Program name: Master of Botany
Program Code: MBOT401

(Choice Based Credit System)
for

M.Sc. Botany

(w.e.f. Session-2017-2018)

Program Code: MBOT401

DEPARTMENT OF LIFE SCIENCES
SCHOOL OF BIO-SCIENCES

RIMT UNIVERSITY, MANDIGOBINDGARH, PUNJAB

Program name: Master of Botany
Program Code: MBOT401

TABLE OF CONTENTS

SECTION 1

Vision & Mission of the University

VISION

To become one of the most preferred learning places and a centre of excellence to promote and nurture future leaders who would facilitate the desired change in the society.

MISSION

- To impart teaching and learning through cutting-edge technologies supported by the world class infrastructure
- To empower and transform young minds into capable leaders and responsible citizens of India instilled with high ethical and moral values.

SECTION 2

Vision and Mission of the Department

VISION

- The Department of Botany represents the understanding regarding Biodiversity, Physiology, Metabolism, Ecology, Genetic Engineering and Breeding of Plants. Besides, it aims to invest the capacities of professors and students in the theoretical and applied researches and scientific studies. It also strives to develop the training, awareness, and health mobilizations according to new bases consistent with recent developments through acquiring advanced technical and professional experiences and then utilizing them in scientific and academic fields.

MISSION

- The Department of Botany has been found to meet the community need for specialized staffs with precise specifications according to modern technical standards. It also aims to have health staff work in different health and research institutions to support both governmental and private sectors. Moreover, the department has a bright, ambitious future mission to provide the best medical teaching skills, to expand horizons of scientific cooperation with the corresponding departments, and related institutions to achieve continuous and high-quality interactions.

SECTION 3

About the Program

Our Botany Program is an Outcome Based Education model which is a 2 year, 4 Semester Full time Program of 104 credit hours with a Choice Based Credit System (CBCS) and Grading Evaluation System. This program comprises of foundational courses, core courses, specialization electives courses, enrichment courses and experimental learning. The suggestive curriculum takes the Botany program to the next level in terms of implementing Outcome Based Education and to develop management professionals who are knowledgeable in their chosen domain, responsive to the environment and culture, unfailing to the communities, ethical in all doings and with a global outlook and approach.

OBJECTIVES

1. Developing the research, scientific and technical capabilities of teachers and graduates, keeping up with recent developments, and encouraging advanced methods in the fields of specialization.

2. Working to establish intense research and scientific relationships with the corresponding departments of public universities and other universities in different countries by participating in seminars, courses, and training workshops for investing them later.

3. Providing scientific, technical, and research consultations to solve some scientific and specialized problems needed by some relevant health institutions.

4. It aspires to achieve the desired future goals in crowning its scientific career by opening higher studies.

SECTION 4

Program Educational Objectives (PEOs), Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Program Education Outcomes

PSO 1	To create knowledge about core areas related to the field of Medical Laboratory
PSO 2	Analyze, interpret and apply concepts of clinical testing for healthcare decision making
PSO 3	To exhibit the knowledge of entrepreneurial qualities and explore entrepreneurial opportunities by Working effectively and professionally in teams and enabling them to evaluate investment.
PSO 4	To employ interpersonal communication skills in relaying laboratory test information and when interacting with patients, lab personnel and other health care professionals.

Program Outcomes

PO 1	To enrich students' knowledge and train them in various branches of Botany such as Cell biology, plant Physiology, genetics, molecular biology, biochemistry, plant ecology, Taxonomy bioanalytical techniques.
PO 2	The students will learn wide variety of roles microorganisms play, modern microbiology has made a significant contribution to various fields, including medicine, agriculture, food sciences, ecology, genetics, biochemistry, and molecular biology. The graduates of this program will be able to retain and apply a variety of microbiological concepts and knowledge upon graduation.
PO 3	Students learn to integrate science with society for the overall development of the nation. Are charged with the concepts to take up higher studies, set up small scale industries, develop confidence to take up challenging tasks of research in the field of botany.

PO 4	The program will also provide a platform for classical genetics in order to understand distribution or inheritance of different traits and diseases among populations, their ethnicity and correlate with contemporary and modern techniques like genomics, metagenomics, genome editing and molecular diagnostic tools
PO 5	The program helps to develop scientific tempers and attitudes, which in turn can prove to be beneficial for the society since the scientific developments can make a nation or society to grow at a rapid pace.
PO 6	After the completion of this course, students have the option to go for higher studies, i.e., M. Sc. Ph.D. and then do research work for the welfare of mankind.
PO 7	The program helps to develop scientific tempers and attitudes, which in turn can prove to be beneficial for the society since the scientific developments can make a nation or society to grow at a rapid pace.
PO 8	The program helps to develop scientific tempers and attitudes, which in turn can prove to be beneficial for the society since the scientific developments can make a nation or society to grow at a rapid pace.
PO 9	After higher studies, students can join as scientist or assistant professor or assistant teacher and can even look for professional job oriented courses, such as Indian Civil Services, Indian Forest Service, Indian Police Service etc.
PO 10	Science graduates can go to serve in industries or may opt for establishing their own industrial unit. Practical and theoretical skills gained in this program will be helpful in designing different public health strategies for social welfare.

Program Specific Outcomes

PSO:1:	Students enrolled in M.Sc. degree program in Botany obtain a comprehensive understanding of disciplinary and allied biological disciplines.
PSO: 2	Students will learn several subjects covered in the core course, including biochemistry, cell biology, virology, molecular biology, and Biochemistry, along with microorganism morphology, physiology, and function. Upon graduation, students will gain a deeper understanding of Botany, starting with a basic understanding of microbes, basic laboratory techniques, and fundamental knowledge.
PSO: 3	In this course, students will learn how to use and maintain basic microbiological equipment as well as perform basic laboratory procedures in microbiology, as well as how to collect and submit microbiological and parasitological specimens.
PSO: 4	Students will have the opportunity to gain hands-on experience using state-of-the-art laboratory equipment in the skill enhancement elective course, which will allow them to conduct high throughput studies on microorganisms as well as perform diagnostic

	procedures for the food and dairy industries.

SECTION 5

Curriculum / Scheme with Examination Grading Scheme

Induction Program (Mandatory)	
Duration	03 weeks
Activities	• Physical Activity • Sports, Yoga & Stress Management • Creative Arts • Universal Human Values • Lectures by Eminent People • Visits to local Areas • Familiarization to Dept./Branch & Innovations

SEMESTER WISE SUMMARY OF THE PROGRAMME: M.Sc. BOTANY (SCHOOL OF BIOSCIENCES)

S. No.	Semester	No. of Contact Hours	Marks	Credits
1.	I	42	700	26
2.	II	42	700	26
3	III	42	700	26
4	IV	32	300	26
	Total	**158**	**2400**	**104**

Program name: Master of Botany
Program Code: MBOT401

Marks Percentage Range	Grade	Grade Point	Qualitative Meaning
80-100	O	10	Outstanding
70-79	A+	9	Excellent
60-69	A	8	Very Good
55-59	B	7	Good
50-54	B	6	Above Average
45-49	C	5	Average
40-44	P	4	Fail
0-39	F	0	Fail
ABSENT	AB	0	Fail

Percentage Calculation: CGPA *10

First Semester:

Subject		Contact Hours/Week			Credit	Evaluation Scheme (% of Total Marks)					Exam Duration (Hours)
Code	Title	L	T	P		CWA	LWA	MTE	ETE	Total	
MBOT-1101	Cell Biology	4			4	16	---	24	60	100	3
MBOT-1102	Genetics and Cytogenetics	4			4	16	---	24	60	100	3
MBOT-1103	Principles of Biochemistry	4			4	16	---	24	60	100	3
MBOT-1104	Viruses, Bacteria and Fungi	4			4	16	---	24	60	100	3
MBOT-1105	Algae and Bryophytes	4			4	16	---	24	60	100	3

MBOT-1106	Practical Paper-I (Cell Biology, Genetics and Cytogenetic, Principles of Biochemistry)			6	3	----	---	-----	100	100	3
MBOT-1107	Practical Paper-II (Viruses, Bacteria and Fungi; Algae and Bryophytes)			6	3	----	---	-----	100	100	3
Total					26	**80**		**120**	**500**	**700**	**21**

Second Semester:

Subject		Contact Hours/Week			Credit	Evaluation Scheme (% of Total Marks)					Exam Duration (Hours)
Code	Title	L	T	P		CWA	LWA	MTE	ETE	Total	
MBOT-1201	Pteridophytes and Gymnosperms	4			4	16	---	24	60	100	03hrs
MBOT-1202	Molecular Biology	4			4	16	---	24	60	100	03hrs
MBOT-1203	Plant Physiology	4			4	16	---	24	60	100	03hrs
MBOT-1204	Plant Metabolism	4			4	16	---	24	60	100	03hrs
MBOT-1205	Bioanalytical Techniques	4			4	16	---	24	60	100	03hrs
MBOT-1206	Practical Paper-I (Pteridophytes and Gymnosperms, Molecular Biology)			6	3	----	---	-----	100	100	03hrs
MBOT-1207	Practical Paper-II (Plant Physiology & Metabolism, Bioanalytical Techniques)			6	3	----	---	-----	100	100	03hrs
Total					26	80		120	500	700	

Program name: Master of Botany
Program Code: MBOT401

Third Semester:

Subject		Contact Hours/Week			Credit	Evaluation Scheme (% of Total Marks)					Exam Duration (Hours)
Code	Title	L	T	P		CWA	LWA	MTE	ETE	Total	
MBOT-2301	Plant Anatomy	4			4	16	---	24	60	100	03hrs
MBOT-2302	Plant Development and Reproduction	4			4	16	---	24	60	100	03hrs
MBOT-2303	Plant Resource Utilization	4			4	16	---	24	60	100	03hrs
MBOT-2304	Evolutionary Biology	4			4	16	---	24	60	100	03hrs
MBOT-2305	Statistical Technique	4			4	16	---	24	60	100	03hrs
MBOT-2306	Practical Paper-I (Plant Anatomy, Plant Development and Reproduction, Plant Resource Utilization)			6	3	----	---	-----	100	100	03hrs
MBOT-2307	Practical Paper-II (Evolutionay Biology, Statistical Technique)			6	3	----	---	-----	100	100	03hrs
Total		20		12	26	80		120	500	700	

Fourth Semster

Subject		Contact Hours/Week			Credit	Evaluation Scheme (% of Total Marks)					Exam Duration (Hours)
Code	Title	L	T	P		CWA	LWA	MTE	ETE	Total	
MBOT-2401	Plant Tissue Culture	4			4	16	---	24	60	100	03hrs
MBOT-2402	Biotechnology and Genetic Engineering	4			4	16	---	24	60	100	03hrs
MBOT-2403	Plant Ecology			6	3	---	---	-----	100	100	03hrs

MBOT-2404	Forestry				15	---	---	-----	-----	-----	03hrs
Total					26	**32**		**48**	**220**	**300**	

Detailed Syllabus

SUBJECT TITLE: CELL BIOLOGY
SUBJECT CODE: MBOT-1101
SEMESTER: I
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	**0**	**0**	**4**

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

- The aim of this course is to achieve an up-to-date level of understanding the basic concept of cell structure and its functioning.
- The objective of this course is to provide training in scientific and transferable skills through modular lecture courses, assignments, tutorials, seminars and supervisions.
- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideasof the students. And hence will serve as a lasting and practical basis for a career.

Section-A **25 hours**

Structural organization of cell: The cell theory, structural organization of the prokaryotic and plant cell. Cell wall- Structure and functions, biogenesis, growth.

Plasma membrane: Structure, models and functions, site for ATPase, transport across membranes- facilitated diffusion, carrier & channel proteins, transporters, active transport, ion carriers, channels and pumps, receptors.

Intracellular compartmentalization of cell: Plasmodesmata and its role in movement of molecules and macromolecules, Cell junctions, cell-cell adhesions, cell-extracellular matrix adhesion.

Section-B **20 hours**

Chloroplast and mitochondria: Structure, genome organization, biogenesis and functions.

Plant vacuole: Tonoplast membrane, ATPases, transporters, as storage organelle.

Nucleus: Structural organization and function of nuclear envelope, nuclear pore and nucleolus.

Cell shape and motility: The cytoskeleton; organization and role of microtubules and microfilaments; motor movements; implications in flagellar and other movements.

Section-C **15 hours**

Other cell organelles: Ultra structure and functions of microbodies, endoplasmic reticulum, Golgi apparatus, lysosomes, ribosomes.

Protein sorting: Targeting of proteins to organelles

Cell cycle and apoptosis: Control mechanism of cell cycle and an account of cyclin, cyclin dependent kinases, MFP, genetics of mitotic cell division.

Course outcomes

CO1	MBOT-1101.1	Students will learn and understand the basic concept of cell structure and its functioning.
CO2	MBOT-1101.2	Students will understand the compostion and functioning of cell organelles and how the organelles are interconnected in the cell to carry out overall functioning of organism.
CO3	MBOT-	Students will learn deeply about the proteins its production, regulation and

	1101.3	functions.
CO4	MBOT-1101.4	Students will learn deeply about the Apoptosis and its role in cancerous cells

Recommended Readings

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. **4th Edition,** 2019, *Molecular Biology of the Cell*, Garland Pub. Inc., New York.
2. Gupta, P.K. 2020, *Cell and Molecular Biology*, Rastogi Pub. Meerut.
3. Karp, G. 2020, *Cell and Molecular Biology: Concepts and Experiments*, John Wiley & Sons Inc. USA.
4. De Robertis, E.D.P. and De Robertis, Jr. E.M.F. 2011, *Cell and Molecular Biology*, Lippincott Williams & Wilkins, USA.
5. https://iisc.ac.in/wp-content/uploads/2019/08/IISc-Handbook-UG-.pdf
6. Pollard, T. D., Earnshaw, W. C., Lippincott-Schwartz, J., & Johnson, G. T. (2017). *Cell biology*.

SUBJECT TITLE: GENETICS AND CYTOGENETICS
SUBJECT CODE: MBOT-1102
SEMESTER: I
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

- The course has been designed to achieve an up-to-date level of understanding the basic concept of cell structure and its functioning.
- The objective of this course is to provide training in scientific and transferable skills through modular lecture courses, assignments, tutorials, seminars and supervisions.
- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideasof the students. And hence will serve as a lasting and practical basis for a career.

Section-A **20 hours**

Chromatin organization: Chromosome structure, euchromatin and heterochromatin, packaging of DNA, nucleosome organization, karyotype analysis, banding patterns. Polytene chromosomes, lampbrush chromosomes, B- chromosomes

Structure of gene: Classical concept, fine structure of phage T4 II locus, overlapping genes, split genes, pseudogenes.

Extranuclear inheritance: Chloroplasts heredity in *Mirabilis*, *Zea mays* and *Chlamydomonas*. Mitochondrial inheritance in *Saccharomyces* and *Neurospora*.

Section-B **20 hours**

Crossing-over and linkage: Cytological basis of crossing over, tetrad analysis, mechanism of crossing over; linkage and it types- complete linkage, incomplete linkage, autosomal linkage and allosomal linkage.

Genetic Recombination: Homologous genetic recombination, Holliday model, proteins and enzymes mediating recombination.

Mutations: Concepts and molecular basis, mechanism of spontaneous mutations, physical and chemical mutagens, detection of mutations in maize and *Drosophila*, Ames assay, site directed mutagenesis.

Section-C **20 hours**

Structural alterations in chromosome: Deletion, duplications, inversions, translocations and their cytological importance; Robertsonian translocations.

Numerical alterations in chromosomes: Types of polyploidy, role of polyploidy in plant breeding, aneuploidy, evolution of major crop plants, origin and types of aneuploids.

Population genetics: Hardy weinberg law, Gene pool and gene frequencies, equilibrium of gene frequencies, change in gene frequencies by mutation, selection, migration and random drift.

Course outcomes

CO1	MBOT-1102.1	Students will learn and understand the basic concept of Chromosome structure organization and function.
CO2	MBOT-1102.2	Students will deeply understand the compostion, structure and functioning genes in organism.
CO3	MBOT-1103.3	Students will learn deeply about the linked genes, recombination at the genetic level in the organism.
CO4	MBOT-1104.4	Students will deeply how and what parameters causes to alter the chromosome number in organism and also learn about the Population dynamics.

Recommended Readings

1. Brown, T.A. 2016.Genomes, John Wiley & Sons, New York.
2. Khush, G.S. 2020. *Cytogenetics of Aneuploids,* Academic Press, New York.
3. Schultz-Schaeffer, J.2018. *Cytogenetics,*Springer_Verlag, New York.

4. Swansom, C.P. 2015. *Cytology and Cytogenetics*, Macmillan India, New Delhi.
5. https://ocw.mit.edu/courses/biology/7-03-genetics-fall-2004/lecture-notes/lecture6.pdf
6. https://ocw.mit.edu/courses/biology/7-03-genetics-fall-2004/lecture-notes/lecture10.pdf
7. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). *Lewin's genes XI*. Burlington, Mass: Jones & Bartlett Learning.
8. Singh B D (2009). Genetics. Kalyani Publishers

SUBJECT TITLE: PRINCIPLES OF BIOCHEMISTRY

SUBJECT CODE: MBOT-1103
SEMESTER: I
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

- The aim of this course is to ensure that you can achieve an up-to-date level of understanding of Biomolecule in plants.
- Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.
- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideasof the students. And hence will serve as a lasting and practical basis for a career.

Section-A **20 hours**

Carbohydrates: Classification, composition, structure and functions of monosaccharides, disaccharides and polysaccharides. Conformations and derivatives of monosaccharides.

Lipids: Classification, structure and function of lipids. Essential fatty acids, tests to check purity of fats and oils, amphipathic lipids.

Nucleic acids: Structure of purines and pyrimidines, DNA double helix, different forms of DNA, structure and types of RNA.

Proteins and amino acids: General structure and classification of amino acids, non-standard amino acids. Structure, classification and functions of proteins.

Section-B **20 hours**

Enzymes: Nomenclature and classification, chemical nature, active site, factors affecting enzyme activity, enzyme kinetics, Michaelis-Menten equation and its significance, mechanism of enzyme action and inhibition, enzyme specificity, regulation of enzyme activity, ribozymes, isozymes, abzymes, immunolization of enzymes and applications.

Vitamins: Structure, functions, dietary sources of various vitamins, coenzymes and deficiency of Thiamine, Riboflavin, Nicotinic Acid, Pantothenic Acid, Pyridoxine, Biotin, Folic Acid, Cyanocobalamin, Ascorbic Acid, Vitamin A , D , E and K.

Section-C **20 hours**

Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties). Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.

Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes. Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds). Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). Stability of proteins and nucleic acids. J. Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.

Course outcomes

CO1	MBOT-1103.1	Students will learn and understand the basic and advanced concept of Biochemistry.

CO2	MBOT-1103.2	Students will deeply understand the production, compostion and function of Biomolecules.
CO3	MBOT-1103.3	Students will learn deeply and understand about the kinetics of Biomolecules.
CO4	MBOT-1103.4	Students will deeply learn about the metabolism and properties of Biomolecules.

Recommended readings:

1. Lehninger, A. Principles of Biochemistry. Worth Publishers, **Seventh Edition**, 2017.
2. Deb, A.C. Fundamental of Biochemistry. 11thed. New Central Book Agency Pvt. Ltd., Kolkutta, 2018.
3. Dey, P.M. and Harborne, J.B. Plant Biochemistry. Academic Press, London, 2012.
4. Hames, D. and Cooper, N. Biochemistry. Garland Science Publishers, U.S.A., 2020.
5. https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/health_science_students/medicalbiochemistry.pdf
6. https://www.iisc.ac.in/wp-content/uploads/2017/09/booklet_v9_with_changes.pdf

SUBJECT TITLE: VIRUSES, BACTERIA AND FUNGI
SUBJECT CODE: MBOT-1104
SEMESTER: I
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned

paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

- The aim of this course is to ensure that you can achieve an up-to-date level of understanding of structure and function of viruses, Bacteria and Fungi
- Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.
- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideas of the students. And hence will serve as a lasting and practical basis for a career.

Section-A **20 hours**

Viruses: General characters, nature, origin, structure and classification.Replication of viruses and their transmission, viroids and prions, importance of viruses.

Bacteria:A general account with particular reference to shape, flagellation types, Gram-positive and Gram-negative bacteria, ultrastructure, classification, modes of reproduction, nutritional types, economic importance.

Archaebacteria: Constituent Groups (Methanogens, Halophiles, and Thermoacidophiles), a general account.

Mollecutes: Properties of representative types, a brief account of their cell shape and reproduction.

Section-B **20 hours**

Fungi- general account: Ultrastructure of cell wall, major growth forms, modes of nutrition, range of thallus organization, specialized somatic structures.

Reproduction in fungi: Variations in asexual reproduction in fungi. Origin and evolution of sex in fungi including hormonal control. Homothallism, heterothallism and parasexual cycle. Evolution of fructifications in fungi.

Section-C **20 hours**

Fungal Systematics: Classification, major taxonomic groups and their phylogenetic relationships. A general account of Chytridiomycota, Zygomycota, Ascomycota and Basidiomycota.

Economic importance of fungi: Role in industry, agriculture, medicine, edible fungi and mushroom cultivation- a general account.

Types, Ecological and Economic Significance of Lichens & Mycorrhizae. An account of fungi like organisms: Slime molds, Oomycota.

CO1	MBOT-1104.1	Students will learn and understand the about the diversity, structure, compostion fuction and properties of Viruses and fungi.
CO2	MBOT-1104.2	Students will learn and understand the about the diversity, structure, compostion fuction and properties of Bacteria, archaebacteria and Mollicutes.
CO3	MBOT-1104.3	Students will learn deeply and understand about the systematic and phylogenetic relationship in Fungi.
CO4	MBOT-1104.4	Students will understand the importance and role of fungi.

Recommended readings

1. Desk encyclopedia of Microbiology by Moselio Schaechter, 2018. Coe library Publishers.
2. Ainsworth, G. C. and Sussman, *The Fungi*. Vol .VIII, Academic Press, New York 2020.
3. Alexopoulos, C.J., Mims, C. W. and Blackwell, M., *Introductory Mycology*, John Wiley and Sons, New York, 2019.
4. Deacon, J. W. *Modern Mycology*, 3rd Edition, Blackwell Science Ltd., U.K.
5. http://www2.centralcatholichs.com/Bio1site/taxonomy%20and%20viruses/virus%20advanced%20notes.PDF

SUBJECT TITLE: ALGAE AND BRYOPHYTES

SUBJECT CODE: MBOT-1105
SEMESTER: I
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40

Program name: Master of Botany
Program Code: MBOT401

End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

- The aim of this course is to ensure that you can achieve an up-to-date level of understanding of structure and function of algae and bryophytes.
- Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.
- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideasof the students. And hence will serve as a lasting and practical basis for a career.

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Section-A **20 hours**

General Introduction: Criteria used for algal classification system. Comparative account of algal pigments, food reserves, cell wall, flagellation, chloroplasts and eye spots; their phylogenetic and taxonomic importance. Various life Cycles of algae (Haplontic, Diplontic, Haplobiontic), Economic importance of algae.

Cyanophyta: Cell Structure, thallus organization, heterocyst and akinete development and their role; chromatic adaptations and reproduction; paddy soil cyanophytes and their role.

Chlorophyta: Range of thallus, methods of reproduction, life cycles and alternation of generation.

Xanthophyta:A general account and characteristics of Xanthophyta & Bacillariophyta.

Section-B **20 hours**

Phaeophyta: Range of thallus structure, reproduction and life history and alternation of generation.

Rhodophyta: Range of thallus structure, reproduction, life history and alternation of generations; post-fertilization development and site of meiosis; brief account of Bangiales and Florideae.

Bryophytes General: Origin and classification; evolution of gametophytic and sporophytic generations; economic and ecological importance; brief account of fossil bryophytes.

Section-C **20 hours**

Hepaticopsida: A brief account of morphology, structure, reproduction and affinities of *Calobryale*s, *Jungermanniales*, *Metzgeriales*, *Sphaerocarpales*, *Monocleales* and *Marchantiales.*

Anthocerotopsida: A general account of morphology, structure, life cycle pattern, spore morphology & germination and affinities of Anthocerotales.

Bryopsida: A brief account of morphology, structure, life cycle pattern and affinities of *Andreaidae*, *Sphagnidae*, *Tetraphidae, Polytrichidae*, *Buxbaumidae*, *Bryidae*, *Archidae*.

Course outcomes

CO1	MBOT-1105.1	Students will learn and understand the diversity and taxonomy of Algae and Bryophytes.
CO2	MBOT-1105.2	Students will learn about the classification of Algae and Bryophytes.
CO3	MBOT-1105.3	Students will learn about the structures, reproduction and life history of Algae and Bryophytes.
CO4	MBOT-1105.4	Students will learn about the importance and roles of Algae and Bryophytes.

Recommended readings

1. W.B. Schofield, Introduction to Bryology, New York : Macmillan Publishing Company, 2018
2. Uses of Bryophytes by Glime, J. M. and Saxena, D. Vol-7, 2017Today & Tomorrow's Printers & Publication, New Delhi.
3. Kumar, H.D. 2018. *Indroductory Phycology,* Affiliated East West Press Ltd., New Dehli.
4. *Bryophytes: Morphology, Growth and Differentiation,* by Puri P., 2016. Atma Ram & Sons, Delhi.
5. Vasishta, B. R. 2018.*Bryophyta,* S. Chand& Co. Ltd., New Dehli.

SUBJECT TITLE: Practical Paper-I
SUBJECT CODE: MBOT-1106
SEMESTER: I
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	6	3

Duration of Exam; 3 Hrs

Practicals

1. To study prokaryotic cell, eukaryotic cell, plant cell and various cell organelles through photographs or charts.
2. Visualization of plant cell by methylene blue.
3. Investigation to determine the effect of temperature on plant cell membrane permeability
4. To isolate various cell organelles from the given plant material.
5. Visualization of nuclear fraction by acetocarmine stain.
6. Demonstration of mitochondria by Janus green B.
7. To study different stages of mitosis and meiosis.
8. To study polytene chromosomes from salivary glands of *Drosophila*.
9. To study microsporogenesis in the given plant material.
10. To analyse the karyotype of the given species.
11. To perform Ames test in *Salmonella* / *E.coli* to study mutagenicity.
12. To detect for the presence of carbohydrates, lipids and proteins.

13. Qualitative tests for alkaloids, phenols, flavonoids and tannins.
14. Quantitative estimation of carbohydrates, proteins.
15. Quantitative estimation of vitamins.
16. Quantitative estimation of alkaloids, phenols, flavonoids and tannins.
17. Estimation of activity of catalase, peroxidase and amylase.

SUBJECT TITLE:Practical Paper-II
SUBJECT CODE: MBOT-1107
SEMESTER: I
CONTACT HOURS/WEEK: 6

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	6	3

Duration of Exam; 3 Hrs

Practicals

1. Study of different plant viruses through photographs.
2. Construction of cryptogram of virus.
3. Gram staining of bacteria.
4. Observation of disease symptoms in hosts infected by fungi:

   Black-wart disease of potato, White rust of crucifers, Stem galls of coriander, Downy mildew of bajra, Rust of wheat, Karnal bunt of wheat, *Melampsora lini*, Smut disease caused by *Ustilago*, Tikka disease of groundnut, , Powdery mildew of wheat and grapes, Ripe fruit rot of chillies.

6. Study of the following genera included under algae:

   Vaucheria, *Ulva*, *Codium*, *Halimeda*, *Caulerpa*, *Acetabularia*, *Cladophora*, *Pithophora*, *Chlorella*, *Hydrodictyon*, *Oedogonium*, *Ulothrix*, *Chara*, *Spirogyra*, *Microcystis*

7. Study of morphology, reproductive structures and anatomy of the bryophytes:

   Marchantia, Targionia, Plagiochasma, Dumortiera, Reboulia, Conocephalum, Funaria, Anthoceros

SUBJECT TITLE: PTERIDOPHYTES AND GYMNOSPERMS
SUBJECT CODE: MBOT-1201
SEMESTER: II
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40

Program name: Master of Botany
Program Code: MBOT401

End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

- The aim of this course is to ensure that you can achieve an up-to-date level of understanding of structure and importance of Pteridophytes and spermatophytes.
- Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.
- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideas of the students. And hence will serve as a lasting and practical basis for a career.

Section-A **20 hours**

Pteridophytes

1. An account of classification, ecological distribution and economic importance; evolution of stele. Fossil order of Pteridophytes
2. Reproduction and life cycle in various divisions, classes and orders evolutionary relations.
3. Fern and fern allies; Lycopsida, Splenopsida, Pteropsida
4. Evolutionary trends in pteridophytes, prothallial evolution, organization and evolution of sorus in ferns, role of polyploidy and hybridization in speciation in ferns, apomictic life cycle, apogamy, apospory, heterospory and development of seed habit.

Section-B **20 hours**

Gymnosperms

1. Characteristic features, origin and evolution, classification and economic importance of Gymnosperms.
2. General structure and evolution of male gametophyte, archegonium and seed and polyembryony in Gymnosperms.

Section-C **20 hours**

1. A general account of Cycadeoidales Cyacadofilicales, Pentoxylales,
2. A general account of Cycadales, Cordaitales,
3. A general account of Coniferales, Ginkgoales, Taxales
4. A general account of Ephedrales, Gnetales, Welwitschiales

Course outcomes

CO1	MBOT-1201.1	Students will learn and understand the diversity and taxonomy of Pteridophytes and Gymnosperms.
CO2	MBOT-1201.2	Students will learn about the classification of Pteridophytes and Gymnosperms.
CO3	MBOT-1201.3	Students will learn about the structures, reproduction and life history of Pteridophytes and Gymnoperms.
CO4	MBOT-1201.4	Students will learn about the importance and roles of Pteridophytes and Gymnopserms.

Recommended readings

1. A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany by AVSS Samamurty. 2018. Publisher- Vedams book Publishers
2. https://gurukpo.com/Content/B.SC/Pteridophytes_Gymnosperms_&_Palaeobotany.pdf
3. Bhatanagar, S. P. and Moitra, A. 1996. *Gymnosperms*, New Age International Pvt. Ltd., New Dehli.

4. Chamberlain, C. J. 1934. *Gymnosperms : Structure and Evolution.* Doves (Reprinted New York).
5. Kubitzki, K. (Ed.) 1990. *The Families & Genera of Vascular Plants, Vol I Pteridophytes and Gymnosperms,* Springer-Verlag, Berlin, New York.
6. Pandey, S. N., Mirza, S. P. & Trivedi, P. S. 1997. *A Text Book of Botany - Vol II,* Vikas Pub. House Pvt.Ltd., New Dehli.
7. Pant, D. D. 1973. *Cycas and the Cycadales,* Central Book Depot, Allahabad.
8. Parihar, N. S. 1996. *Biology and Morphology of Pteridophytes,* Central Book Depot, Allahabad.
9. Raizda, M. B. & Salmi, K.C. 1958. *Indian Forest Records, Vol 5 No.2 - Living Indian Gymnosperms,* F. R. I. Pub. Dehra Dun.
10. Rashid A. 1999. *An Introduction to Pteridophyta,* Vikas Publication House Pvt. Ltd., New Dehli.
11. Sahni, K.C. 1990. *Gymnosperms of India and Adjacent Countries,* BSMPS, Dehra Dun.
12. Sharma, O. P. 2001. *Gymnosperms,* Pragati Prakashan, Meerut.
13. Sporne, K.R. 1965. T*he Morphology of Gymnosperms.* MIS Hutchinson & Co. Ltd., London.
14. Sporne, K.R. 1991. *The Morphology of Pteridophytes,* M/s Publishing Pvt. Ltd., Bombay.
15. Stewart, W. N. 1983. *Paleobotany and the Evolution of Plants,* Cambridge Univ. Press, London.
16. Stewart, W. N. & Rathwell, G. W. 1993. *Paleobotany and the Evolution of Plants,* Cambridge University Press.
17. Vasishta, P. C. 2003. *Gymnosperms.* S.Chand & Co. Ltd., New Dehli.

SUBJECT TITLE: TAXONOMY OF ANGIOSPERMS

SUBJECT CODE: MBOT-1202
SEMESTER: III
CONTACT HOURS/WEEK:4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

OBJECTIVE AND OUTCOME OF COURSE:

- The aim of this course is to ensure that you can achieve an up-to-date level of understanding the systems of angiosperm classification and importance of angiosperms.

- Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.

- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideas of the students. And hence will serve as a lasting and practical basis for a career.

INSTRUCTIONS FOR THE PAPER-SETTER

- The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

Contents of Syllabus:

Section-A **20 hours**

Morphology of stamens and carples – a brief account. A brief account on various taxonomic tools like Herbarium, Botanical Gardens, floras, computers and GIS. Relevance of taxonomy to plant conservation.

Salient features of various systems of classification (Bentham & Hooker, Engler and Prantl, Takhtajan, Hutchinson).

Section-B **20 hours**

Salient features of International code of Botanical Nomenclature (Principles, Ranks of taxa, typification, Principle of priority and citation of authors' names).

Botanical Survey of India – its organization and role. Phylogeny of Angiosperms: Origin, Evolution and inter-relationship of dicots and monocots.

Section C

Salient features and economic impotance of following families of Dicots:

Ranunculaceae, Rutaceae, Rosaceae, Cruciferae, Leguminosae, Magnoliaceae, Fumariaceae, Malvaceae, Anacardiaceae, Solanaceae, Asclepediaceae Cucurbitaceae, Umbelliferae, Compositae, Apocynaceae, Labiatae, Amaranthaceae, Euphorbiaceae and *Cannabinaceae.*

Salient features and economic importance of following families of

Monocots: *Orchidaceae, Agavaceae, Liliaceae* and *Graminae*.

Course outcomes

CO1	MBOT-1202.1	Students will learn and understand the diversity and taxonomy of Angiosperms
CO2	MBOT-1202.2	Students will learn about the classification of Angiosperms.
CO3	MBOT-1202.3	Students will learn about the structures, reproduction and life history of Monocots and Dicots .
CO4	MBOT-1202.4	Students will learn about the importance and roles of Monocots and Dicots.

Recommended readings

1. Judd. W.S. et al. 2012. Plant Systematics, 2nd. Ed. Sunderland
2. T Pullaiah and Karupussamy S., Taxonomy of Angiosperms, 2018, 4th edition. Astral Publications.
3. https://ncerthelp.com/text.php?ques=1401+Morphology+of+Flowering+Plants++Class+11+Notes+Download+in+PDF#:~:text=The%20angiosperms%20are%20characterized%20by,of%20radicle%20of%20the%20embryo.&text=1.,Tap%20root%3A%20Originates%20from%20radicle.
4. Pandey, S.N. and S.P. Misra. Taxonomy of Angiosperms. Ane Books, India. 2018.
5. Sharma,O.P.2012. Plant Taxonomy. Tats McGraw-Hill Publishing Company Limited, New Delhi.
6. Stebbins, G. L. 1974. *Flowering Plant-Evolution Above Species Level*, Edward Arnold Ltd., London.
7. Stace, C. A. 1989. *Plant Taxonomy and Biosystematics* (2nd Edition), Edward Arnold Ltd., London.
8. Takhtajan. A. L. 1997. *Diversity and Classification of Flowering Plants*, Columbia University Press, New York.
9. Woodland, D.W. 1991. *Contemporary Plant Systematics*, Prentice Hall, New Jersey.

Program name: Master of Botany
Program Code: MBOT401

SUBJECT TITLE: PLANT PHYSIOLOGY& METABOLISM

SUBJECT CODE: MBOT-1203
SEMESTER: II
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

- The aim of this course is to ensure that you can achieve an up-to-date level of understanding of different mechanism occur in plants.
- Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.
- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideas of the students. And hence will serve as a lasting and practical basis for a career.

Section-A **20 hours**

Absorption of water and ascent of sap: Apoplast-Symplast concept, active and passive absorption of water, root pressure theory, physical force theory, transpiration pull and cohesion of water theory.
Translocation of organic solutes: Introduction, direction of translocation- source-sink relation, path of translocation, mechanism of translocation through phloem- Munch's hypothesis, phloem loading and unloading, assimilates partitioning, difference between xylem and phloem transport.

Section-B **20 hours**

Photosynthesis: Photosynthetic pigments and light harvesting complexes, Emerson effect, absorption spectrum, action spectrum, Hill's reaction, mechanism of electron and proton transport; carbon assimilation- calvin cycle, photorespiration and its significance, C_4 cycle, CAM pathway, biosynthesis of starch and sucrose.

Respiration: Glycolysis, TCA cycle, electron transport and ATP synthesis, pentose phosphate pathway, cyanide resistant respiration pathway, gluconeogenesis, interconversion of hexoses and pentoses, respiratory quotient, biochemical control of respiration in plants.
Nitrogen metabolism: Biological nitrogen fixation, nodule formation and nod factors, mechanism of nitrate uptake and reduction, ammonium assimilation.

Section-C **20 hours**

Stress physiology: Introduction to concept of stress and strain, biotic and abiotic stress, elastic and plastic biological strains, stress resistance mechanisms-avoidance, tolerance, acclimation, water deficit and drought resistance, salt stress and resistance, cold injury and cold resistance, high temperature stress.
Photoperiodism: Introduction, photoperiodic induction, perception of photoperiodic stimulus and role of florigen
Vernalization & Photomorphogenesis: Introduction, conditions necessary for vernalization, mechanism of vernalization, devernalization, vernalization and gibberellins, significance of vernalization, Phytochrome and cryptochrome mediated photoresponses in plants, mechanism of action of photomorphogenetic receptors- cryptochromes, phototropin, Zeaxanthin.

Course outcomes

CO1	MBOT-1203.1	Students will learn and understand the importance, translocation and role of water in plants
CO2	MBOT-1203.2	Students will learn about the Biochemical fundamental process like Photosynthesis and Respiration.
CO3	MBOT-1203.3	Students will learn about the stress factors and consequence of stress in Plants.
CO4	MBOT-1203.4	Students will learn about the importance of Photoperiodism and vernalization in Plants.

Recommended readings

1. Salisbury, F.B. and Ross, C. (1992). Plant Physiology, Wordsworth Publications Co., California.
2. Taize, L. and Zeiger, E. (2010). Plant Physiology, 5th ed. Sinauer Associates, Inc. PI. Massachusetts, USA.
3. Srivastava, L.M. (2005). Plant Growth and Development: Hormones and Environment. Academic Press, New Delhi.
4. Hopkins, W.G. and Hüner, N.P.A. (2009). Introduction to Plant Physiology (4th Ed.) Wiley & Sons. Inc. USA.
5. Conn, E.E., Stumpf, P.K., Bruening, G and Doi, R.H. (2005). Outlines of Biochemistry, John Wiley & Sons, Singapore.
6. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. (2000). Molecular Cell Biology (4th Eds.) W.H. Freeman Company, England.

SUBJECT TITLE: PLANT TISSUE CULTURE & BIOTECHNOLOGY
SUBJECT CODE: MBOT-1204
SEMESTER: IV
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

- The aim of this course is to ensure that you can achieve an up-to-date level of understanding of mechanism used in plant tissue culture.
- Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.
- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideas of the students. And hence will serve as a lasting and practical basis for a career.

Section-A **20 hours**

Introduction: History, Scope & Significance of plant tissue culture. Culture media, concepts of cellular differentiation, totipotency.

Types of cultures: Cytodifferentiation, Organogenic differentiation, embryo culture, callus culture and Organ culture- prospects and applications.

Somatic embryogenesis: Mechanism, techniques and utility; synthetic seed production.

Section-B **20 hours**

Organogenesis and Micropropagation: Direct and Indirect Organogenesis, Axillary bud proliferation approaches (Meristem and shoot tip culture, Single node culture), Micropropagation.

Cryopreservation and Germplasm Storage: *In vitro* germplasm conservation, methods and application of cryopreservation, establishment of gene banks.

Somaclonal variations: Selection of somaclonal variants, mechanisms and their applications.

Haploids production:*In vitro* production of haploids and their significance, Androgenesis (Anther culture, microspore culture), Gynogenesis (Ovary culture and ovule culture).

Somatic hybridization: Protoplast isolation, fusion, Selection of hybrid cells, Regeneration of hybrid plants, cybrids. Applications and limitations.

Section-C **20 hours**

Plant Biotechnology: Introduction and Scope of plant biotechnology

Gene Cloning Vectors: Enzymes used in cloning, Plasmids, phages, cosmids, phagemids, transposons, artificial chromosomes, BAC, YAC, MAC, shuttle and expression vectors.

Cloning strategies: Genomic libraries, Preparation of DNA fragments for cloning. Positional cloning, chromosome walking, chromosome jumping. C-DNA Synthesis & Cloning. Probe preparation (radiolabelled & non-radiolabelled).

Gene transfer methods in plants: Different methods of gene transfer to plants-electroporation, cation precipitation, liposomes, $CaNO_3$ microinjection and particles gun technology, expression of transgenes, *Agrobacterium* mediated gene transfer.

Transgenic plants: Production of transgenic plants with respect to insect-pest resistance (insect, viral, fungal and bacterial disease resistance), abiotic stress resistance, herbicide resistance, storage protein quality, increasing shelf-life, oil quality.

Course outcomes

CO1	MBOT-1204.1	Students will learn and understand the culturing and somatic embryogenesis.
CO2	MBOT-1204.2	Students will learn about the micropropagation, germplasm,somaclonal variation and haploid production.
CO3	MBOT-1204.3	Students will learn about the Plant Biotechnology and cloning strategies.
CO4	MBOT-1204.4	Students will learn about the gene transsfer methods in plants and transgenic plants.

Recommended readings

1. Lehninger Principles of Biochemistry – 7th edition, 2017. David L. Nelson and Michael M. Cox
2. Cell and Molecular Biology: Concepts and Experiments – Gerald Karp, 2019.
3. Plant Breeding principles & Methods – 2019 – B.D. Singh
4. Basic Ecology: Fundamentals of Ecology – Eugene P. Odum
5. Essential Immunology – Ivan M. Roitt
6. Roitt's Essential Immunology: Includes Desktop Edition – Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt
7. ENZYMES: Biochemistry, Biotechnology, Clinical Chemistry, 2/E – Trevor Palmer and Philip Bonner
8. Genetics: Principles and Analysis – Daniel L. Hartl and Elizabeth W. Jones
9. Molecular Cloning: A Laboratory Manual – Joseph Sambrook and David Russell
10. Genomes 3 – T.A. Brown 2012, Bios Scientific Pub., Oxford, U.K.

11. Chawla H.S. 2015*Introduction to Plant Biotechnology*, Oxford & IBH Pub., New Delhi, India.

SUBJECT TITLE: BIOANALYTICAL TECHNIQUES
SUBJECT CODE: MBOT-1205
SEMESTER: II
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

- The aim of this course is to ensure that you can achieve an up-to-date level of understanding of different techniques used in plant science.
- Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.
- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideas of the students. And hence will serve as a lasting and practical basis for a career.

Section-A **20 hours**

Microscopy: Principles and applications of Microscopy. Light, Electron, Dark field, Bright Field, Phase contrast, confocal, fluorescence, scanning & transmission electron microscopy, Atomic Force Microscopy.

Spectroscopy: Concepts of spectroscopy, Laws of photometry. Beer-Lambert's law, Principles and applications of colorimetry. Visible and UV spectroscopy, ORD, CD, X-ray diffraction, X-ray absorption, ESR, and NMR.

Section-B **20 hours**

Chromatography: Principles and applications of paper, thin layer, ion exchange, affinity, gel permeation, HPLC, GC, adsorption and partition chromatography.

Electrophoretic Techniques: Principles of electrophoretic separation. Types of electrophoresis including paper, cellulose, acetate/nitrate and gel. Electroporation, Pulse field gel electrophoresis. 2D electrophoresis, Isoelectric focusing (IEF).

Centrifugation: Principle of centrifugation, differential and density gradient centrifugation, analytical ultra-centrifugation.

Section-C **20 hours**

Immuno techniques: Detection of molecules using ELISA, RIA, Blotting techniques and its application, immunoprecipitation and immunofluorescence microscopy.

Histochemical Techniques: FISH, GISH, Flow cytometry

Radiolabeling Techniques: Detection and measurement of radioisotopes normally used in biology; incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactivematerial, safety guidelines.

Course outcomes

CO1	MBOT-1205.1	Students will learn and understand the importance and applications of Microscopy and spectroscopy.
CO2	MBOT-1205.2	Students will learn about the chromatography, Electrophoretic Techniques and centrifugation.
CO3	MBOT-1205.3	Students will learn about the importance and applications of immunotechniques and histochemical techniques.
CO4	MBOT-1205.4	Students will learn about the importance and applications of radiolabeling techniques.

Recommended readings

1. Wilsons and Walker, Principles and Techniques in Biochemistry and Molecular Biology, 8th edition, 2019.
2. "Bioanalytical Techniques" by Abhilasha Shourie and Shilpa S Chapadgaonkar, 2020
3. "Fundamentals of Bioanalytical Techniques and Instrumentation" by Sabari and Ghoshal, 2017. Aidas Publishers
4. "Advances in Chemical Bioanalysis (Bioanalytical Reviews)" by Frank-Michael Matysik,
5. "Immunoassay and Other Bioanalytical Techniques" by Jeanette M van Emon,
6. "Introduction to Bioanalytical Sensors (Techniques in Analytical Chemistry)" by Alice J Cunningham,
7. "Biosimilars of Monoclonal Antibodies "A Practical Guide to Manufacturing, Preclinical, and Clinical Development" by Cheng Liu and K John Morrow, Sheo Li Bookas, 2017
8. "High Throughput Bioanalytical Sample Preparation: Methods and Automation Strategies" by David A Wells, 2012, Cambridge publishers, London.

SUBJECT TITLE: Practical Paper-I
SUBJECT CODE: MBOT-1206
SEMESTER: II
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	6	3

Duration of Exam; 3 Hrs

Practicals

1. Study of *Selaginella, Lycopodium, Equisetum, Pteris, Marsilea*
2. Study of Cycas- Leaf and coralloid
3. Study of Pinus- Leaf and coralloid
4. Study of basic structure of flower, variations, floral parts in detail, floral symmetry, insertion of floral parts of following families: Brassicaceae, Rosaceae, Solanaceae, Fabaceae, Meliaceae, Euphorbiaceae, Poaceae.
5. Herbarium (minimum of 20 Herbarium sheets of common plants of Angiosperms & Gymnosperms) with the proper field note book shall be submitted at the Practical Examination.

6. To prepare stock MS solution of different strength.
7. To check pH of given solution using pH strip and pH meter.
8. To study technique of micropropagation by using different explants e.g. auxiliary buds, shoot meristems in MS medium.
9. To study effect of ratio of cytokinin to auxin in MS medium on the growth of explants *in vitro.*
10. Preparation of synthetic seeds.
11. Isolation of plant gnomic DNA by CTAB method.
12. DNA check run by Agarose Electrophoresis.

SUBJECT TITLE: Practical Paper-II
SUBJECT CODE: MBOT-1207
SEMESTER: I1
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	6	3

Duration of Exam; 3 Hrs

Practical's

1. Comparison of loss of water from two surfaces of leaf by four leaf method.
2. To study the effect of temperature on permeability of plasma membrane.
3. To study the process of plasmolysis and deplasmolysis.
4. To study the process of osmosis by using potato osmometer.
5. Demonstration of the path of ascent of sap by eosin ringing experiment.
6. Demonstration of phototropism and geotropism.
7. To study the structure of stomata by preparing a temporary slide of leaf peel.
8. To study the distribution of stomata on the two surfaces of leaf from temporary slide and find the stomatal index.
9. Demonstration of Hill reaction.
10. Demonstration of necessity of CO_2 for photosynthesis- Moll's half leaf experiment.
11. Demonstration of necessity of light and chlorophyll for photosynthesis.
12. Bioassays of different plant growth regulators.
13. Calibration of microscope.
14. Separation of photosynthetic pigments by paper chromatography.

SUBJECT TITLE: PLANT ANATOMY AND PLANT RESOURCE UTILIZATION
SUBJECT CODE: MBOT-2301

Program name: Master of Botany
Program Code: MBOT401

SEMESTER: III
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

- The aim of this course is to ensure that you can achieve an up-to-date level of understanding the anatomy of plant parts.
- Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.
- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideas of the students. And hence will serve as a lasting and practical basis for a career.

Section-A **20 hours**

The Shoot and Root System: Primary structure and basic vasculature, the root-stem transition, secondary growth in stems and roots, origin of cambium and its activity, anomalous secondary growth, polycyclic vasculature, secondary meristems: origin and function, the role of pericycle, phellogen, phellem, phelloderm, distribution of sclerenchyma in leaves, stem and roots.

Xylem: Constituents, Differentiation of treachery elements– ultrastructural approach. Variation in wood structure.

Phloem: Constituents, Differentiation of sieve elements and companion cells – an ultrastructural approach. Abnormal behavior of cambium in angiosperms.

Laticifers and Lenticels: Types and distribution, anatomy in relation to physiological roles

Leaf: Development of leaf, variation in anatomical structure, Kranz anatomy, Leaf abscission, Transfer Cells.

Seed Anatomy: Internal anatomy of dicot and monocot seeds with reference to legumes and cereals.

Section-B **20 hours**

Food crops: Origin and history of botany, cultivation, botany and uses of wheat, rice and maize, Sugar crops-sugarcane, tuber crops-potato.

Fibre crops: Classification, uses and types of fibers, morphology, cultivation and uses of cotton, flax, hemp, sisal.

Fodder crops: Origin, cultivation and uses of sorghum, barseem, guar.

Oil yielding plants: Origin, history, cultivation and uses of mustard, coconut, groundnut and sunflower.

Beverages crops: Origin,history, cultivation, processing, chemical composition and uses of tea and coffee

Section-C **20 hours**

Medicinal Plants: Botanical name, family, plant part yielding active principle and uses of *Aconitum, Cinchona, Belladona, Glycyrrhiza, Rauvolfia, Azadirachta, Ocimum, Justicia, Papaver, Vasaka, Aloe, Paenex.*

Spices and Condiments: Botanic name, family, plant part yielding active principle and uses of Ginger, Turmeric, Cinnamon, Cloves, Cardamom, Chillies, Pepper, Fennel, Coriander, Cumin, Nutmeg and Mace and Saffron.

Timber plants: Soft wood and hard woods, botanic name, family, distribution and uses of teak, sal, deodar, sisham, kikar.

Gums and Resins: A brief account of the gums, resins, tannis, dyes, raw materials for paper and pulp industry.

Course outcomes

CO1	MBOT-2301.1	Students will learn and understand the Root system, Shoot System, Xylem Phloem and other tissues of plants

CO2	MBOT-2301.2	Students will learn about the Food crops, Fiber crops, oil yielding plants and beverages plants.
CO3	MBOT-2301.3	Students will learn about the importance and use of medicinal plants
CO4	MBOT-2301.4	Students will learn about the importance and use of spices and condiments, Timber plants, and Gums and Resins

Recommended readings

9. https://icar.org.in/node/1823
10. https://www.onlinebooksstore.in/icar-handbook-of-horticulture-by-indian-council-of-agriculture-reserch-new-delhi
11. https://www.pau.edu/content/ccil/pf/pp_rabi.pdf
12. http://www.kvkfaridkot.com/pp_kharif_2014.pdf
13. Dawes, C.J., Biological Techniques in Electron Microscopy, Barnes & Noble, Inc., New York, 1971.
14. Esau, K., Anatomy of Seed Plants, John Wiley, New York, 1977.
15. Fahn, A., Plant Anatomy, Pergamon Press, Oxford, 1990.
16. Jane, F.W., The Structure of Wood, Adam and Charles Black, London, 1970.
17. Metcalfe, C.R. and Chalk, L., Anatomy of Dicotyledons, Clarendon Press, Oxford, 1950.
18. Vijayraghwan, M.R. and Shukla, A.R., Histochemistry – Theory and Practice, Bishan Singh, Mohinder Pal, Dehradun, 1990.

7 Kochhar, S.L. 1998. Economic Botany in the Tropics, 2nd Edition, MacMillan Indian Ltd., New Delhi.

SUBJECT TITLE: PLANT DEVELOPMENT AND REPRODUCTION
SUBJECT CODE: MBOT-2302
SEMESTER: III
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40

Program name: Master of Botany
Program Code: MBOT401

End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

- The aim of this course is to ensure that you can achieve an up-to-date level of understanding the growth and development in plants.
- Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.
- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideas of the students. And hence will serve as a lasting and practical basis for a career.

Section-A **20 hours**

Seed germination and seedling growth: Metabolism of nucleic acids, proteins and mobilization of food reserves; tropisms; hormonal control of seed growth; use of mutants in understanding seedling development.

Root development: Organization of root apical meristem (RAM); cell fates and lineages; vascular tissue differentiation; lateral roots; root hairs; root-microbe interaction.

Shoot Development: Organization of shoot apical meristem (SAM); cytological and molecular analysis of SAM; control of cell division and cell to cell communication; control of tissue differentiation.

Leaf growth and differentiation: Phyllotaxy; control of leaf form; differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll.

SECTION-B

Flower development: Genetics of floral organ differentiation; homeotic mutants in *Arabidopsis* and *Artirrhinum*; sex determination.

Fruit growth and development: Dynamics of fruit growth; biochemistry and molecular biology of fruit maturation; fruit types; parthenocarpy.

Vegetative Reproduction: Vegetative options: significance of vegetative reproduction in plants of horticultural, floral and agricultural crops.

Sexual Reproduction: Male and female gametophyte, microsporogenesis; role of tepetum; pollen development; male sterility; sperm dimorphism; pollen germination; pollen tube growth and guidance; pollen storage; pollen allergy; pollen embryos. Ovule development: megasporogenesis: organization of embryo sac; structure of embryo sac cells.

Pollination and pollen pistil interaction: Floral characteristics, pollination mechanisms and vector; breeding systems; structure of the pistil; pollen-stigma interactions, sporophytic and gametophytic self-incompatibility.

SECTION-C

Fertiliztion and seed development: Double fertilization; *in vitro* fertilization; hybrid seed.

Development of embryo in monocot and dicot: Somatic embryogeny, organogenesis, cytodifferentiation.

Embryogenesis: Endosperm types and development; polyembryony; apomixis, types, causes and application.

Latent Life-dormancy: Importance and types of dormancy; seed dormancy; methods overcoming seed dormancy; bud dormancy.

Senescence and Programmemed cell death (PCD): Basic concepts, types of cell death, PCD in the life cycle of plants; metabolic changes associated with senescence and its regulation; influence of hormones and environmental factors on senescence.

Course outcomes

CO1	MBOT-2302.1	Students will learn and understand the seed germination and growth, root and shoot development, leaf development.

CO2	MBOT-2302.2	Students will learn about the flower and fruit development.
CO3	MBOT-2302.3	Students will learn about vegetative propagation, sexual reproduction and pollination in plants.
CO4	MBOT-2302.4	Students will learn about the fertilization, seed development, life dormancy, senescence and Proggrame cell death

Recommended readings

1. Bewley, J.D. and Black, M. 1994. Seeds: Physiology of Development and Germination, Plenum Press, New York.
2. Fahn, A. 1982. Plant Anatomy. (3rd Edition). Pergamon Press, Oxford.
3. Fosket, D.E. 1994. Plant Growth and Development: A molecular Approach, Academic Press, San Diego.
4. Howell, S.H. 1998. Molecular genetics of Plant Development. Cambridge University Press, Cambridge.
5. Lyndon, R.F. 1990. Plant Development. The Cellular Basis, Unnin Hyman, London.
6. Murphy, T.M. and Thompson, W.F.1988. Molecular Plant Development, Prentice Hall, New Jersey.
7. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4th Edition), Wadsworth Publishing, Belmont, California.
8. Waisel, Y., Eshel, A. and Kafkaki, U. (eds.) 1996. Plant Roots: The Hidden Hall (2nd Edition), Marcel Dekker, New York.
9. Shivana, K.R. and Sawhney, V.K. (eds.) 1997. Pollen Biotechnology for Crop Production and Improvement. Cambridge University Press, Cambridge.
10. The plant Cell. Special issue on Reproductive Biology of Plants, Vol. 5 (10) 1993. The American Society of Plant Physiologists, Rockville, Maryland, USA.

11. Srivastava, L.M. (2005). Plant Growth and Development: Hormones and Environment, Academic Press, New Delhi.
12. Atwell, B.J., Kridermann, P.E. and Jurnbull, C.G.N. (eds.) 1999. Plants in Action: Adaption in Nature, Performance in Cultivation, MacMillan Education, Sudney, Australia.
13. Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th revised and enlarged edition), Vikas Publishing House, New Delhi
14. Fageri, K. and Vander Pijl, L. 1979. The Princples of Pollination Ecology, Pergamon Press, Oxford.
15. Proctor, M. and Yeo, P. 1973. The Pollination of Flowers. William Collin, Sons, London.
16. Raghavan, V. 1997. Molecular Embryology of Flowering Plants, Cambridge University Press, London.
17. Raghavan, V. 1999. Developmental Biology of Flowering Plants, Springer-Verlag, New York.
18. Raven, P. H. , Elvelrt, R.F. and Eichorn, S.E. 1992. Biology of Plants (5th Edition), Worth, New York.
19. Waisel, Y., Eshel, A. and Kafkaki, U. (eds.) 1996. Plant Roots: The Hidden Hall (2nd Edition), Marcel Dekker, New York.
20. Shivana K.R. and Sawhney, V.K. (eds.) 1997. Pollen Biotechnology for Crop Production and Improvement. Cambridge University Press, Cambridge.
21. Shivana K.R. and Rangaswamy, N.S. 1992. Pollen Biology: A Laboratory Manual, Springer-Verlag, Berlin.
22. The plant Cell. Special issue on Reproductive Biology of Plants, Vol. 5 (10) 1993. The American Society of Plant Physiologists, Rockville, Maryland, USA.

SUBJECT TITLE: STATISTICAL TECHNIQUES
SUBJECT CODE: MBOT-2303
SEMESTER: III
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40

Program name: Master of Botany
Program Code: MBOT401

End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

- The aim of this course is to ensure that you can achieve an up-to-date level of understanding of statical technique in biology.
- Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.
- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideas of the students. And hence will serve as a lasting and practical basis for a career.

Section-A **20 hours**

Basic statistics: Measures of central tendency (Arithmetic mean, geometric mean, harmonic mean, median, mode), z-score, quartiles, deciles, percentiles

Dispersion: Range, quartile deviation, mean deviation, variance, standard deviation, standard error, coefficient of variation

Section-B **20 hours**

Probability: Basic concept of probability, probability distributions (Normal, Binomial and Poisson)

Correlation and regression: Linear and non-linear correlation, measures of correlation, regression coefficient, types of correlation

Analysis of variance: Types of ANOVA, F-test, computation of analysis of variance

Section-C **20 hours**

Student's t-test: Degree of freedom, t-test for single mean and grouped data, types of t-tests

Chi-square test: Determination of chi-square, chi-square distribution, 2×2 contingency table

Non-parametric test: Sign test; Run & Median test; Wilcoxon Signed Rank Mann-whiteney test; Kruskal Wallis test.

Course outcomes

CO1	MBOT-2303.1	Students will learn basic statistics and, concept and applications of Dispersion.
CO2	MBOT-2303.2	Students will learn about concept and application of Probability in Statistics.
CO3	MBOT-2303.3	Students will learn about correlation and regression, ANOVA and f test.
CO4	MBOT-2303.4	Students will learn about the student t test, chi square test and non parametric test.

Recommended readings

1. Bailey, N.T.J. (1995). Statistical Methods in Biology. Cambridge University Press, Cambridge.
2. Ludwig, J. and Reynolds, J.F. (1988). Statistical Ecology. John Wiley & Sons, New York.
3. Sokal, R.R. and Rohlf, F.J. (1995). Biometry. W.H. Freeman & Co. San Francisco.

SUBJECT TITLE: MOLECULAR BIOLOGY
SUBJECT CODE: MBOT-2304
SEMESTER: II
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

The aim of this course is to ensure that you can achieve an up-to-date level of understanding of Genomic level in plants.

Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.

The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideas of the students. And hence will serve as a lasting and practical basis for a career.

Section-A **20 hours**

DNA topology: DNA supercoiling, linking number, twist and writhe, C-value paradox, cot curves, repetitive DNA, satellite DNA.

DNA Replication: Semi-conservative replication, mechanism of replication in eukaryotes and prokaryotes, enzymes and proteins involved in DNA replication, variations in replication, Role of telomerase in replication of chromosomes in eukaryotes.

DNA Repair: Sources of DNA damage and mechanism of repair.

Section-B **20 hours**

Transcription: Concept of transcription unit, promoters and RNA polymerases; Mechanism of transcription in prokaryotes and eukaryotes, inhibitors of transcription, RNA splicing, RNA processing, RNA editing.

Translation: Genetic code, mechanism of translation in prokaryotes and eukaryotes, chaperons and protein folding, post-translational modification of proteins.

Section-C **20 hours**

Regulation of gene expression: Operon model (lac, tryptophan), attenuation, negative and positive control. Regulation of gene expression in eukaryotes at transcription and translation level.

Transposons: Transposable elements in bacteria and eukaryotes, their genetic significance, retrotransposons.

Introductory Genomics: Structural organization of genome in prokaryotes and eukaryotes; Organelle DNA- mitochondrial, chloroplast. Tools for genome analysis-Principles, type and applications; RFLP, AFLP, RAPD, SSR, SNP.

CO1	MBOT-2304.1	Students will learn about the structuserre and semiconservative DNA Replication.
CO2	MBOT-2304.2	Students will learn about the Protein synthesis.
CO3	MBOT-2304.3	Students will learn about the regulation of gene expression.
CO4	MBOT-2304.4	Students will learn about the Transpososns and applications of markers (barcoding)

Recommended readings

1. "Molecular Biology" by Friefelder David, "Gene VIII" by Lewin Benjamin 2020. , John Wiley & Sons. Inc. USA.
2. "Molecular Biology of the Gene" by Watson J D, 2016. The book publishers, Quinsland
3. "Molecular Biology and Genetics" by Weaver R F, 2019
4. Karp, G. 1999. *Cell and Molecular Biology : Concepts and Experiments*, John Wiley & Sons. Inc. USA.
5. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Waston, J.D. 2019. *Molecular Biology of the Cell*, Garland Publication Inc., New York.

SUBJECT TITLE: PLANT BREEDING
SUBJECT CODE: MBOT-2305

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)

Program name: Master of Botany
Program Code: MBOT401

SEMESTER: III
CONTACT HOURS/WEEK: 4

4	**0**	**0**	**4**

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

- The aim of this course is to ensure that you can achieve an up-to-date level of understanding the cultivation and uses of different plants.
- Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.
- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideas of the students. And hence will serve as a lasting and practical basis for a career.

Contents of Syllabus:

Section-A **20 hours**

1. Introduction : Plant breeding - Defination, and History, Nature, Scope, disciplines of a breeder, Role , Objectives, tools of plant breeding, activities in plant breeding,

2. Mode of reproduction in crop plants, Asexual and Sexual reproduction, mating system in plants. Types, mechanism and utility of self incompatibility, apomixis and male sterility in plant breeding.

3. Self and Cross pollination methods in crops, Plant genetic resources: centers of origin, gene pool concept, primary secondary and tertiary gene pool; Germplasm evaluation and conservation.

Section-B **20 hours**

4. Plant introduction and selection (pure line selection, mass selection, recurrent selection and clonal selection) as methods of plant breeding

5. Hybridisation: procedure, choice of parents, pedigree and bulk methods, back cross methods, composite crosses, wide crosses: significance, cross ability, barriers and methods to overcome, Release of new variety

Section-C **20 hours**

6. Heterosis breeding: hybrid varieties, synthetic varieties

7. Mutation breeding: procedure, Basics of haploidy and polyploidy in plant breeding

8. Molecular markers: types of molecular markers, mapping of molecular markers, marker assisted selection (MAS) for disease resistance and qualitative trait loci (QTLs) and applications of MAS in breeding.

Course outcomes

CO1	MBOT-2305.1	Students will learn about history nature, objective and scope of Plant Breeding.
CO2	MBOT-2305.2	Students will learn about modes of reproduction in Plants.
CO3	MBOT-2305.3	Students will learn about heterosis, haploidy, polyploidy in plant breeding.
CO4	MBOT-2305.4	Students will learn about the molecular markers, mapping of molecular markers, marker assisted selection (MAS) for disease resistance and qualitative trait loci

		(QTLs) and applications of MAS in breeding.

RECOMMENDED READINGS :

1. Singh, B.D. 2018. Plant Breeding, Kalyani Publishers, New Delhi.

2. Allard, R.W. 2011. Principles of Plant Breeding, John Wiley & Sons, Inc., Singapore.

3. Chaudhury, R.C. 1994. Introduction to Plant Breeding. Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi.

4. Gupta, P.K. 1999. Cytogenetics, Rastogi& co. Pub., Meerut, India

SUBJECT TITLE: Practical Paper-I
SUBJECT CODE: MBOT-2306
SEMESTER: III
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	6	3

Duration of Exam; 3 Hrs

Practicals

1. Study of morphology and anatomy of wheat, rice and maize.
2. Comparison of starch grains of wheat, rice, maize and potato.
3. Morphology and microscopic structure of spices pertaining to theory syllabus.
4. Morphology and microscopic structure of Oil yielding plants.
5. Prepare a list of 10 most important sources of firewood, timber and medicinal plants in your locality. Give their local names, scientific names and families to which they belong. Mention their properties.
6. To study the anatomy of dicot and monocot root, stem and leaves.
7. Study of anomalous secondary growth in stem.
8. Study of ergastic substances.
9. Study of T.S. of monocot and dicot seed.
10. Examination of flowers for their pollination mechanism.
11. Structure of anther, microsporogenesis using slides.
12. Study of pollen grains and pollinia using whole mounts.

13. Structure of ovule and embryo sac.
14. Study of nuclear and cellular endosperm using slides.
15. Determination of seed viability using tetrazolium chloride.

SUBJECT TITLE: Practical Paper-II
SUBJECT CODE: MBOT-2307
SEMESTER: III
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	6	3

Duration of Exam; 3 Hrs

Practicals

1. Determination of Statistical averages/ central tendencies- mean, median and mode.
2. Determination of measures of dispersion- standard deviation, standard error and coefficient of variation.
3. Tests of significance- application of ANOVA, chi-square test, t-test.
4. Statistical problems related to probability, correlation and regression.
5. Study of DNA and RNA models
6. DNA isolation from plant cell and microbes.
7. Quantification of DNA by Spectrophotometer.
8. To study the self and cross fertilization methods of plant breeding.
9. To study the methods of selection in plant breeding.
10. To study the methods involved in hybridization.

.

5. Heyward, M;.D. , N.O. Bosemark and I. Romagosa 1993. Plant Breeding: Principles and Prospects, Chapman & Hall, Madras.

6. Miesfield, R.L. 1999. Applied Field Crops, Wiley-Liss, New York, USA.

7. Poehlman, J.M. 1987. Breeding Field Crops. An Avi Book Published by Van Nostrand Reinhold, New York.

8. Shamim. M, 2019. Introductory Plant Breeding, New Delhi Publishers., New Delhi.

SUBJECT TITLE: PLANT TISSUE CULTURE
SUBJECT CODE: MBOT-2401
SEMESTER: IV
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

- The aim of this course is to ensure that you can achieve an up-to-date level of understanding of mechanism used in plant tissue culture.
- Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.
- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideas of the students. And hence will serve as a lasting and practical basis for a career.

Section-A **20 hours**

Introduction: Basic techniques and scope of plant tissue culture, culture media, concepts of cellular differentiation, totipotency.

Types of Cultures: Cytodifferentiation, Organogenic differentiation, Embryo culture, Callus culture and Organ culture. Their prospects and applications.

Somatic Embryogenesis: Mechanisms, techniques and utility; synthetic seed production.

Section-B **20 hours**

Organogenesis and Micropropagation: Direct and Indirect Organogenesis, Axillary bud proliferation approaches (Meristem and shoot tip culture, Single node culture), Applications and Limitations of Micropropagation.

Cryopreservation and Germplasm Storage: *In vitro* germplasm conservation, methods and application of cryopreservation, establishment of gene banks.

Somaclonal variations: Selection of somaclonal variants, mechanisms and their applications.

Section-C **20 hours**

Haploids production: *In vitro* production of haploids and their significance, Androgenesis (Anther culture, microspore culture), Gynogenesis (Ovary culture and ovule culture).

Somatic hybridization: Protoplast isolation, fusion, Selection of hybrid cells, Regeneration of hybrid plants, cybrids. Applications and limitations.

Applications of plant tissue culture: Role of plant tissue culture and biotechnology in agriculture, medicine and human welfare.

Course outcomes

CO1	MBOT-2401.1	Students will learn about basic techniques in Plant tissue culture, types of culture and somatic embryogenesis.
CO2	MBOT-2401.2	Students will learn about organogenesis, Micropropagation, cryopreservation and germplasm storage.
CO3	MBOT-2401.3	Students will learn about heterosis, haploidy, polyploidy in plant breeding.
CO4	MBOT-2401.4	Students will learn about somatic hybridization, applications of plant tissue culture.

Recommended readings

1. Collins, H.A., and Edwards, S. 1998 *Plant Cell Culture,* Bios Scientific Pub., Oxford, U.K.
2. Vasil, I.K. and Thorpe, T.A. 1998 *Plant Cell and Tissue Culture,* Kluwer Academic Publ., Dordrecht, Boston, London.
3. Narayanaswamy, S. 2004. *Plant Cell and Tissue Culture,* Tata McGraw-Hill Pub., New Delhi India.
4. Singh, S.K. 2006 *Plant Tissue Culture,* Campus Books International Pub., New Delhi, India.
5. Chawla H.S. 2005 *Introduction to Plant Biotechnology,* Oxford & IBH Pub., New Delhi, India.

SUBJECT TITLE: BIOTECHNOLOGY AND GENETIC ENGINEERING
SUBJECT CODE: MBOT-2402
SEMESTER: IV
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

- The aim of this course is to ensure that you can achieve an up-to-date level of understanding of principles and application of biotechnology .
- Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.

- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideas of the students. And hence will serve as a lasting and practical basis for a career.

Section-A **20 hours**

Molecular Tools used in Genetic Engineering: Restriction endonucleases. DNA modifying enzymes- Nuclease, Polymerase, Enzymes that modify the ends of DNA molecules, DNA ligase-joining DNA Molecules. Homopolymer tailing, Linkers, Adaptors.

Gene Cloning Vectors: Plasmids, phages, cosmids, phagemids, transposons, artificial chromosomes, BAC, YAC, MAC, shuttle and expression vectors.

Cloning strategies: Genomic libraries, Preparation of DNA fragments for cloning. Positional cloning, chromosome walking, chromosome jumping. C-DNA Synthesis & cloning. Probe preparation (radiolabelled & non-radiolabelled).

Section-B **20 hours**

Techniques used in DNA Technology: Isolation and purification of nucleic acids. Nucleic acids hybridization: Southern, northern and western blotting hybridization. Gel Electrophoresis, DNA chip technology, DNA and protein sequencing methods, Gene amplification by PCR, DNA foot printing, DNA fingerprinting.

Gene transfer methods in plants: Different methods of gene transfer to plants- electroporation, cation precipitation, liposomes, $CaNO_3$ microinjection and particles gun technology, expression of transgenes, *Agrobacterium* mediated gene transfer.

Section-C **20 hours**

Transgenic plants: Production of transgenic plants with respect to insect-pest resistance (insect, viral, fungal and bacterial disease resistance), abiotic stress resistance, herbicide resistance, storage protein quality, increasing shelf-life, oil quality.

Tools for genome analysis: Principles, type and applications; RFLP, AFLP, RAPD, SSR, SNP.

Course outcomes:

CO1	MBOT-2402.1	Students will learn about molecular techniques in genetic engineering, gene cloning vectors and cloning stratigies.
CO2	MBOT-2402.2	Students will learn:Southern, northern and western blotting hybridization. Gel Electrophoresis, DNA chip technology, DNA and protein sequencing methods, Gene amplification by PCR, DNA foot printing, DNA fingerprinting.
CO3	MBOT-2402.3	Students will learn about production and importance of transgenic plants.
CO4	MBOT-2402.4	Students will learn about tools used for genome analysis.

Recommended readings

1. Purohit, S.S., Kothari, P.R. and Mathur, S.K. 1993. Basic and Agricultural Biotechnology, Agro Botanical Pub. Bikaner, India.
2. Rehm;, H.I. and Reed, S.G. (Eds.) 1995. Fundamentals of Genetic Engineering, Pallicut, London, UK.
3. Gupta, P.K. 1996. Elements of Biotechnology, Rastogi & Co., Pub., Meerut, India.
4. Hammond, J., McGarvey, P. and Yusibov, V. (Eds.) 1999. Plant Biotechnology – New Products and Applications, Springer Pub., New York, USA.
5. Lea, P. and Leegood, R.C. 1999. Plant Biotechnology and Molecular Biology (2nd Ed.) John Wiley & Sons, Ltd., England.

SUBJECT TITLE: PLANT ECOLOGY

Program name: Master of Botany
Program Code: MBOT401

SUBJECT CODE: MBOT-2403
SEMESTER: IV
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

- The aim of this course is to ensure that you can achieve an up-to-date level of understanding of interaction of plants and animals with environment.
- Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.
- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideas of the students. And hence will serve as a lasting and practical basis for a career.

Section-A **20 hours**

The Environment: Physical environment; biotic environment; biotic and abiotic interactions.

Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation– demes and dispersal, interdemic extinctions, age structured populations.

Section-B **20 hours**

Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.

Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.

Section-C **20 hours**

Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C, N, P); primary production and decomposition.

Environmental Global Issues: Ozone Depletion and Global warming: Green house gasses, strategies and measures to combat ozone depletion and Global warming; Acid rain; Eutrophication.

Conservation Biodiversity: Principles of conservation, major approaches to management, In situ and ex situ conservation.

Course outcomes

CO1	MBOT-2403.1	Students will learn about environment, habitat and niche.
CO2	MBOT-2403.2	Students will learn about Population ecology and species interaction.
CO3	MBOT-2403.3	Students will learn about ecological succession and community ecology.
CO4	MBOT-2403.4	Students will learn about structure and function of ecosystem, Global warming and how to conserve the Biodiversity for future survival of humans.

Recommended readings

1. Begon, M. Harper, J.L. and Townsend, C.R. 1996. Ecology. Blackwell Science, Cambridge, U.S.A.
2. Chapman, J.L. and Reiss, M.J. 1988. Ecology – Principles and Applications, Cambridgde University Press, U.K.

3. Odum, E.P. and Barrett, G.W. 2005. Fundamentals of Ecology. Thomson Books/Cole, United States.
4. Sharma, P.D. 1992. Ecology and Environment, Rastogi Publ. Meerut.
5. Tiwari, S.C. 1993. Concept of Modern Ecology, Bishan Singh Mahendra Pal Singh, Dehra Dun.

SUBJECT TITLE: FORESTRY
SUBJECT CODE: MBOT-2404
SEMESTER: IV
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	0	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Sections A will consist of twelve multiple choice questions carrying one mark each from all over the syllabus of concerned paper. Section B will have six questions of four marks each and section consist three questions of eight marks each from the respective sections of the syllabus.

OBJECTIVE AND OUTCOME OF COURSE:

- The aim of this course is to ensure that you can achieve an up-to-date level of understanding of forest types and its law for protection.
- Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.

- The course will increase critical thinking capacity, ability to design and execute an experiment, confidence and ability in communicating ideas of the students. And hence will serve as a lasting and practical basis for a career.

SECTION A

Silviculture: Definition, Regeneration : Types, Natural regeneration from seeds (different factors on which regeneration depends, seedlings establishment period), Regeneration from vegetative parts (Coppice, Root suckers, Cuttings, Layering, Grafting, Budding, Pollarding, Lopping and Pruning); Nursery making.

Forest Protection: Protection, causes and control of forest fires; Major diseases of forest plants.

SECTION B

Social and Urban Forestry: Social forestry - Non commercial farm forestry, scope and limitations of Non commercial forestry, community forestry, scope and limitations of community forestry, social land allocation programmes (Taungya system). Economic benefits of social forestry, Urban forestry.

Forest Laws and Forest Conservation: Salient features of the Indian Forest Act 1972 (preliminary, reserved forests, protected forests), different methods employed for conservation of forests.

SECTION C **20 hours**

Forests Types: Climate of India, different climatic regions of India. Central characters and distribution of the different forest types of India.

Forest Effects : General effects of forests on climate, control of runoff, effects on snow, soil erosion, wild life, pollution control, nutrient cycling, social values and ecotourism, economic values, floods, green belts and control of temperature.

Course outcomes

CO1	MBOT-2404.1	Students will learn about regeneration of forests and forest protection.
CO2	MBOT-2404.2	Students will learn difference and importance of social and urban forestry.
CO3	MBOT-	Students will learn about Laws of Forest protection.

	2404.3	
CO4	MBOT-2404.4	Students will learn about types of forests in India and effects of forests on environment.

SUGGESTED READINGS

1. Batish, D.R., R.K. Kohli, S. Jose and H.P. Singh. *Ecological Basis of Agroforestry*. CRC Press

2. Chaturvedi, A.N. *Forest Mensuration.* International Book Distributors, Dehradun. 403 pp. 1982.
3. Dwivedi, A.P. *A Text Book of Silviculture.* International Book Distributors, Dehradun. 505 pp. 2006.
4. Gopikumar, K., S. Gopakumar and E.V.Anoop. *Forest Nursery and Tree Husbandry*. International Book Distributors, Dehradun. 169 pp. 2003.
5. Jha, L.K. *Forestry for Rural Development.* APH Publishing Corporation, NewDelhi. 669 pp. 1996.
6. Khosla, P.K. and R.K.Kohli. *Social Forestry for Rural Development.* I.S.T.S. Solan, India. 1988.
7. Kohli, R.K., K.S. Arya, H.P. Singh and H.S. Dhillon. *Tree Directory of Chandigarh*. DNAES, Chandigarh, India. 1994.
8. Negi, S.S. *Forest Fires.* International Book Distributors, Dehradun. 164 pp. 2000.
9. Negi, S.S. *Elements of General Silviculture*. International Book Distributors, Dehradun. 316 pp.
2003.
10. Negi, S.S. *Hand Book of Forest Ecology and Biology*. Internat BookDistributors, Dehradun. 268pp. 2004.
11. Rangarajan, M. *Fencing the Forest* . Oxford University Press, New Delhi. 1996.

SUBJECT TITLE: Practical Paper-I
SUBJECT CODE: MBOT-2405
SEMESTER: IV
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	6	3

Duration of Exam; 3 Hrs

Practicals

13. To prepare stock MS solution of different strength.
14. To check pH of given solution using pH strip and pH meter.
15. To study technique of micropropagation by using different explants e.g. auxiliary buds, shoot meristems in MS medium.
16. To study the effect of addition of hormones in MS medium on the growth of explants *in vitro.*
17. To study effect of ratio of cytokinin to auxin in MS medium on the growth of explants *in vitro.*
18. Preparation of synthetic seeds.
19. Isolation of plant gnomic DNA by CTAB method.
20. DNA check run by Agarose Electrophoresis.

SUBJECT TITLE: Practical Paper-II
SUBJECT CODE: MBOT-2406
SEMESTER: IV
CONTACT HOURS/WEEK: 4

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	6	3

Duration of Exam; 3 Hrs

Practicals

1. To draw ecological pyramids based on number, biomass and energy utilization.
2. To estimate utilization of net productivity of leaves by primary consumers.
3. To determine minimum area required for a quadrat to study grassland community by species area curve method.
4. To determine the frequency, density and abundance of a grassland community by quadrat method.
5. To determine the community coefficient of two strands of an assigned grassland community.
6. To determine the primary productivity of an aquatic ecosystem.
7. To measure diameter at breast height (dbh), diameter over bark (dob) and diameter under bark (dub) and girth of trees.
8. To measure height of standing trees by Abney's level.
9. To determine the moisture content, specific gravity and weight density of common timber trees of Punjab.
10. To compare the anatomy of Hard wood and soft wood .
11. Propagation studies on important common forest trees of Punjab regarding Height and diameter increments (under similar soil conditions) at two months intervals under natural conditions of day length and temperature for young tree saplings of known age and represent the results in a graphic form.
12. Visit to the nearby forest nursery.

Program name: Master of Botany
Program Code: MBOT401