J.C. Bose University of Science & Technology, YMCA Faridabad

(NAAC Accredited "A" Grade University of State Govt. established by Haryana State Legislative Act No.21 of 2009)

Department of Life Sciences

Scheme and Syllabi

M.Sc. Botany

(SEMESTER- III and IV)

PROGRAM OUTCOMES OF PG PROGRAM OF FACULTY OF SCIENCES

PO1	**Knowledge**	Capable of demonstrating comprehensive disciplinary knowledge gained during course ofstudy
PO2	**Research Aptitude**	Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis
PO3	**Communication**	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large
PO4	**Problem Solving**	Capability of applying knowledge to solve scientific and other problems
PO5	**Individual and Team Work**	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
PO6	**Investigation of Problems**	Ability of critical thinking, analytical reasoning and research-based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PO7	**Modern Tool usage**	Ability to use and learn techniques, skills and modern tools for scientific practices
PO8	**Science and Society**	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices
PO9	**Life-Long Learning**	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
PO10	**Ethics**	Capability to identify and apply ethical issues related to one‘s work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects ofwork
PO11	**Project Management**	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

PROGRAMSPECIFICOUTCOMES(PSOs)

Theprogramspecificoutcomes(PSOs)arethestatementofcompetencies/abilitieswhichdescribet heknowledgeandcapabilities, thepost-graduate students will have obtained bytheend of the program.

Aftersuccessful completionofM. Sc. Botany,thestudents willbe able to

PSO1	Understanding the nature and basic concepts of all the plant groups, their metabolism, components at the molecular level, biochemistry, taxonomy and ecology. The course will make them aware of natural resources and environment and the importance of conserving it.
PSO2	Botanists are able to contribute to all these fields and therefore, are mainly employed with educational institutions, government or public sectors or companies in industries, such as agriculture or forestry, oil, chemical, biotechnology, environmental protection, drugs, genetic research, plant resources laboratories, plant health inspection services, lumber and paper, food, fermentation, nursery, fruit and so on.
PSO3	Inculcate strong fundamentals on modern and classical aspects of Botany, understand knowledge of Botany is an essential pre-requisite for the pursuit of many applied sciences. It will facilitate students for taking up and shaping a successful career in Botany and allied sciences.
PSO4	Knowledge gained through theoretical and lab-based experiments will generate technical personnel in various priority areas such as genetics, cell and molecular biology, plant systematics and biotechnology.

Scheme of M.Sc. Botany (Four Semester Course)

SEMESTER- III

Couse Code	Subject	Teaching hours per week			Maximum Marks		Total	Credits	Category Code
		L	T	P	Internal	External			
Discipline Core Course (DCC) – Compulsory									
MBOT 301	Developmental Biology	4	0	0	25	75	100	4	DCC
MBOT 302	Plant Systematics	4	0	0	25	75	100	4	DCC
MBOT 303	Physiology and Biochemistry	4	0	0	25	75	100	4	DCC
MBOT 304	Genetics	4	0	0	25	75	100	4	DCC
MBOT 305	Lab Course - I (Based on MBOT 301-302)	0	0	6	30	70	100	3	DCC
MBOT 306	Lab Course - II (Based on MBOT 303-304)	0	0	6	30	70	100	3	DCC
MBOT 307	Seminar				25	0	25	1	DCC
*Open Elective Course (OEC)									
XXX	*Open Elective Course	3	0	0	25	75	100	3	OEC
Total							**725**	**26**	

*Open Elective Course-The students have to choose one Open elective course related to another branch of Science/Engg. /other discipline required for enhancing professional performance as provided by the department/university.

OES-301A- Waste Management in Daily Life

OES-302A- Environmental Conservation

OCH 307A- Chemistry for sustainable Development

Scheme of M.Sc. Botany (Four Semester Course)

SEMESTER IV

Couse Code	Subject	Teaching hours per week			Maximum Marks		Total	Credits	Category Code
		L	T	P	Internal	External			
Discipline Core Course (DCC) – Compulsory									
MBOT 401	Plant Pathology	4	0	0	25	75	100	4	DCC
MBOT 402	Plant Anatomy and Resource Utilization	4	0	0	25	75	100	4	DCC
MBOT 403	Plant Biotechnology	4	0	0	25	75	100	4	DCC
MBOT 404	Lab Course (Based on MBOT 401-402)	4	0	0	25	75	100	3	DCC
MBOT 405	Lab Course (Based on MBOT 403)	0	0	4	30	70	100	3	DCC
MBOT 406	Project Report			12	30	70	100	6	DCC
Total Credits								**24**	

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA
FARIDABAD DEPARTMENT OF LIFE SCIENCES

M.Sc. BOTANY

Syllabus, Semester – III

Course Code: MBOT-301
Subject: Developmental Biology **MaximumMarks: 100**
No. of credits: 4 **Theory exam: 75**
L P **Sessional: 25**
4. 0

Course Objectives: This course aims at making the students acquainted with the fundamentals and present understanding of the mechanisms associated with development and differentiation of various plant organs.

Unit-I

Algae Habitat diversity, thallus organization, cell structure and reproduction. **Archegoniatae:** Comparative morphology and developmental anatomy of Hepaticae, Anthocerotae and Musci; comparative anatomy of vegetative organs of Pteridophytes; study of stem apex, leaf initiation and early leaf ontogeny in ferns; development of long and short shoots, origin and pattern of development of cortex, pith and procambium in conifers.

Unit - II

Vascular plants: Meristems; patterns of cell fate, determination and lineage in root and shoot; leaf growth and differentiation; secondary growth; wood development and its diversity; cambial variants; ultrastructure and control of xylem and phloem differentiation; secretory ducts and laticifers; flower, seed and fruit anatomy; patterns of evolution in seed; anatomical adaptations for special habitats, biotic and abiotic stresses;

Unit - III

Reproductive Biology: Development of flower: Transition to flowering - vegetative to reproductive evocation, floral homeotic mutations in *Arabidopsis*, *Antirrhinum* and *Petunia*, axis development in flower, gender expression in monoecious and dioecious plants.

Developmental biology of male and female gametophytes: Regulation of anther and ovule development, microsporogenesis and microgametogenesis, megasporogenesis and megagametogenesis, male sterility- mechanisms and applications, pollen embryogenesis.

Unit - IV

Pollen-pistil interaction: *In vivo* and *in vitro* pollen germination, pollen tube growth and guidance, double fertilization, self-compatibility mechanisms, incongruity. **Embryogenesis and seed development:** Polarity during embryogenesis, pattern mutants, *in vitro* fertilization, endosperm development, apomixis, polyembryony, somatic embryogenesis

Suggested Readings:

- Anderson R.A., (2005). Algal Culturing Techniques. Physiological Society of America. Elsevier Academic Press, USA. 1st Edition.

- Bhatnagar SP and Moitra A. (1996). Gymnosperms. New Age Interactive (P) Ltd. Publishers, New Delhi.
- Johri B. M. and Srivastava P. S. (2001). Reproductive biology of plants. Narosa Pub. House, New Delhi.
- Bhojwani S. S. and Bhatnagar S. P. (1999). The embryology of angiosperms. Vikas Pub. House,.
- Bhojwani S.S. and Soh W.Y. (2001). Current Trends in Embryology of Angiosperms. Kluwer Academic Publishers
- Carlquist S. (2001). Comparative Wood Anatomy, Springer-Verlag, Germany.
- Cutler D.F. (1978). Applied Plant Anatomy, Longman, United Kindom
- Dickinson W.C. (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA.
- Fahn A. (1982). Plant Anatomy, Pergmon Press, USA & UK.
- Fosket D.E. (1994). Plant Growth and Development: A Molecular Approach, Academic Press. 1st Edition.
- Fritsch F.E. (1945). The Structure and Reproduction of Algae Vols. I and II. Cambridge University Press, Cambridge, UK.
- Gilbert (2016). Developmental biology. Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA. 11th Edition.
- Hopkins W.G. (2006). The Green World: Plant Development, Chelsea House Publication. 1st Edition.
- Howell SH. (1998). Molecular Genetics of Plant Development, Cambridge University Press.
- Leyser O and Day S (2003). Mechanism of Plant Development, Blackwell Press.
- Mauseth J.D. (1988). Plant Anatomy, The Benjamin/ Cummings Publisher, USA.
- Parihar N.S. (1961). An Introduction to Embryophyta: Vol I – Bryophyta, Vol II – Pteridophyta, Central Book Dept. Allahabad.
- Raghavan V. (2000). Developmental Biology of Flowering Plants, Springer, Netherlands
- Raghavan V. (1997). Molecular Embryology of Flowering Plants. Cambridge. University Press.
- Richards A.J. (1997). Plant Breeding System, George Allen and Unwin. 1st Edition.
- Shivanna K.R. (2019). Pollen Biology and Biotechnology, Science Publishers. 1stEdition.

Course Learning Outcomes:

The students will be able to:

CO-1- Understand about mechanism of organ formation that occurs in the early land plants that resulted to diversity of species of bryophytes, Pteridophytes and Gymnosperms.

CO-2- Gain knowledge about the main growing regions of the plant and how these regions maintain their meristmatic identity while forming cells that are determined and ready to differentiate.

CO-3- Understand about how plants form their three-dimensional structure and what are the mechanisms that are responsible for the huge diversity observed in their architecture?

CO-4- Understand about establishment of male and female germlines, seed development, and

necessity of fertilization. Students will be made aware about the cross-talk between fertilized egg and central cells that lead to embryo and endosperm formation.

Mapping of CO and PO for MBOT301

CourseOutcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3	3	1	3	3	1	1	3	3	3	3
CO2	3	3	2	3	2	3	2	3	3	1	2	3	3	2	3
CO3	3	3	2	3	2	2	1	3	2	1	2	3	3	3	2
CO4	3	3	2	2	2	3	2	3	3	1	1	3	3	2	3

Course Code: MBOT-302
Subject: Plant Systematics **Maximum Marks: 100**
No. of credits: 4 **Theory exam: 75**
L P **Sessional: 25**
4. 0

Course Objectives: This course aims to add to understanding of the students about the diversity of plants, their Description, Identification, Nomenclature and their classification including recent advances in the field.

Unit - I

Systematics: Concepts and components; Plant identification: Taxonomic keys, Principles and outline of classification, Classification of flowering plants: APG IV classification. Taxonomic evidence: structural and biochemical characters, systematic phylogeny and economic importance of families: Magnoliaceae, Capparidaceae Caryophyllaceae, Asteraceae, Apocynaceae, Boraginaceae, Convolvulaceae, Scrophulariaceae, Acanthaceae, Bignoniaceae, Lamiaceae, Verbenaceae, Polygonaceae, Euphorbiaceae, Orchidaceae, Amaryllidaceae, Araceae and Arecaceae.

Unit - II

Botanical Nomenclature: International code of botanic nomenclature, Principles of nomenclature, Scientific names, Ranks, Author citation, Nomenclatural types, Valid publications, Priority of publications, typification, rules of effective and valid publications, Conservation of names, Name changes, Synonyms.

Unit - III

Numerical Taxonomy: Aims and objectives, characters and attributes, OTUs, coding cluster analysis, merits and demerits

Chemotaxonomy: Role of phytochemicals (non-protein amino acids, alkaloids, betalains, cynogenic glucosides) in taxonomy.

Plant Molecular Systematics: DNA sequence data, Types of sequence data, Sequence alignment, Phylogenetic analysis (parsimony, Maximum Likelihood, Bayesian approaches, Neighbor-Joining), DNA barcoding and its practical implications, Applications of DNA markers in angiosperm taxonomy, angiosperm phylogeny groups.

Unit - IV

Plant Collecting and Documentation: Methods of collecting plants, Herbaria and data information systems: Herbarium specimens, Herbarium operations, Data Information Systems; Role of Botanic Gardens in the conservation of biodiversity.

Suggested Readings:

- Angiosperm Phylogeny Group, 2016. An update of the Angiosperm Phylogeny Group Classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnaean Society 181: 1-20.
- Crawford, D.J. (1990). Plant Molecular Systematics. Cambridge University Press, Cambridge, UK.

- Judd, W.S., Campbell, C.S, Kellogg, E.A., Stevens, P.A. and Donoghue, M.J. (2016). Plant Systematics: A Phylogenetic Approach. Sinauer Associates, Inc., Massachusetts.
- Singh G (2018). Plant systematics – Theory and Practices, oxford and IBH Publishing Co, New Delhi, 3rd Edition.
- Simpson, M.G. (2010). Plant Systematics. Elsevier, Amsterdam.
- Stuessy TF. (2009). Plant Taxonomy: The systematic Evaluation of Comparative Data. Columbia University Press, New York. 2nd Edition.
- Stuessy, T.F., Crawford, D.J., Soltis, D.E. and Soltis, P.S. (2014). Plant Systematics: The origin, interpretation, and ordering, of plant biodiversity. Koeltz Scientific Books, Konigstein, Germany.

Course Learning Outcomes:

The students will be learning:

CO-1- What do we mean by systematics.? What are different components of systematics? Why is systematics important? What are different data sources in systematics?

CO-2- What are different methods of naming plants? What are different principles of nomenclature? Why name changes?

CO-3- What is phylogeny and phylogenetic systematics? Which methods are used in molecular systematic studies? What do mean by DNA barcoding and its practical implications??

CO-4- What are different methods of collecting and preserving plants? What is the importance of maintaining plants in botanic gardens?

Mapping of CO and PO for MBOT302:

CourseOutcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3	2	2	2	3	2	3	3	2	3	3
CO2	3	3	2	3	3	2	2	2	3	2	2	3	2	3	3
CO3	3	3	2	3	3	3	3	3	2	2	3	3	3	2	3
CO4	3	3	3	2	3	2	3	3	3	2	3	3	3	3	3

Course Code: MBOT-303
Subject: Physiology and Biochemistry **Maximum Marks: 100**
No. of credits: 4 **Theory exam: 75**
L P **Sessional: 25**
4. 0

Course Objectives: This course aims to educate student on concepts of proteins, enzymes, basic plantsignaling mechanisms, sensory photobiology. The course further deals with physiology of nutrient uptake, photosynthesis and nitrogen metabolism.

Unit - I

Protein structure and Enzymes: Hierarchical structure of proteins; folding; ticketing; degradation; purification, detection and functional characterization; sequence alignments; molecular motors and pumps. Application of principles of thermodynamics in biology; origin and evolution of biocatalytic reactions; enzyme technology; regulation of enzymatic activity.

Unit - II

Carbon assimilation: Photosynthetic pigments, role of photosynthetic pigments, antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO2 reduction, photorespiration, C4 pathway; Crassulacean acid metabolism; Factors affecting CO2 reduction.

Carbon oxidation: Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, anaplerotic reactions, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.

Unit - III

Sensory Photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; scotomorphogenesis and photomorphogenesis.

Nutrient Uptake: Apoplastic and symplastic transport mechanisms, role of aquaporins and transporter proteins, structure-function relationship of inward and outward ion channels, dual action of ATPases/pumps and modulation of their activity, specialized mechanisms for phosphorus and iron uptake, monitoring of ion channel activity.

Unit - IV

Plant hormones and other growth regulators: Concept of hormones as chemical messengers, techniques for detection and quantitation of plant hormone, hormones in defense against abiotic and biotic stresses, synthetic regulatory compounds and their uses.

Physiology of plants Reproduction: Reproductive strategies in higher plants and their significance. Sexual and non-sexual modes. Flowering as a multi-organ function, floral induction, evocation and development. Regulation of flowering by light and temperature. Role of circadian rhythm. Involvement of hormones.

Suggested Readings:

- Buchanan B, Gruissem G and Jones R. (2015). Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA. 2nd Edition.
- Davies P J. (2010). Plant Hormones: Biosynthesis, Signal Transduction, Action., Kluwer Academic Publisher, Dordrecht, The Netherlands. 3rd Edition.
- Jordan BR. (2006). The Molecular Biology and Biotechnology of Flowering, 2nd Edition, CAB International, Oxfordshire, U.K. 2nd Edition.
- Lehninger, A. L., Nelson, D. L. 1., & Cox, M. M. (2017). Lehninger principles of biochemistry, New York, 7th Edition.
- Taiz, L. and Zeiger, E. (2010). Plant Physiology. 5th Edition.
- Hans-Walter Heldt Birgit Piechulla (2010). Plant Biochemistry. 4th Edition.

Course Learning Outcomes:

CO-1- The students will be learning about the various signal transduction mechanisms in plants. The concept of second messengers, calcium signaling, kinases/phosphatases in plant signaling would be delineated to enhance their grasping power for understanding of different signaling pathways operative in plants. Two component signaling concept would be introduced and extended to plant hormone signaling. Quorum sensing and its potential biotechnological applications should be clear to students after these classes.

CO-2- During the course students will gain knowledge about various mechanisms such as channel or transport proteins involved in nutrient uptake in plants.

CO-3- Course will deal with various phytohormones and their role in physiology of growth and development. This course will introduce students to physiological advances in sensory photobiology.

CO-4- Students will gain the knowledge on reproductive strategies in higher plants along with physiology of flowering, molecular and hormonal basis of flowering mechanism.

Mapping of CO and PO for MBOT303:

CourseOutcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3	2	2	2	2	3	2	2	3	3	3	2
CO2	3	3	3	3	3	2	2	2	3	2	3	3	3	3	3
CO3	3	3	3	2	3	2	2	2	3	3	2	3	3	3	2
CO4	3	3	2	2	3	2	2	2	3	3	3	3	3	3	3

Course Code: MBOT-304
Subject: Genetics **Maximum Marks: 100**
No. of credits: 4 **Theory exam: 75**
L P **Sessional: 25**
4. 0

Course Objectives: To develop and demonstrate an understanding of the structure and function of genes and the organization of the human genome; the patterns of inheritance and clinical manifestations of genetic diseases; chromosomes, chromosomal abnormalities, and the clinical features of common chromosomal disorders.

UNIT – I

Mendelian vs. Non-Mendelian inheritance, monohybrid and dihybrid crosses, Mendelian Principles-Dominance, Segregation and Independent assortment. Extensions of Mendelian principles: Codominance, Incomplete dominance, Multiple Allelism. Gene interactions Epistasis, Collaboratory gene action, Duplicate genes, Complementary Gene action, Complementation Test. Pleiotropy, Phenocopy. Probability and Pedigree analysis. sex limited and sex influenced characters. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL. Extrachromosomal Inheritance, Maternal effect.

UNIT – II

Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes. Linkage maps, recombination, tetrad analysis (Ordered and unordered Tetrad analysis), mapping with molecular markers, mapping by using somatic cell hybrids. Linkage Group

UNIT - III

Cytogenetics: Chromosome: structure and nomenclature, centromere and telomere; Structural and numerical alterations of chromosomes: Deletion, duplication, Pericentric and Paracentric inversion, Inversion heterozygotes, Inversion homozygotes. Reciprocal and nonreciprocal translocation, Homozygotes as well as Heterozygote Trans locants. ploidy (Aneuploidy and Euploidy) and their genetic implications.

UNIT - IV

Mutation: Types, causes and detection, mutant types – lethal, conditional, Base substitution and frame shift Mutation. biochemical, loss of function, gain of function, germinal verses somatic mutants, Ames Test.

Epigenetics: Introduction, methylation, histone modifications.

Allele frequency, Gene Frequency, Hardy Weinberg Equilibrium

Suggested Readings:

- Russell P. J. (2016). Genetics-A Molecular Approach, Pearson Education Inc.
- Gardner E. J., Simmons M. J., Snustad D. P. (2006). Principles of Genetics, John Wiley & Sons. 8th Edition.
- Strickberger M.W. (2008). Genetics, Pearson (Prentice Hall).
- Acquaah G. (2012). Principles of Plant Genetics and Breeding, Blackwell Publishing Ltd. USA. 2nd Edition.
- Allard R. W. (1999). Principles of Plant Breeding, John Wiley and Sons.
- Singh R. J., (2002). Plant Cytogenetics, CRC Press. 2nd Edition.
- Hartwell L. H., Hood L., Goldberg M. L., Reynolds A. E., Silver L. M., Veres R. C. (2006).
- Genetics-From Genes to Genomes, McGraw Hill. 3rd Edition.
- Lewin B. (2007). Genes IX, Jones and Barlett Publishers. 9th Edition.
- Hartl D. L. and Jones E. W. (2000), Genetics-Analysis of Genes and Genomes, Jones and Barlett publishers. 5th Edition.

Course Learning Outcomes:

CO-1- Students will be able to set hands on genetic crosses to understand recessive and dominant, segregation, pattern of inheritance and finally evaluating statistical significance by counting the progeny as statistical analysis provides crucial. insight into many biological processes.

CO-2- Students will learn how genetic information is passed on in eukaryotes and prokaryotes, how genes work together in a complex manner in biological system and any alteration can lead to major phenotypic change.

CO-3- Students will appreciate the concept of epigenetics as a key mechanism of regulation of gene expression steering development and cell fate that can ultimately be affected in disease condition.

CO-4- Genetics has made extensive use of model organisms, many of which will be used to teach this course. By observing genetic mutations in Drosophila, students can correlate phenotype with genotype, understand genetic interaction and their molecular basis.

Mapping of CO and PO for MBOT304:

CourseOutcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	2	3	3	3	2	3	3	3	3
CO2	3	3	3	3	2	3	3	2	3	2	3	3	2	2	3
CO3	3	3	3	3	3	3	3	3	3	2	2	3	2	2	2
CO4	3	3	3	3	3	3	2	2	3	2	3	3	3	2	3

Course Code: MBOT-305
Subject: Lab Course-I (Based on MBOT301-302)
No. of credits: 3
L P
0 6

1. Study of thallus structures of different groups of algae through preparation of whole mounts and sections.
2. Study of morphology and anatomy of thalloid and leafy forms of Bryophytes; Study of Protonema.
3. Study of fern gametophyte and soral variations
4. Comparative anatomy of conifers and gnetales.
5. Study of apical meristems with the help of dissections, whole mount preparations, sections and permanent slides.
6. Origin and development of epidermal structures (trichomes, glands and lenticels). 7. Study of xylem and phloem elements using maceration, staining, light and electron micrographs (xerophytes, hydrophytes and halophytes).
8. Study of secretory structures (nectaries and laticifers).
9. Study of secondary growth (normal and unusual) of selected woods with the help of wood microtome and permanent slides.
10. Study of the stages of pollen and ovule development in the wild and mutant plants using permanent slides, electron micrograph and available phenotypes
11. Taxonomic description of plants of families namely, Capparidaceae, Caryophyllaceae, Asteraceae, Apocynaceae, Boraginaceae, Convolvulaceae, Scrophulariaceae, Acanthaceae, Bignoniaceae, Lamiaceae, Verbenaceae, Polygonaceae, Euphorbiaceae, Amaryllidaceae, and other locally available families
12. Plant collection: Identification, preservation and submission of at least 30 herbarium sheets, survey of local flora and preparation of report
13. Techniques in molecular systematics.
14. Phylogenetic analyses using PAUP/MEGA.

**** A minimum of eight practical's should be done from the above-mentioned list. **Addition or deletion of the lab experiments can be done as per the availability of resources in lab.***

Course Outcomes:

CO1- The objective of this laboratory course is to provide the students practical skills in the identification and characterization of different plant species.

CO2- Students will learn the dissection procedures used in the preparation of samples for studying structures of different plant species. Students will develop an proficiency in the experimental techniques and methods of appropriate analysis of lower plant groups.

CO3- The course will familiarize students with basic concepts and applications of performing taxonomic studies. Students will develop a basic knowledge of taxonomic diversity and important families of useful plants.

Mapping of CO and PO for MBOT305:

CourseOutcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	3	3	2	2	3	2	3	3	3	3	3
CO2	3	3	2	3	3	3	2	2	3	2	3	3	3	3	3
CO3	2	3	2	3	3	3	2	2	3	1	3	3	3	3	3

Course Code: MBOT-306

Subject: Lab Course-II (Based on MBOT303-304).

No. of credits: 3

L P

0 6

1. Preparation of mitotic and meiotic spreads and analysis of various stages of cell division (Phlox, Allium and Rhoeo). Preparation of Karyotypes, Determination of Mitotic index. 2. Study of Mendelian Inheritance and gene interactions using suitable examples/ seeds. 3. Study of Linkage, recombination, gene mapping using the available data. 4. Centromere mapping by tetrad analysis.
5. Pattern of inheritance of given pedigree.
6. Bacterial gene mapping by interrupted conjugation method.
7. Calculation of co-transformation and co-transduction frequency
8. Calculation of deviation in phenotypic ratios of different intergenic gene interactions.
9. Comparison of ploidy level with respect to given example.
10. In vivo assay for nitrate reductase in leaf tissues.
11. Comparative assessment of methods for protein quantitation.
12. Study of enzyme kinetics for determination of Km value, nature of inhibition – competitive/non-competitive.
13. Study of enzyme kinetics for effect of time/ enzyme concentration/ pH. 14. Extraction of proteins from plant tissue and their quantitative (Bradford's) and qualitative (SDS, PAGE gel) analysis.
15. Detection of phosphoproteins in plant (Brassica) extract by pro Q diamond staining. 16. Qualitative and quantitative analysis of photosynthetic pigments and anthocyanins by spectrophotometric and chromatographic techniques.

**** A minimum of eight practical's should be done from the above-mentioned list.***

*****Addition or deletion of the lab experiments can be done as per the availability of resources in lab.***

Course Outcomes:

CO1- The objective of this laboratory course is to provide the students practical knowledge in the field of cytology and genetics.

CO-2- Students will be able to able to observe mitotic cell division through the cytological preparation from plant material. Students will also work out problems related to genetics that will help them in gaining knowledge about solving problems in plant biology.

CO2- Students will learn the techniques to isolate plant biomolecules and perform qualitative and quantitative analysis using various molecular techniques.

Mapping of CO and PO for MBOT306

CourseOutcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	3	3	3	2	3	3	3	2	3	2	3
CO2	3	3	2	3	3	3	3	2	3	3	3	2	3	2	3
CO3	3	3	2	3	3	3	3	2	3	3	3	2	3	2	3

Seminar:

Seminar will be of 30- 45minute duration during which the presentation will be followed by questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/Faculty members/student advisors well in advance so that the same may be displayed on the notice board. The presenter has to write an Abstract to be distributed during Seminar in addition to two copies of write-up giving relevant details of the background of the subject, methods used and references/List of sources from where the material for presentation has been collected.

J. C. Bose University of Science and Technology, YMCA, Faridabad

(Established by Haryana State Legislative Act No. 21 of 2009 & Recognized by UGC Act 1956 u/s 22)

Accredited 'A' Grade by NAAC

DEPARTMENT OF LIFE SCIENCES

Program M.Sc. (Botany)

Scheme Course Index of the Year 2020-21

Mapping of the Courses with the Employability/Entrepreneurship/Skill Development

M.Sc. Botany Semester III(Program Code: 756)

Sr. No.	Course Code	Course Name	Employability	Entrepreneurship	Skill Development
1	MBOT301	Developmental Biology	√		
2	MBOT302	Plant Systematics	√		√
3	MBOT303	Physiology and Biochemistry	√		
4	MBOT304	Genetics and Cytogenetics	√	√	√
5	MBOT305	Lab course I (based on MBOT301-302)	√	√	√
6	MBOT306	Lab course II (based on MBOT302-304)	√	√	√

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD
DEPARTMENT OF LIFE SCIENCES

Scheme of M.Sc. Botany (Four Semester Course)

SEMESTER IV

Couse Code	Subject	Teaching hours per week			Maximum Marks		Total	Credits	Category Code
		L	T	P	Internal	External			
Discipline Core Course (DCC) – Compulsory									
MBOT 401	Plant Pathology	4	0	0	25	75	100	4	DCC
MBOT 402	Plant Anatomy and Resource Utilization	4	0	0	25	75	100	4	DCC
MBOT 403	Plant Biotechnology	4	0	0	25	75	100	4	DCC
MBOT 404	Lab Course (Based on MBOT 401-402)	4	0	0	25	75	100	3	DCC
MBOT 405	Lab Course (Based on MBOT 403)	0	0	4	30	70	100	3	DCC
MBOT 406	Project Report				30	70	100	6	DCC
Total Credits								**24**	

Course Code: MBOT-401
Subject: Plant Pathology **Maximum Marks: 100**
No. of credits: 4 **Theory exam: 75**
L P **Sessional: 25**
4. 0

Course Objectives: This course aims to enhance the understanding of students in basic concepts of mycology, fungal biology and importance of fungi. Develop skills for handling fungi. The coursedeals with basic concepts in plant pathology and the interaction of plants with herbivores. Introduction to agricultural pathogens and pests of national importance will be accompanied by basic concepts in integrated disease/pest management, and breeding plants for durable resistance against insect pests and pathogens

Unit – I

Overview of Fungi and fungus-like organisms (Myxomycetes, Acrasiomycetes, and Oomycetes), A higher-level phylogenetic classification of the Fungi. True fungi: Characteristics and important Genera of Phyla – Chytridiomycota, Zygomycota, Glomeromycota, Ascomycota, and Basidiomycota. Physiology of fungal growth, reproduction (asexual and sexual), and mating compatibility, Importance and ecological role of fungi.

Unit - II

Plant Pathology: Introduction, effect of plant diseases on human affairs,classification of plant diseases caused by fungi, bacteria, viruses and parasitic organisms. Koch's Postulates, importance of plant pathology, Mechanism of infection, penetration and entry by plant pathogens, the role of enzymes and toxins in plant disease.

Defense mechanisms of plants against infection: Pre-existing structural and chemical defence, induced structural and chemical defence, Management of plant diseases - Cultural, chemical, biological, biopesticides, breeding for resistant varieties, plant quarantine, integrated pest management

Unit - III

Plant disease epidemiology and plant disease forecasting: Importance of disease forecasting, methods used in plant disease forecasting, Dispersal of plant pathogens; Direct transmission and indirect transmission, Application of biotechnology and plant pathology; Use of tissue culture, recombinant technology, monoclonal antibodies in plant pathology, Phyto pathological techniques; Isolation of fungi, common culture media used in laboratory, sterilization techniques.

Unit - IV

Study of plant diseases caused by fungi, bacteria, viruses, nematodes and mycoplasma like organisms: Wart disease of potato, blight of colocasia, downy mildew of cucurbits, powdery mildew of wheat, stem gall of coriander, ergot of bajra, smut of sugarcane, Karnal bunt of wheat, linseed rust, Tikka disease of groundnut, red rot of sugarcane, Panama disease of banana, bacterial blight of rice, yellow vein mosaic of bhindi, mosaic of sugarcane, potato spindle tuber mosaic, ear cockles of wheat, grassy shoot of sugarcane, phylloidy of sesamum, citrus greening

Suggested Readings:

- R.S. Mehrotra and Ashok Aggarwal (2017) Plant Pathology, TataMcgraw Hill, New delhi.
- Agrios GN (2006) Plant Pathology, Elsevier Academic Press, Amsterdam. 5th Edition.

Webster J and Weber R (2007). Introduction to Fungi. Cambridge University Press.

Cambridge and New York. 3rd Edition.
- Sethi IK and Walia SK (2018) Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi, India. 2nd Edition.
- Dickinson M, (2003) Molecular Plant Pathology, Bios Scientific Publishers, London. 1stEdition.
- Sharma PD (2017) Mycology and Phytopathology. Rastogi Publishers, Meerut, India. 1stEdition.
- Burchett, S and Burchett, S (2018) Plant Pathology, Garland Science, US. 1st Edition.
- Koul O, Dhaliwal GS and Cuperus GW (2004) Integrated Pest Management: Potential, constraints and challenges , CABI Press, UK
- Dhaliwal GS and Arora R (1996) Principles of insect pest management, National Agricultural Technological Information Center, Ludhiana, India
- John AL (1998) Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press, Boca Raton, USA
- Robert N, Trigiano, Windham MT, Windham AS (2003) Plant Pathology: Concepts and Laboratory Exercises, CRC Press, Boca Raton, USA. 1st Edition.
- Bridge PD, Clarkson JM (1998) Molecular Variability of Fungal Pathogens, CAB International, Oxfordshire.
- Singh RS (2018) Plant Diseases, Oxford and IBH Publishing Co Pvt Ltd, New Delhi. 9thEdition.
- Singh RS (2017) Principles of Plant Pathology, Oxford and IBH Publishing Co Pvt Ltd, New Delhi. 4th Edition.
- Dhingra OD, James B, Sinclair (1995) Basic Plant Pathology Methods, CRC Publication, Boca Raton, USA.

Course Learning Outcomes:

The students will be able to:

CO-1- Understand basic fungal biology, taxonomy of the fungi and major fungal lineages. Gain skills necessary to isolate and handle fungi from nature, and to discern important microscopic characteristics of fungi.

CO-2- Develop functional knowledge on differentiating disease caused by virus, fungi, and bacteria.

CO-3- Learn about the biology of major, and emerging pathogens and pests of crop plants.

CO-4- Examine advantages and disadvantages of current control practices based on chemical ecology, genetics of plant resistance and breeding including transgenic approaches. Combine theoretical and practical knowledge of plant disease and pest management.

Mapping of CO and PO for MBOT401

CourseOutcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	3	2	3	3	3	2	2	3	3	3	2
CO2	3	3	3	3	3	2	2	3	3	2	2	3	3	2	2
CO3	3	3	3	3	2	2	2	3	3	2	2	3	3	3	2
CO4	3	2	3	3	3	2	3	3	3	2	2	3	3	3	2

Course Code: MBOT-402
Subject: Plant Anatomy and Resource Utilization **Maximum Marks: 100**
No. of credits: 4 **Theory exam: 75**
L P **Sessional: 25**
4. 0

Course Objectives: The objective of the course is to acquaint students with internal basic structure and cellular composition of the plant body.The course will enable students to correlate structure with important functions of different plant parts. Students will gain knowledge on the economically importance of diverse plants that offer resources to human life. It emphasize the plants used as -food for man, fodder for cattle, feed for poultry, plants having medicinal values and plant source of huge economic value etc.

Unit - I

Introduction toplant anatomy and plant body: Internal organization of plant body: tissue system, types of cells and tissues; simple and complex tissues (no phylogeny), cytodifferentiation of tracheary elements and sieve elements; pits and plasmodesmata
Stem and leaf: Organization of shoot apex; Types of vascular bundles; Structure of dicot and monocot stem; Structure of dicot and monocot leaf, Kranz anatomy; Development of Leaf.
Root: Organization of root apex Quiescent centre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.

Unit – II

Vascular Cambium: Structure, function and seasonal activity of cambium; Secondary growth in root and stem, Anomalies in secondary growth in stem
Wood: Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology.
Periderm: Development and composition of periderm; rhytidome and lenticels.
Adaptive and Protective Systems: Epidermal tissue system; cuticle; epicuticular waxes; trichomes; stomata (classification); Anatomical adaptations of xerophytes and hydrophytes.

Unit – III

Origin of Cultivated Plants: Concept of centres of origin, their importance with reference to Vavilov's work.
Utilization of Plant Wealth (Cereals and Millets, Pulses and Legumes, Fruits, Sources of Sugars and Starches) –Cereals; Wheat and Rice (origin, morphology and uses), Brief account of millets and pseudocereals, Legumes: General account with special reference to Gram and Soybean, Fruits: Mango and Citrus (Origin, morphology, anatomy and uses), Sugars and Starches: Morphology, ratooningand processing of sugarcane, products and by-products of sugarcane industry; Potato – morphology, tuber anatomy, propagation (conventional and TPS) and uses.

Unit – IV

Utilization of Plant Wealth (Spices, Beverages, Oil and fats, Rubber, Drug yielding plants, Fibres)
Spices: General account with special reference to clove and black pepper(Botanical name, family, part used, morphology and uses), Beverages: Tea, Coffee (morphology, processing & uses), Oils and fats: General description; groundnut, coconut, linseed, mustard (Botanical name, family & uses),Natural Rubber: Para-rubber: tapping, processing and uses, Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Papaver and Cannabis, Fibers: Cotton (morphology, extraction and uses) and Jute (morphology, extraction and

uses).

Course Learning Outcomes:
The students will acquire understanding of:
CO-1- Knowledge of various cells and tissues, meristem, epidermal and vascular tissue system in plants.
CO-2- Various aspects of growth, development of the tissues and differentiation of various plant organs. Knowledge of basic structure and organization of plant parts in angiosperms.
CO-3- Core concepts of Economic Botany
CO-4- Diversity of plants and the plants products in human use.

Suggested Readings:

- Dickison, W.C. (2000).Integrative Plant Anatomy. Cambridge, U.K.,Harcourt Academic Press.
- Evert, R.F., Eichhorn, S. E. (2006). Esau's Plant anatomy: Mersitems, Cells, and tissues of the Plant Body: their structure, function and development. New Jersey, U.S.,Wiley-Liss.
- Mauseth, J.D. (1988). Plant Anatomy. San Francisco, California, The Benjammin Cummings Publisher
- Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
- Kochhar, S.L. (2016). Economic Botany in Tropics. New Delhi, India, MacMillan & Co.
- Wickens, G.E. (2006). Economic Botany: Principles & Practices.The Netherlands, Kluwer Academic Publishers.
- Chrispeels, M.J. and Sadava, D.E. (1994) Plants, Genes and Agriculture, Jones & Bartlett Publishers.
- Sambamurty, AVSS and Subrahmanyam, N.S. (2008). A Textbook of Modern Economic Botany. 1st Edition, Paperback . CBS Publishers & Distributors Pvt.Ltd.; 1st edition.
- Samba Murty, AVSS and Subrahmanyam, N.S. (1989). A text book of Economic Botany. Wiley Eastern Ltd., New Delhi.

Mapping of CO and PO for MBOT402

CourseOutcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	2	3	3	3	2	2	3	3	3	3
CO2	3	2	3	2	3	2	2	3	3	2	2	3	3	3	3
CO3	3	2	3	2	2	2	2	3	2	2	3	3	3	3	3
CO4	3	2	2	2	3	2	2	2	2	2	3	3	3	3	3

Course Code: MBOT- 403
Subject: Plant Biotechnology **Maximum Marks: 100**
No. of credits: 4 **Theory exam: 75**
L P **Sessional: 25**
4. 0

Course Objectives: This course would provide students with an understanding of principles and techniques of plant tissue culture, concepts and methods associated with development and analysis of transgenic plants, and their applications in basic and applied research. In addition, students would be exposed to the economic importance and current research paradigms in various categories of commercially cultivated plants.

Unit - I

Plant breeding: Maintenance and conservation of germplasm, Cryopreservation, Mass selection and Pure line selection, Heterosis and hybrid seed production, Male sterility, types and its use in plant breeding. Polyploidy breeding-types of polyploids, origin and effects of auto and allopolyploids in plants; application of auto and allopolyploids in plant breeding; limitations. Mutation breeding- types: chemical mutagens, radiation, transposons; handling and release of mutagenic varieties.

Unit - II

Plant tissue culture: Culture media; composition, preparation and sterilization
Totipotency: definition and importance, dedifferentiation and redifferentiation, callus and suspension culture, meristem culture, somaclonal variation, somatic embryogenesis, synthetic seeds, anther culture and production of haploids, protoplast culture, somatic hybrids, cybrids

Unit - II

Genetic transformation of plants – *Agrobacterium* biology and biotechnology; plant - *Agrobacterium* interactions.
Vectors for plant transformation: Agrobacterium-based vectors, improved Agrobacterium based vectors, virus-based vectors for transient expression, vectors for chloroplast transformation, vectors for marker-free selection.
Transformation techniques: Agrobacterium-mediated, direct gene transfer methods: particle bombardment, electroporation, PEG-mediated and floral-dip.
Screening and analysis of transformants in subsequent generations. – copy number, heterozygosity, stable expression, silencing.

Unit - IV

Applications of genetic transformation – Case studies on use of transgenic technology for basic studies and crop/plant improvement; phenotypic, genetic and molecular analysis of transgenic plants; factors influencing transgene expression levels; transgene silencing; marker-free transgenics; genome editing for crop improvement; environmental, social and legal issues.

Suggested Readings:

- Bhojwani S.S., Razdan M. K. (1996). Plant Tissue Culture: Theory and Practice, revised edition, Elsevier Science, Amsterdam.

- Newmann K.H. (2009). Plant Cell and Tissue Culture, A Tool in Biotechnology: Basics and Applications (Principles and Practice), Springer, Berlin.
- Loyola- Vargas V.M., Flota F.V. (2005). Plant Cell Culture Protocols, Humana Press, Totowa. 2nd Edition.
- Slater A., Scott N.W., Mark R. (2008). Fowler Plant Biotechnology: An Introduction to Genetic Engineering, Oxford University Press, Oxford.
- Halford N. (2006). Plant Biotechnology - Current and Future Applications of Genetically Modified Crops, John Wiley and Sons, London. 1st Edition
- Jain S.M., Sopory S.K., Velleux R.E. (2010). *In Vitro* Haploid Production in Higher Plants, Vol 1-5, Kluwer Publishers, Dordrechi, Netherlands. 1st Edition.
- Vasil IK, Thorpe T.A. (2010). Plant Cell and Tissue Culture, Kluwer Academic Publishers, Netherlands. 1st Edition.
- Razdan M.K. (2019). An Introduction to Plant Tissue Culture, Oxford & IBH Publishing Co, New Delhi. 3rd Edition.
- Bassett C L. (2007). Regulation of Gene Expression in Plants: The Role of Transcript Structure and Processing.
- Trigiano R.N. and Gray D.J. (2016). Plant Tissue Culture, Development and Biotechnology, CRC Press, Boca Raton, USA. 1st Edition.
- Adrian S, Nigel W.S., Mark R.F. (2008). Plant Biotechnology: The genetic manipulation of Plants, Oxford University Press. 2nd Edition.
- Buchanan B., Gruissem G., Jones R. (2015). Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA. 2nd Edition.
- Butenko R.G. (2000). Plant Cell Culture, University Press of Pacific.
- Davies PJ (2010) Plant Hormones, Kluwer Academic Publishers, Netherlands. 3rdEdition.
- Halford N. (2006). Plant Biotechnology - Current and future applications of genetically modified crops, John Wiley and Sons, England. 1st Edition.

Course Learning Outcomes:

The students will learn about

CO-1- Concepts, tools and techniques related to *in vitro* propagation of plants.

CO-2- Different methods used for genetic transformation of plants, use of *Agrobacterium* as a vector for plant transformation, components of a binary vector system.

CO-3- Various case studies related to basic and applied research in plant sciences using transgenic technology.

CO-4- Principles and methods used for phenotypic, genetic and molecular analysis of transgenic plants. Uses and current research paradigms in various plants of economic value.

Mapping of CO and PO for MBOT403

CourseOutcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	3	3	3	3	3	2	2	2	3	2	3
CO2	3	3	2	3	3	3	3	3	3	2	3	3	3	2	3
CO3	3	3	3	2	3	2	3	3	3	2	2	3	3	2	3
CO4	3	3	3	2	3	3	3	3	3	2	3	2	3	3	3

Course Code: MBOT-404
Subject: Lab Course-I (Based on MBOT401-402)
No. of credits: 3
L P
0 6

1. Methods of sterilization; Media preparation (selective media); inoculation procedures.
2. Study of plant diseases, namely wart of potato, blight of colocassia, downy mildew of cucurbits, wart of sesame, stem gall on coriander, ergot of bajra, smut of sugarcane, linseed rust, tikka disease of groundnut, red rot of sugarcane, bacterial blight of rice, yellow vein mosaic of bhindi, mosaic of sugarcane, grassy shoot of sugarcane and other local diseases on crops
3. Isolation and identification of rhizosphere soil fungi, seed borne fungi
4. Cereals: Wheat (habit sketch, L.S/T.S. grain, starch grains, micro-chemical tests), Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests). Millets and Pseudocereals (specimens / photographs and grains)
5. Legumes: Soybean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
6. Fruits: Mango (habit sketch, L.S. fruit, micro-chemical tests in ripe fruit); Citrus (habit sketch, T.S. hesperidium, W.M. vesicle, micro-chemical tests including test for vitamin C)
7. Sugars and starches: Sugarcane (habit sketch; cane juice- micro-chemical tests); Potato (habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, W.M. starch grains, micro-chemical tests).
8. Spices: Black pepper, Fennel and Clove (habit and sections L.S./T.S.).
9. Beverages: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
10. Oils and fats: Coconut- T.S. nut, Mustard–plant specimen, seeds
11. Rubber: specimen, photograph/model of tapping, samples of rubber products.
12. Drug-yielding plants: Specimens of Cinchona, Digitalis, Papaver and Cannabis (male & female plant).
13. Fiber-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole
    mount of fiber and test for cellulose)
14. Study of anatomical details through permanent slides/temporary stain mounts/ macerations/
    museum specimens with the help of suitable examples.
    a) Apical meristem of root, shoot and vascular cambium.
    b) Distribution and types of parenchyma, collenchyma and sclerenchyma.
    c) Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
    d) Wood: ring porous; diffuse porous; tyloses; heartwood and sapwood.
    e) Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
    f) Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
    g) Root: monocot, dicot, secondary growth.
    h) Stem: monocot, dicot - primary and secondary growth; phloem wedges in Bignonia, included
    i) phloem in Leptadenia/Salvadora; periderm; lenticels.
    j) Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
    k) Adaptive Anatomy: xerophytes, hydrophytes.

**** A minimum of eight practical's should be done from the above-mentioned list. **Addition or deletion of the lab experiments can be done as per the availability of resources in lab.***

Course Outcomes:

CO1- Students will learn about different plant pathological diseases and various biological methods of studying plant diseases.

CO-2- Students will analyse the composition of different parts of plants and their relationships.

CO-3- Students will learn to perform the micro-chemical tests to demonstrate various components in economically important plants.

Mapping of CO and PO for MBOT404

CourseOutcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	3	3	3	2	3	2	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3

Course Code: MBOT-405
Subject: Lab Course-II (Based on MBOT 403).
No. of credits: 3
L P
0 6

1. Aseptic manipulation; washing, capping, packing & sterilization, laminar flow operation & general precautions, stock solutions & media preparation.
2. Preparation of different types of standard tissue culture media such as M S medium.
3. Callus induction from leaf tissues by using 2-4D as growth regulator.
4. Induction of shooting/multiple shoots from nodal explants of *Spilanthusacmella*.
5. In vitro regeneration of *Bryophyllum* plants from leaf segments.
6. Shoot-tip meristem culture for raising virus-free plants.
7. Induction of embryogenesis in anther culture of *Datura innoxia*.
8. Preparation of synthetic seeds by using different micropropagules for germplasm conservation.
9. To study cyto-differentiation in different types of calluses.
10. Agrobacterium transformation by electroporation.
11. Agrobacterium tumefaciens-mediated transformation of plant tissues. Visualization of GFP or YFP in transgenic Arabidopsis.
12. Evaluation of a transgenic phenotype (viz., Herbicide resistance) under containment conditions in the field. for nitrate reductase in leaf tissues.

**** A minimum of eight practical's should be done from the above-mentioned list. **Addition or deletion of the lab experiments can be done as per the availability of resources in lab.***

Course Outcomes:

CO1- The objective of this laboratory course is to provide the students with basic training of plant tissue culture. In plant tissue culture practical, students will be able to learn the laboratory techniques such as washing, storage of glassware, plastic ware, preparation, sterilization and storage of nutrient media, aspetic manipulation of plant material, and maintenance of cultures under controlled conditions and finally observation of the growth of cultures.

CO2- Students will different techniques pertaining to plant biotechnology.

CO3- The course will familiarize students with basic techniques in genetic engineering.

Mapping of CO and PO for MBOT405

CourseOutcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	3	3	3	2	3	3	3	2	3	2	3
CO2	3	3	2	3	3	3	3	2	3	3	3	2	3	3	3
CO3	3	3	2	3	3	3	3	2	3	3	3	2	3	3	3

Course Code: MBOT-406
Subject: Project Report
No. of credits: 6

Course Objectives:

The objective of this advanced course is to provide students with a hands on training in specialized area of plant sciences

Contents:

The student will be reading and analysing the published information in the chosen area of plant science under direct mentoring of a faculty member and will participate in research activity.

Course Learning Outcomes:

Students will acquire the following:

1. Knowledge on techniques and tools of research
2. Quantitative and qualitative data analysis
3. Analysis and interpretation of data in the perspective of existing knowledge

J. C. Bose University of Science and Technology, YMCA, Faridabad

(Established by Haryana State Legislative Act No. 21 of 2009 & Recognized by UGC Act 1956 u/s 22)

Accredited 'A' Grade by NAAC

DEPARTMENT OF LIFE SCIENCES

Program M.Sc. (Botany)

Scheme Course Index of the Year 2020-21

Mapping of the Courses with the Employability/Entrepreneurship/Skill Development

M.Sc. Botany Semester IV(Program Code: 756)

Sr. No.	Course Code	Course Name	Employability	Entrepreneurship	Skill Development
1	MBOT401	Plant Pathology	√		√
2	MBOT402	Plant Anatomy and Resource Utilization	√		
3	MBOT403	Plant Biotechnology	√	√	√
4	MBOT404	Lab course I (based on MBOT401-402)	√	√	√
5	MBOT405	Lab course II (based on MBOT403)	√	√	√
6	MBOT406	Project Work	√	√	√