dairy product: Cheese, Yogurt, Cream and Buttermilk
UNIT - 4	Food Microbiology: Fermented vegetables: Sauerkraut and Kumis. Food borne illness, microbial spoilage and food preservation
UNIT - 5	Industrial production: Alcohol, Beer, Wine, Vinegar, Citric acid, Vitamins, enzymes and steroids

SUGGESTED READINGS

1. Cappuccino, J and Sherman, N 2014 *Microbiology*: *A Laboratory manual* 9th edn, Pearson publication.
2. Casida, LE. JR 2019, *Industrial Microbiology*, 2nd edn, New Age International Publishers.
3. Maheshwari, DK, 2010, *Practical Microbiology*, S. Chand and Co. Ltd.
4. Dubey, RC & Maheshwari, DK 2013, *A Text Book of Microbiology*, S. Chand and Co. Ltd.
5. Pelczer, MJ Jr., Chan, ECS & Krieg, NR 2010 *Microbiology: An application Based Approach* Tata McGraw Hill.
6. Powar, CB & Daginawala, HF 2008, *General Microbiology*. Himalaya Publishing House.
7. Reed, G (Ed.) 2004, *Prescott & Dunn's Industrial Microbiology,* 4th edn, CBS Publishers & Distributors, New Delhi.
8. Staubury, PF & Whitaker 1984, *Principles of Fermentation Technology*, PergamonPress.
9. Tortora, GJ, Funke, BR & Case, CL 2008 *Prescott, Harley & Klein's Microbiology,*7th edn, Tata McGraw Hill.

MSBO323B: PRACTICAL II1 (COVERING MSBO 314B)

SUGGESTED LABORATORY EXERCISES:

1. Preparation of culture media.
2. Culturing of microorganisms and cultural characteristics of bacteria.
3. Study of some important industrially important genera of fungi.
4. Enzymatic test of Milk by Methyl Blue Reductase Test.
5. Metabolism of microorganisms–carbohydrate fermentation, hydrolysis of starch, urea and gelatin.
6. Microbiological analysis of food product.
7. Presumptive test of coliform group of bacteria.

SPOTS:

a. Upstream processing
b. Canning and Packaging
c. GRAS
d. Probiotics
e. Sauerkraut
f. Bioreactor
g. Cheese Production
h. Louis Pasteur.

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION -III
M.Sc. BOTANY
SEMESTER- III
(MSBO323B: Covering Paper –MSBO314B)

Time: 4 hours **Max. Marks: 35**

1. Perform the given exercise. 18
2. Identify and Comment upon the spot from 'a' to 'c': 3 x4= 12
   a. _____
   b. _____
   c. _____
3. Viva Voce 5

MSBO314: SPECIAL/ ELECTIVE PAPER I MSBO314C: BIOSTATISTICS AND BIOINFORMATICS	
UNIT - 1	Introduction to statistics, designing and methodology of an experiment, sample and sampling techniques, collection and representation of data (diagrammatic and graphical). Measures of Central tendency: Mean-Arithmetic, Geometric and Harmonic Mean; Median, Mode
UNIT - 2	Measures of Dispersion: Range-characteristics, coefficient, merits and demerits, Variance and Standard Deviation-calculation, merits and demerits, standard error, coefficient of variation, Measures of Skewness and Kurtosis, Probability distributions (Normal, Binomial and Poisson), Confidence Limits.
UNIT - 3	Idea of two types of errors and level of significance, Paired Mean Comparison (t-test; Chi-square). Multiple Mean Comparison (DMRT), Analysis of variance- RBD and its application in resource evaluation. Correlation-Types, Methods, Deduction of auto correlation, Correlation Coefficient; Simple Regression analysis and its coefficient, Computer application in data analysis (MS-Excel and SPSS
UNIT - 4	Introduction to computer: component, generation and types. Introduction to Internet: history, IP address, URL, types of networking and applications. Introduction to bioinformatics: definition, history and principle. Database concept, biological databases (GENBANK, DDBJ, EMBL, SWISS-PROT, PROSITE), types of nucleotide sequences, types of databases (primary, secondary, composite databases), information retrieval from databases
UNIT - 5	Sequence analysis: homology search, sequence alignment: types and methods of alignment, alignment score, multiple sequence alignment and Clustal W. Phylogenetic analysis: Dendrogram, Cladogram, Extraction of a phylogenetic data set, Tree building methods (UPGMA, NJ, MP, ML), Tree evaluation (Boot strap and Jack knifing) and use of various software (TREE VIEW, PHYLIP) in phylogeny and genetic diversity analysis

SUGGESTED READINGS

1. Baxevanis, AD & Ouellette, BFF 2004, *Bioinformatics – A Practical Guide to the Analysis of Genes and Proteins*, 2nd edn, Wiley Publishers.
2. Bergeron, B 2002, *Bioinformatics Computing*, Pearson Education, US.
3. Khan, IF & Khanum, A 2004, *Fundamentals of Biostatistics*, Ukaaz Publications, Hyderabad.
4. Lesk, AM 2010, *Introduction to Bioinformatics,* Oxford University Press, USA.
5. Medhi, J, *Statistical Methods*, Willey Eastern Limited.
6. Mount, DA 2004, *Bioinformatics: Sequence and Genome Analysis*, 2nd edn, CSH Press, UK.
7. Orengo, CA & Thornton, JM 2009, *Bioinformatics: Genes, Proteins and Computers,* Taylor and Francis, US.
8. Prasad, S 2013, *Elements of Biostatistics*, 3rd edn, Rastogi Publications, Meerut.
9. Rashidi, H & Buchler, LK. 2005, *Bioinformatics Basics: Application in Biological Science and Medicine*, CRC Press.
10. Rastogi, VB, 2009, *Fundamentals of Biostatistics*, 2nd edn, Ane Books Pvt. Ltd, New Delhi.
11. Sharma, V, Munjal, A & Shankar, A 2008, *A Text Book of Bioinformatics*, Rastogi Publications, Meerut.
12. Simpson, RJ (ed.) 2008, *Proteins and Proteomics: A Lab Manual,* Cold Spring Harbor, US

MSBO323C: PRACTICAL II1 (COVERING MSBO 314C)

SUGGESTED LABORATORY EXERCISES:

1 Retrieval of required sequence from search engine.
2 Homology search for given unknown sequence using BLAST.
3 Similarity search using FASTA.
4 Primer designing for given nucleotide sequences.
5 Multiple sequence alignment using suitable software.
6 Searching Exon coding regions, Intron and SNPs in the given nucleotide sequence.
7 Preparation of phylogenetic tree
8 Measurement of Central Tendency-Mean, Mode and Median.
9 Measurement of Variance and Standard Deviation
10 Chi Square Test
11 Analysis of variance (RBD)
12 Analysis of Correlation and Regression
13 Phylogenetic study of biological samples through PHYL

SPOTS:

1 BLAST
2 NCBI
3 EMBL
4 FASTA
5 MSA (Multiple sequence alignment)
6 Phylogenetic tree (cladogram, dendrogram)
7 PHYLIP
8 Clustal W
9 ANOVA
10 t-test
11 Standard deviation
12 Standard error

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PRACTICAL EXAMINATION -III
M.Sc. BOTANY
SEMESTER- III
(MSBO323C: Covering Paper –MSBO314C)

Time: 4 hours **Max. Marks: 35**

1. Perform the following:

a. Bioinformatics Exercise 8

b. Biostatistics Exercise 8

2. Identify and Comment upon the spot from 'a' to 'c': 3 x 4= 12

a. _____

b. _____

c. _____

3. Viva Voce 5

Semester IV							
Core course 12	MSBO411	Biodiversity and Resource Utilization	4-0-0	4	30	70	100
Core course 13	MSBO412	Genetic Engineering	4-0-0	4	30	70	100
Core course practical 7	MSBO421	Board I covering theory papers MSBO411 and MSBO412	0-0-16(8+8)	4	30	70	100
Core course 14	MSBO413	Applied Ecology	4-0-0	4	30	70	100
Core course practical 8	MSBO422	Board II covering theory paper MSBO413	0-0-8	2	15	35	50
Discipline Specific Special Paper/Elective 2	MSBO414A/B/C One paper from the list of Elective papers		4-0-0	4	30	70	100
Discipline Specific Special Paper/Elective practical 2	MSBO423	Board III covering elective theory paper MSBO414 A/B/C	0-0-8	2	15	35	50
Skill course IV	MSBOSC431 As per the list		2-0-4				
Total				24	180	420	600

MSBO411: BIODIVERSITY AND RESOURCE UTILIZATION	
UNIT - 1	**Origin of Agriculture and Green Revolution**: Primary and secondary centers of diversity of cultivated plants. History of agriculture revolution, Green revolution and new challenges of food security
UNIT - 2	**Desert Plant Resources:** Important fire-wood and timber yielding plants with special reference to Rajasthan desert; Non-wood forest products (NWFPs) and their uses; Bamboos, gums, resins, dyes and tannins from natural plant resources and their economic utility
UNIT - 3	**Food, Fiber, Medicinal and Aromatic Plants:** Origin, botany, cultivation and utilization of food, forage, fodder and fiber crops of Rajasthan. Origin, botany, cultivation, chemical constituents and uses of medicinal, aromatic, and vegetable oil-yielding crops of Rajasthan
UNIT - 4	**Biostatistics:** Central tendency, dispersion, standard error, coefficient of variation; Probability distributions (normal, binomial of Poisson). Test of statistical significance (t-test; Chi-square): Analysis of variance- RBD and its application in plant breeding and genetics; Correlation, Simple Regression Analysis
UNIT - 5	**Techniques for *In-situ and Ex-situ* Conservations and Institutes:** Strategies for – *in-situ* conservation: protected areas in India – biosphere reserves, national parks, sanctuaries, wetlands, mangroves and coral reefs for conservation of wild biodiversity. Strategies for– *ex-situ* conservation: botanical gardens, field gene banks, seed banks, *in vitro* repositories and cryobanks. General account of the activities of Botanical Survey of India (BSI), National Bureau of Plant Genetic Resources (NBPGR), AYUSH (Ministry of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy) and Indian Spice Board

SUGGESTED READINGS

1. Chandel, KPS, Shukla, G. & Sharma, N 1996, *Biodiversity of Medicinal and Aromatic Plants in India: Conservatio and Utilization.* National Bureau of Plant Genetic Resources, New Delhi.
2. Council of Scientific & Industrial Research (1948-2005), *The Wealth of India. A Dictionary of Indian Raw Materia and Industrial Products*, New Delhi. Raw Materials I-XII, Revised Vol. I-III (1985-1992) Supplement (2000).
3. Guerrant, EO, Havens, K. and Maunder, M 2004, *Ex situ Plant Conservation,* Island Press.
4. Hamilton, A 2013, *Plant Conservation: An Ecosystem Approach. Routedge*.
5. Henry, RJ 2010, *Plant Resources for Food, Fuel and Conservation*. Earthscan.
6. Kochar, SL 2009, *Economic Botany In the Tropics,*3rd edn, Mac-Millan India Ltd., New Delhi.
7. Sahni, KC 2000, *The Book of Indian Trees*, 2nd edn. Oxford University Press, Mumbai.

8. Sharma, OP 1996, *Hill's Economic Botany* (Late Dr. A.F. Hill, adapted by O.P. Sharma). Tata McGraw Hill Co. Ltd New Delhi.
9. Sofo, A 2011, *Biodiversity* (Ed), InTech Publisher, DOI: 10.5772/1836
10. Swaminathan, MS and Kocchar, SL (eds) 1989, *Plants and Society*. Macmillan Publication Ltd., London.
11. Thakur, RS, Puri, HS and Husain, A 1989*, Major Medicinal Plants of India*. Central Institute of Medicinal ar Aromatic Plants, CSIR, Lucknow.
12. Thomas, P 2000, *Trees: Their National History*. Cambridge University Press, Cambridge, U.K.
13. Rashidi, H & Buchler, LK. 2005, *Bioinformatics Basics: Application in Biological Science and Medicine*, CRC Press.
14. Rastogi, VB, 2009, *Fundamentals of Biostatistics*, 2nd edn, Ane Books Pvt. Ltd, New Delhi.
15. Sharma, V, Munjal, A & Shankar, A 2008, *A Text Book of Bioinformatics*, Rastogi Publications, Meerut.
16. Simpson, RJ (ed.) 2008, *Proteins and Proteomics: A Lab Manual,* Cold Spring Harbor, US

MSBO412: GENETIC ENGINEERING	
UNIT - 1	Tools and techniques: Restriction enzyme, DNA ligase, polynucleotide kinase, alkaline phosphatase, DNA polymerase, terminal transferase. RNAse and DNAse; Reverse transcriptase. Vector: Characteristics of plasmids (pBR322 and pUC19), phages, phagemids, cosmids, viruses, YAC and BAC as vector
UNIT - 2	DNA cloning strategies - steps involved. Cohesive and blunt end ligation: Linkers, Adaptors, Homopolymeric tailing. Preparation and screening of genomic and cDNA libraries. Reporter and Marker genes. Screening of recombinants- insertion inactivation, blue-white screening, Immunological screening and Colony Hybridization
UNIT - 3	Genetic engineering of plants: Aims, strategies for development of transgenics; Methods of gene transfer: Physical, Chemical and Biological methods *Agrobacterium* - the natural genetic engineer; Mechanism of tumour formation by *A. tumefaciens*; Vectors engineered from Ti Plasmid; Root formation using *Agrobacterium rhizogenes*
UNIT - 4	Gene expression and function: Expression vectors- pMal, GST, pET-based vectors. Study of- transcript of cloned gene, regulation of gene expression, translation product of cloned gene and protein-protein interactions
UNIT - 5	Application of plant transformation for productivity and performance: herbicide resistance, insect resistance with special reference to Bt genes, virus resistance, Terminator gene technology and quality improvement; Transplastomics. Biosafety and Bioethics; Containment facilities, Biotechnology risk assessment, Patenting life forms

SUGGESTED READINGS

1. Brown, TA 2010, *Gene Cloning and DNA Analysis: An Introduction*, 6th edn, Wiley-Blackwell publishing, UK.
2. Chawla, HS 2009 *Introduction to Plant Biotechnology*, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Dale, JW, Schantz, M & Plant, N 2011, *From Genes to Genomes: Concepts and Applications of DNA Technology,* 3rd edn, Wiley-Blackwell publishing, UK
4. Gibson ,G & Muse, SV 2004 , *A Primer of Genome Science,*2nd edn*,* Sinauer Associates, USA
5. Glick, BR & Patten, CL 2017, *Molecular Biotechnology: Principles & Applications of Recombinant DNA,* 5th edn, Taylor & Francis.
6. Greene, JJ & Rao VS (eds) 1998, *Recombinant DNA–Principles and Methodologies*. Marcel Dekker, New York.
7. Gupta, PK 2012, *Biotechnology and Genomics*, 1st edn, Rastogi publications, Meerut.
8. Hansen, E & Harper, G (eds) 1997, *Differentially Expressed Gene in Plants*, Taylor and Francis Ltd. London.
9. Joshi, P 2007, *Genetic Engineering and Its Applications*, 2nd edn, Agrobios- India, Jodhpur.
10. Mitra, S 2000, *Genetic Engineering- Principles and Practice*. Macmillan India Limited, New Delhi.
11. Primrose, SB & Twyman RM 2015, *Principles of Gene Manipulation and Genomics*, Blackwell Science, Oxford,
12. Sambrook, J, & Russell, DW 2001, *Molecular Cloning: A Laboratory Manual*, 3rd edn, Cold Spring Harbor Laboratory Press, New York.
13. Satyanarayana, U 2005*, Biotechnology*, 1st edn, Books and Allied Publishers, Kolkata.
14. Singh, BD 2012, *Biotechnology: Expanding Horizons,* 4th edn, Kalyani Publishers, Ludhiana.
15. Sharma, V, Munjal, A & Shankar, A 2008, *A Text Book of Bioinformatics*, Rastogi Publications, Meerut.
16. Simpson, RJ (ed.) 2008, *Proteins and Proteomics: A Lab Manual,* Cold Spring Harbor, US

MSBO421: Practical I (Covering MSBO 411 and 412)

SUGGESTED LABORATORY EXERCISES:

Biodiversity and Resource Utilization:

1. Quantification of starch in food crops (wheat, rice, maize, potato & sweet potato)
2. Quantification of starch in forage/fodder crops (sorghum, bajra, gram & guar bean)
3. Quantification of acid detergent fibre (ADF) content in fibre crops (cotton, jute, coir & silk Cotton)
4. Morpho-anatomical features of plant fibres (cotton, jute, coir & silk cotton)
5. Quantification of saponification value in vegetable oils (mustard, groundnut, soybean, coconut, sunflower & castor)
6. Quantification of acid value in vegetable oils (mustard, groundnut, soybean, coconut, sunflower & castor)
7. Quantification of iodine value in vegetable oils (mustard, groundnut, soybean, coconut, sunflower& castor)
8. Micro-chemical test for fats & oils
9. Micro-chemical test for gums (guar & kumbhatia)
10. Micro-chemical test for tannins (*Acacia, Terminalia, Cassia* & tea leaves)
11. Micro-chemical test for dyes (*Butea* & henna powder)
12. Impurity test for natural products (honey, saffron, katha & mustard oil).
13. Educational Visit*

*The students shall prepare a brief illustrated narrative of the Educational Visit.

After evaluation, the marks would be added to the CIA of the practical examination.

Spots:

a. **Food crops:** wheat, maize potato, chickpea, sugarcane & sweet potato
b. **Forage/Fodder crops:** sorghum, bajra, gram & guar bean
c. **Fiber crops:** cotton, jute, coir & silk cotton
d. **Medicinal plants:** *Papaver, Catharanthus, Adhatoda, Allium, Rauwolfia, Withania, Phyllanthus* & *Aloe*
e. **Aromatic plants:** *Mentha, Rosa, Jasminum, Cymbopogon* & *Pandanus*

Genetic Engineering:

1. Isolation and visualization of plasmid DNA from bacteria (minipreparation of plasmid).
2. Performing restriction and digestion of lambda phage DNA (kit based).
3. Performing DNA ligation of restricted lambda DNA (kit based).
4. Preparation of competent cells of bacteria (kit based).
5. Transformation of *E. coli* cells with standard plasmids (kit based).
6. Calculation of transformation efficiency.

Spots:

1. Southern Hybridization
2. Western Hybridization
3. Biochip
4. Biosensors
5. Bacterial Artificial Chromosome (BAC)
6. Yeast Artificial Chromosome (YAC)
7. Ti Plasmid
8. Restriction enzymes
9. Reporter and marker genes
10. Expression Vector

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION -I
M.Sc. BOTANY
SEMESTER- IV
(MSBO421: Covering Papers –MSBO411&412)

Time: 6 hours **Max. Marks: 70**

1. Perform the given Biodiversity & resource utilization exercise. 18
2. Perform the given Genetic Engineering exercise. 18
3. Identify and Comment upon the spot from 'a' to 'f': 6x 4= 24
    a. _____
    b. _____
    c. _____
    d. _____
    e. _____
    f. _____
4. Viva Voce 10

MSBO413: APPLIED ECOLOGY	
UNIT - 1	Ecosystem Stability &Management: Ecosystem services, Concept of ecosystem resistance and resilience. Natural and anthropogenic ecological perturbation and their impact on plants and ecosystem. Ecosystem restoration; Ecology of plant invasion
UNIT - 2	Biodiversity and Ecological Management: Biodiversity concept and levels, biodiversity role in ecosystem function and stability. Speciation and extinction; IUCN categories of threat; distribution and global patterns. Convention on Biological Diversity (CBD), Terrestrial biodiversity hot spots
UNIT - 3	Sustainable development: Concept of sustainable development; Capitals and currencies, problems and solutions. Concept of sustainable consumption, sustainability indicators; Food security and human population growth
UNIT - 4	Environmental pollution and industrial ecology: Air, water and land pollution - kinds, sources, effects on plants and ecosystem. Bioremediation, Environment impact assessment, Concept of industrial ecology
UNIT - 5	Climatic changes and consequences: The greenhouse effect, greenhouse gases; CO_2, CH_4, N_2O, CFCs - sources, trends and role; Global warming; Ozone layer and hole; CO_2 fertilization, sea level rise and radiation; Concept of carbon credit

SUGGESTED READINGS

1. Barbour, MG, Burk, JH & Pitts, WD 1998, *Terrestrial Plant Ecology*, Benjamin /Cummings Publication Company, California.
2. Begon, M, Harper, JL &Townsend, CR 2005, *Ecology*, 4th edn, Blackwell Science, Cambridge, U.S.A.
3. Cadish, G & Giller, KE 1997, *Driven by Nature: Plant Litter Quality and Decomposition*, CAB International Wallingford, U.K.
4. Chapman, B & Bilharz, S 1997, *Sustainability Indicators*, John Wiley &Sons, New York.
5. Chapman, JL, & Reiss MJ 2005, *Ecology: Principles and Applications*, Cambridge University Press.
6. Hill, MK 1997, *Understanding Environmental Pollution*, Cambridge University Press.
7. Koromondy, EJ 2017, *Concepts of Ecology*, 4th edn, Pearson Education.
8. Ludwig, J & Reynolds, JF 1988, *Statistical Ecology*, John Wiley & Sons New York.
9. Odum, EP 2004, *Fundamentals of Ecology,* Saunders, Philadelphia.
10. Odum, EP 1983, *Basic Ecology,* Saunders, Philadelphia.
11. Rana, SVS 2005, *Essentials of Ecology and Environmental Science,* Prentice Hall of India.
12. Singh, JS, Singh, SP & Gupta, SR 2015, *Ecology, Environmental Science and Conservation*, S. Chand & Co. Pvt. Ltd.
13. Smith, RL & Smith, TM 2001, *Ecology & Field Biology*, 6th edn, Benjamin /Cummings Publication Company, California.
14. Smith, TM & Smith, RL 2014 *Elements of Ecology*, 8th edn, Pearson Education

MSBO422: PRACTICAL II (COVERING MSBO 413)

SUGGESTED LABORATORY EXERCISES:

1. Water quality assessment for polluted water bodies:
    a. Physical- pH, Electrical conductivity, transparency
    b. Chemical- CO_3^-, HCO_3^-, Cl^-, Hardness, Dissolved oxygen.
    c. Biological- Pathogenic and non-pathogenic microorganisms.
2. Growth curve / biomass quantification in terms of protein for bio-remediating protists.
3. Comparison of community status in disturbed and undisturbed areas.
4. Comparison of soil microbial biomass/ carbon in unpolluted and polluted soil.
5. Estimation of chlorophyll content in SO_2 fumigated and unfumigated plant.
6. Study of environmental impact of a given developmental activity using check list as method.
7. To calculate the dust capturing capacity of the leaves.
8. To calculate the percentage of the injured area in the leaves, California.
9. Smith, TM & Smith, RL 2014 *Elements of Ecology*, 8th edn, Pearson Education

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION -II
M.Sc. BOTANY
SEMESTER- IV
(MSBO422: Covering Paper –MSBO413)

Time: 4 hours **Max. Marks: 35**

1. Perform the given major exercise	20
2. Perform the given minor exercise	10
3. Viva Voce	05

MSBO414: SPECIAL/ ELECTIVE PAPER II MSBO414A: APPLIED PLANT TISSUE CULTURE	
UNIT - 1	Planning and design of tissue culture facility for mass propagation of plants: Concept of clean area. Mass media preparation, dispensation and storage. Autoclaving and contamination control. Hatcheries, transfer area, control of physical environment in growth room, air –handling and conditioning, culture room lighting, air exchange, humidity control
UNIT - 2	Greenhouse location and design. General nursery practices, maintenance of plants under nursery shade. Available technologies for micropropagation of ornamentals, fruit plants, plantation crops, spices and condiments, oil seeds and legumes, commercialization of plant tissue culture in India
UNIT - 3	Principal classes of secondary metabolites (alkaloid, terpenes, phenolics), shikimic acid and mevalonate pathways. Production of pharmaceutically important drugs in culture – alkaloids (*Catharanthus, Nicotiana, Papaver*), anti-tumour agents (taxol, podophyllotoxins, vincristine), saponins and sterols (diosgenin, guggul, ginseng); food additives (sweetners, flavours and colours) and insecticides. Basic methods of extraction and isolation of secondary metabolites: alkaloids, polyphenolics and terpenes
UNIT - 4	Bioreactors: types of bioreactors (stirred tank, air lift, membrane type, immobilized cell bioreactors), process and operation, factors affecting the mass scale production of secondary metabolites (optimization, selection, hairy roots, elicitation)
UNIT - 5	Bioconversion of molecules by cell free system, and cell cultures, freely suspended and immobilized cells and enzymes. Molecular farming: production of drugs by genetic engineering technology, metabolic engineering for the production of useful metabolites

SUGGESTED READINGS

1. Bhojwani, SS & Razdan, MK 1996, *Plant Tissue Culture: Theory and Practice*. Elsevier Science Publishers, New York. USA.
2. Gamborg, OL & Phillips, GC 2005, *Plant Cell, Tissue and Organ Culture, Fundamental Methods*. Narosa Publishing House, New Delhi.
3. Ignacimuthu, S 2015, *Biotechnology: An Introduction*. Narosa Publishing House.
4. Kirakosyan, A & Kaufman, PB 2009, *Recent Advances in Plant Biotechnology*, Springer.
5. Michael R Davey & Paul Anthony 2010, *Plant Cell Culture: Essential Methods*. Wiley-Blackwell A John Wiley & Sons, Ltd.
6. Purohit, SD 2013, *Introduction to Plant cell, Tissue and organ culture*. PHI Learning Private Limited, Delhi.
7. Ramawat, KG & Merillon, JM (eds.) 2013, *Natural Products: Phytochemistry, Botany and Metabolism of Alkaloids, Phenolics and Terpenes*, Oxford & IBH, Pvt. Ltd.
8. Ramawat, KG & Merillon, JM 2010, *Biotechnology: Secondary metabolites*, Oxford & IBH, Pvt. Ltd.
9. Ramawat, KG 2000, *Plant Biotechnology*. S. Chand & Co., New Delhi.
10. Ramawat, KG 2006, *Biotechnology: Secondary metabolites: Plant and Microbes*, Science Publisher.
11. Reed, BM 2008, *Plant Cryopreservation: A Practical Guide*. Springer.
12. Singh, BD & Shekhawat, NS 2017, *Molecular Plant Breeding*, Scientific Publishers, Jodhpur.
13. Singh, RS & Singh, MP 2007, *Fundamentals of Plant Biotechnology*, Satish Serial Publishing House, Delhi.
14. Slater, A, Scott, N & Fowler, M 2003, *Plant Biotechnology: The Genetic Manipulation of Plants*. Oxford University Press

MSBO423A: PRACTICAL II1 (COVERING MSBO 414A)

SUGGESTED LABORATORY EXERCISES:

1. Experiments on multiple shoot induction from mature nodal shoot segments of economically important plant species.
2. Demonstration of anther culture in *Datura*.
3. Encapsulation of somatic embryos/buds using alginate.
4. Preparation of *in vitro* rooting medium.
5. Experiments on *in vitro* root induction from cultured shoots.
6. Experiment on *ex vitro* rooting.
7. Establishment of suspension culture.

8. Preparation of synthetic seeds.
9. Extraction & separation of secondary metabolites using TLC.

SPOTS:

1. Green House
2. Growth Room
3. Bioreactor
4. Molecular Farming
5. Taxol
6. Hairy root culture
7. Bioconversion
8. Vincristine
9. Pyrethrins

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PRACTICAL EXAMINATION -III
M.Sc. BOTANY
SEMESTER- IV
(MSBO423A: Covering Paper –MSBO414A)

Time: 4 hours **Max. Marks: 35**

1. Perform the given exercise. 14

2. Identify and Comment upon the spot 'a' to 'c': 3 x 4= 12

   a. _____

   b. _____

   c. _____

3. Dissertation 09

MSBO414: SPECIAL/ ELECTIVE PAPER II MSBO414B: INDUSTRIAL MICROBIOLOGY II	
UNIT - 1	Antibiotics: Classification, mode of action, commercial production: Penicillin and streptomycin. Production of vaccines
UNIT - 2	Nitrogen fixing Biofertilizers: *Rhizobium, Azospirillum,* and *Azatobactor.* Plant growth promoting *Rhizobacteria*, Blue green algae. Phosphate mobilizing Biofertilizers. Industrial Production of Biofertilizer
UNIT - 3	Biopesticides and Bioherbicides, Plant incorporated protectants (PIPs). Biofuel: Biogas production. Role of EPA (Environmental Protection Agency)
UNIT - 4	Biofilm, Biochip, Biosensor, Biosurfactants, Biosorption, Bioremediation and Bioleaching
UNIT - 5	Textile microbiology: (Cotton and wool). Petroleum microbiology and Leather Microbiology

SUGGESTED READINGS

1 Cappuccino, J and Sherman, N 2014, *Microbiology*: *A Laboratory manual*, 9th edn, Pearson publication.
2 Casida, LEJR 2019, *Industrial Microbiology*, 2nd edn, New Age International Publishers.
3 Maheshwari, DK 2010, *Practical Microbiology*, S. Chand and Co. Ltd.
4 Dubey, RC & Maheshwari, DK. 2013, *A Text Book of Microbiology*, S. Chand and Co. Ltd.
5 Pelczer, MJ Jr., Chan, ECS & Krieg, NR 2010 *Microbiology: An Application Based Approach*, Tata McGraw Hill.
6 Powar, CB & Daginawala, H.F.2008, *General Microbiology*. Himalaya Publishing House.
7 Reed, G (Ed.) 2004, *Prescott & Dunn's Industrial Microbiology,* 4th edn, CBS Publishers & Distributors, New Delhi.
8 Whitaker, A, Stanbury, PF & Hall, SJ 1984, *Principles of Fermentation Technology*. Elsevier.
9 Tortora, GJ, Funke, BR & Case, CL 2008 *Prescott, Harley & Klein's Microbiology,* 7th edn, Tata McGraw Hill.

MSBO423B: PRACTICAL II1 (COVERING MSBO 414B)

SUGGESTED LABORATORY EXERCISES:

1. Effect of various factors on the growth of microorganisms (pH, Temp,UVlight)
2. Cultivation of Nitrogen fixing Biofertilizers: *Rhizobium, Azospirillum, Azatobacter*.
3. Oligodynamic action of heavy metals.
4. Antibiotic sensitivity test by agar disc diffusion and
5. Antibiotic sensitivity test by tube dilution methods.
6. Isolation &identification of Mycorrhizal fungi from Rhizosphere soil.
7. Production of penicillin
8. Production of citric acid.
9. Isolation and characterization of bacteria from hydrocarbon contaminated soils.

SPOTS:

a. Mycorrhiza
b. N_2 Fixing genes
c. Recombinant Viral Vaccines
d. *Jatropa sp.* as Biofuel
e. Bioaugmentation
f. Bioleaching
g. Biosensor

1 Ananda Mohan Chakrabarty

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION -III
M.Sc. BOTANY
SEMESTER- IV
(MSBO423B: Covering Paper –MSBO414B)

Time: 4 hours **Max. Marks: 35**

1. Perform the given exercise. 14

2. Identify and Comment upon the spot 'a' to 'c': 3 x 4= 12

   a. _____

   b. _____

   c. _____

3. Dissertation 09

MSBO414: SPECIAL/ ELECTIVE PAPER II MSBO414C: GENOMICS AND PROTEOMICS	
UNIT - 1	Introduction to Genomics- Structural, Functional, Comparative and Evolutionary genomics; Plant genomes; Indian initiatives in plant genome sequencing
UNIT - 2	DNA sequencing methods: Dideoxy chain termination, Pyrophosphate sequencing. High throughput, Ultra high throughput sequencing. Tools for genome analysis-PCR-Working and types; Molecular markers: RFLP, DNA Fingerprinting and its applications, RAPD, AFLP, SSR, SNP
UNIT - 3	Proteome: definitions and conceptualization; Protein structure; Post-translational modifications (PTM) - phosphorylation, glycosylation, ubiquitination, additional modifications; Mass spectrometric characterization of PTM –Identification of phosphorylated, glycosylated proteins and other PTM
UNIT - 4	Proteomics: Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Peptide fingerprinting; MALDI-TOF; Differential display proteomics, Protein-protein interactions
UNIT - 5	Functional genomics and proteomics: Microarrays; Protein and peptide microarray-based technology; PCR-directed protein *in situ* arrays; Structural proteomics; Concept of Transcriptomics, Metabolomics and Metagenomics

SUGGESTED READINGS

1. Campbell, AM & Heyer, LJ 2007, *Discovering Genomics, Proteomics and Bioinformatics,* 2nd edn, Benjamin Cummings Publ. Co., San Francisco, California, USA.
2. Gibson, G & Muse, SV 2004, *A Primer of Genome Science,* 2nd edn, Sinauer Associates, USA.
3. Glick, BR & Patten, CL 2017, *Molecular Biotechnology: Principles & Applications of Recombinant DNA,* 5th edn, Taylor & Francis.
4. Primrose, S & Twyman R 2006, *Principles of Gene Manipulation and Genomics*, 7th edn, Blackwell Publ. Co., London.
5. Sambrook, J, Fritsch, EF & Maniatis, T 1989, *Molecular Cloning- A Lab Manual,* Cold Spring Harbor Laboratory Press, New York.
6. Veenstra, TD & Yates, JR 2006, *Proteomics for Biological Discovery*, Wiley-Liss

MSBO423C: PRACTICAL II1 (COVERING MSBO 414C)

SUGGESTED LABORATORY EXERCISES:

1. Amplification of nucleic acid through polymerase chain reaction (demonstration).
2. Construction of restriction map of the plasmid pBR322.
3. Isolation of the gene (neomycin phosphotransferase) from the plasmid pUC7 KAPA (kit based)
4. Cloning of the Bam HI fragment containing the neomycin phosphotransferase gene into the Bam HI site of pUC19 B/W screening (kit based)
5. DNA sequencing from the given data / photograph by Sanger's / Maxam Gilbert's method.
6. Determination of the effect of different concentrations of agarose on banding pattern of DNA.

SPOTS:

1. DNA Fingerprinting
2. Human Genome Project
3. 2-D PAGE
4. Biochip
5. Protein- protein interactions
6. Thermocycler
7. Transplastomics
8. MALDI
9. *C. elegans*- a model organism

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PRACTICAL EXAMINATION -III
M.Sc. BOTANY
SEMESTER- IV
(MSBO423C: Covering Paper –MSBO414C)

Time: 4 hours **Max. Marks: 35**

1. Perform the given exercise. 14

2. Identify and Comment upon the spot 'a' to 'c': 3x 4= 12

   a. _____

   b. _____

   c. _____

3. Dissertation 09

SKILL COURSES IN BOTANY

1- INTELLECTUAL PROPERTY RIGHTS

1. Introduction, Historical perspectives and Forms of IPR.
2. Concept related to Patent: Requirements, procedure, duration.
3. Revocation of patent, Infringement and Litigation with case studies on patent.
4. Fundamentals of Copy Rights, Trade Marks and Industrial Designs.
5. Basics of Geographical Indications; Trade Secrets and Traditional Knowledge.
6. Protection of Plant Varieties (Plant Breeders Rights and Farmer's Right).
7. IPR and Biodiversity (CBD; Protection in biotechnology, protection of other biological materials).
8. Introduction to the leading International Agreements concerning Intellectual Property Rights: WTO (GATT, TRIPS), WIPO, Madrid Protocol, Berne Convention, Paris Convention.
9. Indian Legislations for the protection of various types of Intellectual Properties.
10. Management and Valuation of Intellectual Property.

SUGGESTED READINGS

1. Acharya, NK. 2001, *Text book on Intellectual Property Rights*. Asia Law House.
2. Arthur, RP and Micheal, HD 2000, *Intellectual Property: Patents, Trademarks and Copyright in a nutshell*, West Group Publishers.
3. Das, HK. 2010, *Text book of Biotechnology*, 4th edn. Wiley India.
4. Erbisch, FH & Maredia, K.1998, *Intellectual Property Rights in Agricultural Biotechnology*. CABI.
5. Ganguly, P. 2001 *Intellectual Property Rights: Unleashing Knowledge Economy*, McGraw-Hill.
6. Saha, R. (Ed.). 2006, *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*, Daya Publ. House.
7. Singh, BD 2010, *Biotechnology: Expanding horizons*, Kalyani Publishers.
8. Wadhera, BL 2007, *Law Relating to Intellectual Property*, Universal Law Publishing.
9. Wattal, J. 1997 *Intellectual Property Right,* Oxford Publication House.

SKILL COURSES IN BOTANY

2- DATA ANALYSIS AND PRESENTATION

1. Sampling techniques
2. Central tendency – Mean, Median, Mode, Variance, Normalized Variance, Standard Error, Coefficient of Variance
3. Analysis of Variance
4. Correlation
5. Regression
6. Tables and Graphs
7. Preparation of Power Point Presentation

SUGGESTED READINGS

1. Gomez, AK & Gomez, AA 1984, *Statistical Procedures for Agricultural Research* 2nd edn, John Wiley & Sons, New York
2. Mishra, BN & Mishra MK 1989, *Introductory Practical Biostatistics,* NayaPrakash Publication, Calcutta.
3. Panse, VG & Sukhatme, PV 1989, *Statistical Methods for Agricultural Workers,* Indian Council of Agricultural Research, New Delhi.
4. Quinn, PG & Keough, JM 2002, *Experimental Design and Data Analysis for Biologists*, Cambridge University Press Cambridge, UK.
5. Sundar Rao, PSS & Richard, J 2011, *Introduction to Biostatistics and Research Methods,* 4th edn, PHI Learning Pvt. Ltd., New Delhi.
6. Williams, BG 2015, *Biostatistics- Concepts and Applications for Biologists,* Chapman & Hall, London

LABORATORY/FIELD EXERCISES
1. Basic operations in MS-Excel 2. Computation of Central tendency quantifiers in MS-Excel 3. Computational techniques for ANOVA in MS-Excel 4. Computational techniques for Correlation in MS-Excel 5. Computational techniques for regression in MS-Excel 6. Techniques for table preparation in MS-Excel 7. Hands on exercises for Power point presentation

SKILL COURSES IN BOTANY
3-MICROPROPAGATION
1. Basic layout of Mircropropagation laboratory and Green House. 2. Basic Concepts of Micropropagation. 3. Tools and Techniques of Micropropagation: LAFB, Autoclave, Filter Sterilization. 4. Medium composition and Preparation. 5. Basic concept of Aseptic Culture establishment. 6. Hardening and Acclimatization

SUGGESTED READINGS
1. Bhojwani, SS 1990, *Plant Tissue Culture: Applications and Limitations,* Elsevier Science Publishers, New York, USA. 2. Bhojwani, SS & Razdan, M K. 1996, *Plant Tissue Culture: Theory and Practice* (a revised edition), Elsevier Science Publishers, New York, USA. 3. Vasil, IK. & Thorpe, TA 1994, *Plant Cell and Tissue Culture*, Kluwer Academic Publishers, The Netherlands. 4. Woung-Young, S. & Bhojwani, S. S. 1999, *Morphogenesis in Tissue Cultures* (ed.), Kluwer Academic Publishers

LABORATORY/ EXERCISES
1. Selection of explants, surface sterilization and inoculation to initiate cultures of tobacco/ cereals/ legumes. 2. Studies on effects of plant growth regulators on cell, tissue and organ culture. 3. Experiments on rejuvenation and multiple shoot induction from mature nodal shoot segments of trees/ horticultural/floricultural crops. 4. Encapsulation of somatic embryos/buds using alginate. 5. Experiments on root induction from cultured shoots.

SKILL COURSES IN BOTANY
3-MICROPROPAGATION
1. General Introduction of mushroom. 2. Taxonomy and Biology of Mushroom. 3. Neutraceutical (nutritional) values of mushroom. 4. Pharmaceutical (medicinal) values of mushroom. 5. Mushroom laboratory/ farm design. 6. Mushroom production technology. 7. Spawn production technology. 8. Compost (natural and synthetic). 9. Management of mushroom disease. 10. Post - harvest technology of mushroom. 11. Economics of mushroom cultivation. 12. Mushroom producers, Exporters, consultants, literature and sources of inputs

SUGGESTED READINGS

1. Bahl, N 1984, *Handbook on Mushroom,* Oxford and IBH, New Delhi.
2. Chandra, KL & Sharma, SR 1995, *Mushroom, Advances in Horticulture*, Volume XIII Malhotra Publishing House, New Delhi, India.
3. Kannaiyan, S & Ramasamy, K. 1980, *A Handbook of Edible Mushroom,* Today and Tomorrows printers and publishers, New Delhi.
4. Kapoor, JN 1989, *Mushroom Cultivation*, ICAR Publishers, Coimbatore.
5. Purkayastha, RP & Chandra, A 1985, *Manual of Indian Edible Mushrooms,* Today and Tomorrows printers and publishers, New Delhi.
6. Saini, LC & Parashar, RD 1992, *Khumb Utpadan* HAU Publication Hissar.
7. Singh, H 1991, *Mushroom- The Art of cultivation.* Sterling Publishers Pvt. Ltd. New Delhi.
8. Singh, RP 1986, *Bulletins of Successful Mushroom Production.* GB Pant University, Pantnagar.
9. Tewari, SC & Kapoor, P 1988, *Mushroom Cultivation: An Economics Analysis.* Oxford and IBH New Delhi.

LABORATORY/ EXERCISES

1. Survey and collection of local edible mushrooms.
2. Visit to mushroom cultivation Laboratory.
3. General studies on laboratory rules, equipments, tools and precaution.
4. Principles and demonstration of Laboratory Instruments.
5. Preparation of culture media.
6. Isolation and culture of Spawn (mushroom seed/spore)
7. Preparation of composting.
8. Cultivation of white button mushroom.
9. Post- harvest technique.
10. Preservation of mushroom.