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

(w.e.f. 2021)

Scheme and Syllabi

M.Sc. Botany

(SEMESTER- I and II)

(w.e.f 2020)

ANNEXURE-I

Scheme of M.Sc. Biotechnology

SEMESTER-I

Sr. No.	Course Code	Subject	Teaching Hours per Week			Maximum Marks			Credits	Category Code
			L	T	P	Int	Ext	Total	4	
1	MLS−101	Cell Biology	4			25	75	100	4	DCC
2	MLS−102	Structure and Functions of Biomolecules	4			25	75	100	4	DCC
3	MLS−103	General Microbiology	4			25	75	100	4	DCC
4	MLS−104	Molecular Biology	3			25	75	100	3	DCC
5	MLS−105	Biostatistics	3			25	75	100	3	DCC
6	MLS−106	Lab Course− I (Based on MLS 101−102)			**6**	30	**70**	**100**	**3**	DCC
7	MLS−107	Lab Course− II (Based on MLS 103− 105)			**6**	30	**70**	**100**	**3**	DCC
8	MLS−108	MOOC*								
	Total Marks							**700**	**24**	

DCC: Discipline Core Course; MOOC: Massive Online Open Course, L: Lecture; T: Tutorial; P: Practical

*The students have to pass at least one mandatory MOOC course with 4−6 credits (12−16 weeks) from the list given on the Swayam portal or the list given by the department/ university from 1st semester to 3rd semester as notified by the university.

Instructions to the students regarding MOOC

1. Two types of courses will be circulated: branch specific and general courses from the website https://swayam.gov.in in the month of June and November every year for the forthcoming semester.
2. The department coordinators will be the course coordinators of their respective departments.
3. Every student has to pass a selected MOOC course within the duration ass specified below:

Programme Duration for M.Sc./M.Tech./MA/MBA: Sem. I to Sem. III

The passing of a MOOC course is mandatory for the fullfilment of the award of the degree of concerned programme.

4. A student has to register for the course for which he is interested and eligible which is approved by the department with the help of course coordinator of the concerned department.
5. A student may register in the MOOC course of any programme. However, a UG student will register only in UG MOOC courses and a PG student will register in only PG MOOC courses.
6. The students must read all the instructions for the selected course on the website, get updated with all key dates of the concerned course and must inform his/her progress to their course coordinator.
7. The student has to pass the exam (online or pen−paper mode as the case may be) with at least 40% marks.
8. The students should note that there will be a weightage of Assessment/quiz etc. and final examination appropriately as mentioned in the instructions for a particular course.
9. A student must claim the credits earned in the MOOC course in his/her marksheet in the examination branch by forwarding his/her application through course coordinator and chairperson.

ANNEXURE-II

Scheme of M.Sc. Biotechnology

SEMESTER-II

Sr. No.	Course Code	Subject	Teaching Hours per week			Maximum Marks			Credits	Category Code
			L	T	P	Int	Ext	Total		
1	MLS−201	Biotechniques	4			25	75	100	4	DCC
2	MLS−202	Metabolism	4			25	75	100	4	DCC
3	MLS−203	Bioinformatics and Biomolecular Modelling	3			25	75	100	3	DCC
4	MLS−204	Genetic Engineering	3			25	75	100	3	DCC
5	MLS−205	Environment and Ecology	4			25	75	100	4	DCC
6	MLS−206	Lab Course− I (Based on MLS 201−202)			6	30	70	100	3	DCC
7	MLS−207	Lab Course− II (Based on MLS 203− 205)			6	30	70	100	3	DCC
8	MLS−208	Audit Course**	2	0	0	25	75	100	0	AUD
	Total Marks							**800**	**24**	

** The students have to choose one Audit course from the list provided by the department/ university.
Only passing of the audit course is mandatory.

Semester-I

Course Code: MLS-101
Subject: Cell Biology
No. of Credits: 04

L	P
4	0

Maximum Marks: 100
Theory Exam: 75
Sessional: 25

Course Objectives: To understand structural and functional aspects of cells and basic mechanisms underlying cell signaling and cell division

Unit-I

Biomembranes: Molecular composition and arrangement, functional consequences, Transport Recapitulation of the plasma membrane; diffusion, active transport and pumps, uniports, symports and antiports, Donnan equilibrium; ion movements and cell function: acidification of cell, organelles and stomach, Maintenance of cellular pH; cell excitation; bulk transport; Receptor mediated endocytosis, Transepithelial transport

The Extra Cellular Matrix and Cell interactions, Cell walls, The ECM and cell-matrix, nteractions,Cell-cell interactions: adhesion junctions, tight junctions, gap junctions, plasmodesmata Ca^{++} Dependent and Ca^{++} Independent Homophilic cell-cell adhesion

Unit-II

Cytoskeleton and cell movement: Structure and organization of actin filaments, Actin, myosin and cell movements, Structure and dynamic organizations of microtubules, Microtubule motors and movement, Intermediate filaments, Cilia and flagella, Cell matrix adhesion, Integrins, Collagen, Non-collagen components, Auxin and cell expansion, Cellulose fibril synthesis and orientation, Protein sorting and transport, Protein uptake into the ER, Membrane proteins and Golgi sorting, Mechanism of vesicular transport, Lysosomes, Molecular mechanism of secretory pathway.

Unit-III

Cell cycle: The eukaryotic cell cycle, Regulators of cell cycle progression, The events of M phase, Meiosis and fertilization, Genome organization, Chromosomal organization of genes and non-coding DNA, Mobile DNA, Morphological and functional elements of eukaryotic chromosomes, Cell – Cell signalling, Signaling molecules and their receptors, Function of cell surface receptors, Pathways of intracellular signal transduction, Signaling networks

Unit-IV

Cell death and cell renewal: Programmed cell death, Stem cells and the maintenance of adult tissues, Embryonic stem cells and therapeutic cloning, Biology of Cancer, The development and causes of cancer, Oncogenes, Tumor suppressor genes, Molecular approaches to cancer treatment, Biology of Ageing

Course Outcomes:

CO1.Students will know about the cell and its biology, which will help the students to understand the origins of cells and the generation of cell diversity, as well as the common features of cellular structure and function –how they obtain energy, synthesize new molecules, communicate, proliferate and survive.

CO2.Students will understand the structures and purposes of basic components of cell cycle.

CO3.Students will understand the cellular components underlying cell movements and cytoskeleton.

CO4.The understanding of cells is used for learning the processes such as, cell death and cell renewal, stem cells and biology of cancer etc.

Suggested Readings:

1. Molecular Cell, Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Book, Inc.,USA.
2. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York
3. Cell and Molecular Biology by De Robertis
4. Molecular Cell Biology, Lodishet al., W.H. Freeman and Company (8th Ed. 2016)

Semester-I

Course Code: MLS-102
Subject: Structure and Functions of Biomolecules
No. of Credits: 04

L	P
4	0

Maximum Marks: 100
Theory Exams: 75
Sessional: 25

Course Objectives: To learn about structure and boding in water, its significance as biological solvent, study of carbohydrates, Aminoacids, proteins, lipids, nucleic acids

Unit-I

Water : Structure, hydrogen bonding, as a biological solvent, ionization and fitness of the aqueous environment for living organisms; pH; Buffers; Henderson-Hasselbalch equation; Physiological buffers.

Carbohydrates : Structure, occurrence and biological importance of important monosaccharides, oligosaccharides and polysaccharides; Ring structures and anomeric forms; mutarotation; sugar derivatives; reactions of monosaccharides; Glycosamino glycans; Hetero polysaccharides of bacterial and algal cell walls; Proteoglycans; Glycoproteins; Lectins.

Unit-II

Amino acids and Proteins : Common structural features, classification by R group, Zwitter ion structures, acid-base properties and titration curves of amino acids; Essential amino acids; Separation of amino acids; Peptides including biologically active peptides; Classification anddifferent structural levels (Primary, secondary, tertiary & quaternary) of proteins; Ramachandran plot; Determination of amino acid composition of proteins; Characteristic amino acid composition of proteins; Determination of amino acid sequences of proteins; Effect of amino acid sequence on the function of a protein and stability of α-helix; Protein folding and role of chaperons in protein folding; Chemical synthesis of polypeptides.

Unit-III

Lipids : Classification, structures, nomenclature and properties of fatty acids; Essential fatty acids; Acylglycerols; Characterization of fats-Saponification value, iodine number, rancidity, acid value, Reichert-Meisselnumber; Structure and properties of different types of phospholipids and sphingolipids (sphingomyelins, cerebrosides & gangliosides); Structure and functions of prostaglandins, Prostacyclins, Thromboxanes, and Leukotrienes; Terpenes of biological significance; Sterols and bile acids.

Unit-IV

Nucleic Acids: Structure and properties of purines and pyrimidine bases; Nucleosides and Nucleotides; Biologically important nucleotides; Nucleic acids as the genetic material – experimental evidences; Chargaff's rules; The covalent backbone of nucleic acids; Double helical model of DNA structure; Structural polymorphism of DNA (A,B and Z-DNA) and RNA; Denaturation & annealing of DNA; Biological functions of nucleotides; Chemical synthesis of oligonucleotides.

Course Outcomes:

After the successful completion of the course the learner would be able to
CQ.1.comprehend the importance of chemical foundation in living organisms

CQ.2.analyzethe various types of weak interactions between the biomolecules and water
CQ.3.correlate how the large biomolecules such as proteins, carbohydrates, lipids, nucleic acids are made from the simple precursors
CQ.4. interpret the structure-functionrelationships oftheproteins, carbohydrates, lipids, and nucleic acids

Suggested Readings:

i) *Liljas, Anders***Textbook of structural biology** New Jersey: World Scientific, cop. 2009
1) Berg.J.M, Tymoczko.J.L, Stryer, L. Biochemistry. 6 th ed. Freeman, 2006.
2) D.A. Harris. Bioenergetics at a glance. John Willey and Sons Ltd, 1995.
3) Nelson.D.L, Cox. M. M. Lehninger's .Principle of Biochemistry. 6 th ed. Freeman, 2009
4) Voet and Voet. Biochemistry.4th edition, John Wiley, 2010.

Semester-I

Course Code: MLS-103
Subject: General Microbiology
No. of Credits: 04
L P
4 0

Maximum Marks: 100
Theory Exam: 75
Sessional: 25

Course Objectives: To study the fungi, bacteria, virus, microbial; classification and taxonomy, Sterilization methods and microbial ecology

Unit – I

Fungi: Introduction and classification: Thallus organisation, cell structure and cell wall composition, Nutrition, reproduction (vegetative, asexual and sexual), life cycles, Classification of fungi. and Economic importance of fungi. History and contributions of various scientists to this science with particular reference to the contribution of the following scientists A.V.Leeuwenhoek, Louis Pasteur, Edward Jenner, Robert Koch, Alexander Fleming and Joseph Lister.

Morphology and arrangement of bacterial cells, Bacterial- flagella, Fimbriae, capsule, spores and cysts, cell walls of Gram +ve and Gram –ve bacteria, Nutritional requirements and nutritional categories of microorganisms, Physical factors for growth, Enrichment culture techniques for isolation of microorganisms, pure culture techniques and preservation techniques, study of growth curve, measurement of growth.

Unit – II

Distinguishing features of bacteria, viruses, fungi, protozoa, algae. Introduction to Microbial Classification and Taxonomy, Taxonomic ranks, Various approaches for identification of microorganisms including molecular approaches; Gram (+) and Gram (-) bacteria of medical and industrial importance. Characteristics of Mycobacterium and Mycoplasmas; photosynthetic prokaryotes (purple bacteria, green bacteria, cyanobacteria) and actinomycetes; brief account of different types of viruses with special reference to lambda phage, herpes, adenoviruses and retroviruses, viriods and prions; fungi and algae of industrial importance.

Unit – III

Sterilization methods- dry heat, moist heat, radiations, filtration, and gaseous sterilization. Validation of sterilization processes; Factors affecting antimicrobial action, Mode of action of antimicrobial agents, Antibiotics and their mode of action, Microbiological assay of antibiotics (ampicillin, streptomycin, tetracycline etc.), Disinfectants, Types of toxins and their mode of action.

Unit – IV

Microbial ecology: Biogeochemical cycles; Physical environment: Microenvironment & Niche, Microorganisms and ecosystems. Soil microbiology: Types & functions of microorganisms in soil. Microorganism associations with vascular plants (Mycorrhizae, Rhizobia), Microorganism growth in Foods. Methods to control food spoilage, Food borne diseases

Course Outcomes:

CO1. Student will understand the diversified branches of microbiology

CO2.Student will know the aspects of microbial growth and physiology

CO3.Students will learn about the morphology and physiological characteristics of different groups of microorganisms

CO4.This course will make the students to understand various sterilization methods

Suggested Readings:

1) Jacquelyn G. Black. Microbiology-Principles and explorations 8 th edition: Publisher John Wiley & Sons 2012

2) Prescott, Harley and Klein- Microbiology-7 th edition; Publisher: McGraw Hill science 2007 Gerard J. Tortora, Berdell, R. Funke, Christine L. Case

3) Microbiology: An Introduction. 11th edition, Publisher: Benjamin Cummings. 2012

4) Atlas RM. Principles of Microbiology. 2ndedition. 1997

5) WM.T.Brown Publishers.2.Black JG. Microbiology: Principles and Explorations. 7thedition. Prentice Hall, 2008

Semester-I

Course Code: MLS-104
Subject: Molecular Biology
No. of Credits: 03
L P
3 0

Maximum Marks: 100
Theory exam: 75
Sessional: 25

Course Objectives:

To make students understand the complex molecular mechanisms occurring in cell and the applications of molecular technologies.

Unit-I

DNA Replication: Prokaryotic and eukaryotic DNA replication, Mechanics of DNA replication, enzymes and accessory proteins involved in DNA replication and DNA repair.
Transcription: Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Regulatory elements in mechanisms of transcription regulation, Transcriptional and post-transcriptional gene silencing, Modifications in RNA: 5‟-Capformation, Transcription termination, 3‟-end processing and .polyadenylation, Splicing, Editing, Nuclear export of mRNA, mRNA stability

Unit-II

Translation: Prokaryotic and eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination, Regulation of translation, co- and post translational modifications of proteins.
Protein Localization: Synthesis of secretory and membrane protein, Import into nucleus, mitochondria, chloroplast and peroxisomes, Receptor mediated endocytosis, Oncogenes and Tumor Suppressor Genes: Viral and cellular oncogenes, tumor suppressor genes from humans, Structure, Function and mechanism of action of pRB and p53 tumor suppressor proteins

Unit-III

Antisense and Ribozyme Technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme; hammer head, hairpin and other ribozymes, strategies for designing ribozymes, Applications of Antisense and ribozymetechnologies
Homologous Recombination: Holliday junction, gene targeting, gene disruption, FLP/FRT and' Cre/Lox recombination, RecA and' other recombinases Molecular Mapping of Genome: Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, Simple sequence repeat loci, Southern and fluorescence in situ hybridization for genome analysis,Chromosome micro dissection and micro cloning.

Course Outcomes:

After the successful completion of the course the learner will get complete idea about the
CQ.1. DNA replication, recombination and repair, transcription and translation
CO2.Students will be aware of protein localization
CO3.Students will understand the biology and application of antisense and ribozyme technologies

Suggested Readings:

1. Molecular Biology of the Gene, J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A Steitz and A.M. Weiner. The Benjamin/Cummings Pub. Co., Inc., California.
2. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Books, Inc., USA
3. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd., New York.
4. Molecular Biology LabFax, T.A Brown (Ed.), Bios Scientific Publishers Ltd., Oxford.

Semester-I

Course Code: MLS-105
Subject: Biostatistics
No. of Credits: 03
L P
3 0

Maximum Marks: 100
Theory exam: 75
Sessional: 25

Course Objectives:

The paper develops concepts about types of data observed in biological experiments, its handling and processing. It develops concepts of hypothesis and formulation of experiments. It gives understanding of various statistical operations needed to carryout and process the biological data.

Unit-I

Types of data, Collection and Graphical representation of data, Measures of central tendency: Mean, Median, Mode, Quartile, and Percentile. Measures of Dispersion: Range, Variance, Standard deviation, Coefficient of Variation, Correlation and Regression.

Unit-II

Probability and its applications: Laws of Addition and Multiplication, Compound Probability, Bayes theorem. Probability distributions: Binomial, Poisson and Normal distributions and their applications.

Testing of hypothesis: Parameter and Statistic, Sampling distribution and Standard error, Null and Alternative hypotheses, Simple and composite hypotheses, Two types of errors, Level of significance and Power of the test, One tailed and two tailed tests.

Unit-III

Tests of significance: t and Z tests for mean and proportion for one and two samples, Chi square test of goodness of fit and independence. F test, Analysis of variance for one way and two way classification, Elementary ideas of Designs of Experiments

Important statistical softwares and their applications

Course Outcomes:

After the successful completion of the course the learner will get complete idea about the

CQ.1. An ability to apply knowledge of statistics to design and conduct experiments, as well as to analyze and interpret data related to domain of biology

CQ.2. An ability to apply the knowledge of basic mathematical & statistical tools used in biological research/ biotechnology in industry and research lab

CQ.3. An ability to understand the principle and application of Differential Calculus, Differential Equations and various Computational Techniques

Suggested Readings:

1. Daniel, Wayne W. (2007) Biostatistics: A Foundation for Analysis in Health Sciences 10th Edition, Wiley Series.
2. Pagano, Marcello and Gauvreau, Kimberlee (2000) Principles of Biostatistics, 2nd Edition,

CRC Press
3. Chap T. Le, Introductory Biostatistics (2017), Wiley India Pvt Ltd.
4. P.N. Arora and P. K. Malhan, Biostatistics, Himalaya Publishing House
5. B. K. Mahajan, Methods in Biostatistics: For Medical Students and Research Workers, JPB

Semester-I

Course Code: MLS-106
Subject: Lab Course-1
No. of Credits: 03
L P
0 6

Maximum Marks: 100
Theory exam: 70
Sessional: 30

1. Preparation of mitotic and meiotic chromosomes
2. Calculation of morphometric data and preparations of idiogram.
3. Determination of chiasma frequency and terminalization coefficient
4. Preparation of polytene chromosomes and mapping
5. Titration of amino acids
6. Colorimetric determination of pK
7. Model building using space filling/ball and stick models
8. Reactions of amino acids, sugars and lipids
9. Isolation of DNA and protein
10. Quantization of Proteins and Sugars
11. Analysis of oils-iodine number, saponification value, acid number
12. UV, Visible, Fluorescence and IR spectroscopy, Absorption spectra
13. Separation techniques - Centrifugation, Chromatography (Gel permeation, Ion exchange, TLC etc. and Electrophoresis

Semester-I

Course Code: MLS-107
Subject: Lab Course-II
No. of Credits: 03

Maximum Marks: 100
Theory Exam: 70
Sessional: 30

L P
0 6

1. Isolation of genomic DNA
2. Southern blotting
3. RFLP analysis
4. Isolation of RNA
5. Isolation of polyA +RNA
6. Northern blotting
7. Preparation of probes
8. In vitro Transcription
9. In vitro translation
10. Metabolic labeling of proteins and immune precipitation
11. Descriptive statistics: Systemic tabular summarization of data (before analysis), measures of central tendency, measures of dispersion (using calculators).
12. Correlations (Product Moment and Spearman's Rank Correlation) and Linear Regression Tests of significance (Mean, Standard Deviation, proportion, Correlation Coefficient)
13. Chi Square Test of Goodness of fit, test of independence of attributes, Analysis of Variance (One way and Two way)
14. Preparation of Graphs and statistical calculations using software

ANNEXURE-II

Scheme of M.Sc. Biotechnology

SEMESTER-II

Sr. No.	Course Code	Subject	Teaching Hours per week			Maximum Marks			Credits	Category Code
			L	T	P	Int	Ext	Total		
1	MLS−201	Biotechniques	4			25	75	100	4	DCC
2	MLS−202	Metabolism	4			25	75	100	4	DCC
3	MLS−203	Bioinformatics and Biomolecular Modelling	3			25	75	100	3	DCC
4	MLS−204	Genetic Engineering	3			25	75	100	3	DCC
5	MLS−205	Environment and Ecology	4			25	75	100	4	DCC
6	MLS−206	Lab Course− I (Based on MLS 201−202)			6	30	70	100	3	DCC
7	MLS−207	Lab Course− II (Based on MLS 203− 205)			6	30	70	100	3	DCC
8	MLS−208	Audit Course**	2	0	0	25	75	100	0	AUD
	Total Marks							**800**	**24**	

** The students have to choose one Audit course from the list provided by the department/ university.
Only passing of the audit course is mandatory.

Annexure -B

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

M.Sc. (Biotechnology) Syllabus, Semester-II

Course Code: MLS-201
Subject: Biotechniques
No. of credits: 4
L P
4 0

Maximum Marks: 100
Theory exam- 75
Sessional-25

Course Objectives: To learn various techniques used in biological sciences and their applications in different research works. The course also aims to make students learn about modern instruments for various analytical works.

Unit-I

Microscopy: Light Microscopy – Magnification, resolving power, Numerical aperture, Limit of Resolution, Bright field, Phase contrast, Fluorescence microscopy. Principle and applications of Electron Microscopy (SEM and TEM), Cryogenic Electron Microscopy, Confocal Microscopy, Atomic Force Microscopy, Polarised Light Microscopy

Centrifugation Techniques: Principle of sedimentation, centrifugation, types of rotors, general applications of centrifugation, ultracentrifugation, analytical centrifugation, preparative centrifugation, precautions and safety aspects

Unit-II

Spectrophotometric Techniques: Electromagnetic spectrum, Beer Lambert's Law. Photometry, UV/VIS Spectrophotometry, Infrared spectroscopy, Raman SpectroscopyCircular dichroism (CD), Molecular structure determination using X-ray diffraction, Xray crystallography and NMR, Different types of mass spectrometry and surface plasmon resonance method

Unit-III

Principles and different types of ELISA, Radioimmune Assay (RIA), Immunoprecipitation, flowcytometry, Genomic Insitu Hybridisation (GISH). Chromosome walking, Chromosome painting. Chromosome Banding Techniques.

Unit-IV

Principles and applications of Chromatography. Ion exchange chromatography, Gel filtration chromatography, Hydrophobic interaction chromatography, Affinity chromatography, GC, HPLC.

Electrophoresis-Agarose Gel electrophoresis, Polyacrylamide Gel Electrophoresis (Native, SDS PAGE), 2-Dimenional Gel electrophoresis,

Course Outcomes:

CO-1- To impart knowledge and application of various bioanalytical techniques

CO-2- Students will learn centrifugation and electrophoretic techniques involved in isolation, purification and analysis of biomolecules.

CO-3- Students will learn spectrophotometric techniques for qualitative and quantitative analyses of biomolecules.

CO-4- Students will gain the knowledge and will analyses the biophysical techniques for theIsolation, Identification and Quantification of Biomolecules

Suggested Readings:

1. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, Andreas Hofmann and Samuel Clokie (8^{th} Edition).
2. NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry, Harald Ganther (3^{rd} Edition)
3. Crystallography Made Crystal Clear - Gale Rhodes, academic Press (3^{rd} Edition).
4. Molecular Biology and Biotechniques: the fundamental approach- Aga Syed Sameer (2^{nd} Edition).
5. Biotechniques- Theory and Practice, S.V.S Rana, Rastogi Publication (1^{st} Edition).
6. Principles of Immunodetection and Immunotechniques: Preview and Emerging Applications, Shelza Thakur, Navnit Kumar Mishra, Hardeep Singh Tuli, Anil K. Sharma (1^{st} Edition)

Semester-II

Course Code: MLS-202
Subject: Metabolism
No. of credits: 4
L P
4 0

Maximum Marks: 100
Theory exam- 75
Sessional-25

Course Objectives: Students will learn about different metabolic pathways related to carbohydrate, proteins, nucleic acid and fatty acids, including its significance and regulation in biological system.

Unit I

An overview of metabolism including catabolism and anabolism, Bioenergetics, ATP synthesis, Electron transport chain, Phosphorylation, Oxidative phosphorylation, Substrate phosphorylation and photophosphorylation.

Unit II

Carbohydrates – Fermentation, Pathways and regulations of glycolysis (Entner-Doudoroff pathway), citric acid cycle, pentose phosphate pathway, gluconeogenesis, glycogenesis and glycogenolysis, glyoxylate pathways, Cori cycle, anaplerotic reactions, glucuronate pathway. Energetics of metabolic cycle.

Unit III

Fatty acid metabolism including catabolism and anabolism. Ketone bodies metabolisms, keto acids, fatty acid synthesis and oxidation, cholesterol synthesis and regulation, Biosynthesis and degradation of tri-acyl-glycerol and phospholipids, diseases caused by abnormal metabolic pathway.

Unit IV

Catabolism of amino acids, glucogenic and ketogenic amino acids, disorders of amino acid metabolism. Biosynthesis of urea and urea cycle, related disorders, Nucleotides, de novo synthesis and breakdown of purine and pyrimidine nucleotides, regulation, salvages pathway, inhibitors of nucleotide metabolism, disorders of nucleotide metabolism and Vitamins and role in metabolic synthesis.

Course Outcomes:

CO-1- To comprehend various biochemical changes in living system.

CO-2- Recognize how the catabolic and anabolic breakdown of the substances is associated with the release during synthesis of biomolecules

CO-3- Assessing the role of different inhibitors in metabolic pathways.

CO-4- Provide deeper insight in the understanding, application and regulation ofvarious metabolic pathways

Suggested Readings:

1. Biochemistry and Molecular Biology, Elliott and Elliott, Oxford University press, New York, USA (4^{th} edition).
2. Harper's Illustrated Biochemistry, Murray, Granner and Rodwell, McGraw Hill, New York, USA. (28^{th} edition)
3. Biochemistry, Voet and Voet, John Wiley (4^{th} edition).
4. Nelson DL Cox, MM Lehninger's Principal of Biochemistry (7^{th} edition).
5. Biochemistry, Satyanarayana U, Chakrapani U, Elsevier (5^{th} edition).
6. Fundamentals of Biochemistry, JL Jain, Sanjay Jain, Nitin Jain, S Chand (4^{th} edition)

Semester-II

Course Code: MLS-203

Subject: Bioinformatics and Biomolecular Modelling

No. of credits: 3

L	**P**
3	**0**

Maximum Marks: 100
Theory exam- 75
Sessional-25

Course Objectives: This course is meant to impart knowledge to students for analysing and interpreting vast biological data using computational techniques. The course is designed in such a way that it gives a walkthrough of the major aspects of bioinformatics such as the development of databases and computationally derived hypothesis. We will focus on DNA and protein sequence databases and analysis, secondary structures and 3D structural analysis.

Unit I

Introduction to bioinformatics and Biological databases: Introduction to genomics and proteomics databases- nucleic acid sequence databases; GenBank, UCSC, ENSEMBL, EMBL, DDBJ, protein sequence databases; Swiss-Prot, PDB, BLAST, PSI- BLAST (steps involved in use and interpretation of results), BLAST vs FASTA, file formats- FASTA, ClustalW, Databank search- data mining, data management and applications.

Unit II

Sequence alignment: Nucleic acid and protein sequence information, composition and properties, Pair-wise sequence alignment, gaps, gap-penalties, scoring matrices, PAM 250, BLOSUM 62, global and local sequence alignment, similarity searching (FASTA and BLAST), Identification of genes in genomes, primer designing, Phylogenetic analysis with reference to nucleic acids and protein sequences using PHYLIP, DISTANCES, and GROWTREE, Identification of ORFs, Identification of motifs.

Unit III

Protein structure and Molecular Interaction: Introduction to protein structure, secondary structure prediction, tertiary structure prediction, protein modelling; principles of homology and comparative modelling, threading, structure evaluation and validation and Modelling, applications; Molecular docking, Autodoc.

Applications of Bioinformatics in various fields: Environment, biotechnology, molecular biology, neurobiology, agriculture, drug designing, biomedical genome medicines, medical microbiology.

Course Outcomes:

CO-1- To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis

CO-2- To gain knowledge about various Biological databases that provide information about nucleic acids and protein

CO-3- Understanding of the concept of pairwise sequence alignment and tools for pairwise alignment, also students will learn about Multiple Sequence Alignment, its significance,

algorithms and tools used for MSA.

CO-4- The students will learn about biological macromolecular structures and structure prediction methods

Suggested Readings:

1. Bioinformatics: Sequence and Genome Analysis, David W. Mount, Cold Spring Harbor Laboratory Press, New York, USA (2nd Edition).
2. Bioinformatics: A primer, P. Narayan, New Age International Publishers (1st Edition).
3. Bioinformatics Principles and Applications, Harshawardhan P. Bal, Tata McGraw- Hill Publishing Company (1st Edition).
4. Understanding Bioinformatics, Marketa Zvelebil and Jeremy O. Baum, Garland Science (1st Edition).
5. Bioinformatics: Methods and Applications (Genomics, Proteomics and Drug Discovery), S. C. Rastogi, Namita Mendiratta and Parag Rastogi, Prentice Hall ofIndia (4th Edition).
6. Fundamental Concepts of Bioinformatics, Dan E. Krane and Michael L. Raymer Pearson Education (1st Edition).
7. Bioinformatics For Dummies, Jean Michael Claverie and Cerdic Notredame, Wiley India Pvt Ltd (2nd Edition).

Semester-II

Course Code: MLS-204
Subject: Genetic Engineering
No. of credits: 3

L	**P**
3	**0**

Maximum Marks: 100
Theory exam- 75
Sessional-25

Course Objectives: To understand the basic concepts in Gene cloning; to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology; and to appraise them about applications of genetic engineering as well as genome editing tools.

Unit-I

Recombinant DNA technology: Restriction and modification enzymes; Restriction Digestion-Partial as well as complete digestion, Linkers and adaptors. Vectors - Plasmids, Cosmids, bacteriophage and other viral vectors, bacterial and yeast artificial chromosomes; Expression vectors, shuttle vectors. Plasmid incompatibility. Introduction of DNA into living cells. Selectable and Screenable markers. Selection of transformed and recombinant cells. Insertional inactivation of genes. Ti plasmid and Agrobacterium mediated Gene transfer. Functions of different of Vir genes.

Unit-II

The construction of cDNA and Genomic libraries. Genomics and its application, Expressed sequence tags, Human genome project- strategies and implications, Gene therapy: principles, strategies. DNA sequencing methods, Maxam and Gilbert's chemical and Sanger's chain termination methods, and Pyrosequencing.
Polymerase chain reaction and its application in research. TA cloning. Real time/quantitative PCR.

Unit-III

Differential gene expression profiling by Microarray. Differential protein expression profiling. The Southern, Northern, Western blotting. Analysis of DNA-Protein Interactions-Electromobility shift assay, ChIP assay, DNase Foot printing. Protein-protein interactivestudy: The yeast two hybrid system, Random amplification of polymorphic DNA (RAPD), RFLP (Restriction fragment Length Polymorphism), Site-directed mutagenesis.

Course Outcomes:

CO-1- Provide deeper insight in the understanding, application of the tools of restriction digestion and modification system as well as cloning.

CO-2- To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences

CO-3- To train students in strategizing research methodologies employing genetic engineering techniques.

CO-4- To expose students to methods and application of DNA sequencing in biotechnological research

Suggested Readings:

1. Gene Cloning and DNA analysis- an introduction - T. A Brown, Wiley-Blackwell (7^{th} Edition)
1. Molecular Biotechnology: Principles and applications of Recombinant DNA- Bernard R Glick, Jack J Pasternak (3^{rd} Edition)
2. Principles of Biotechnology- Christina A. Crawford, Grey House Publishing (1^{st} Edition)
3. Principles of Gene Manipulation and Genomics- Primrose, S. B., & Twyman, Wiley-Blackwell (7^{th} Edition)
4. Biotechnology-David P. Clark, Nanette J. Pazdernik, Elsevier Science (2^{nd} Edition)
5. Plant Biotechnology and Genetic Engineering- C M Govil, Ashok Aggarwal, Jitender Sharma, PHI Learning (1^{st} Edition)

Semester-II

Course Code: MLS-205
Subject: Ecology and Environment
No. of credits: 4

L	P
4	0

Maximum Marks: 100
Theory exam- 75
Sessional-25

Course Objectives: The objective of this course to make awareness among the youngstudents about the surrounding environment, basic concepts of ecology, the impact of climate change and its mitigation, biodiversity and conservation.

UNIT I

Environment: Introduction to ecology and basic environmental concepts; Physical environment, biotic environment, laws and limiting factors, ecological models, biotic and abiotic interactions, climate and soil pattern of world.
Habitat ecology: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement and major habitat types of the subcontinent.

UNIT II

Population ecology: Characteristics of a population; population growth curves; population dynamics and regulation; life history strategies (*R* and *K* selection), age structured populations, Competition and coexistence, intra-specific and inter-specific interactions, scramble and contest competition model, mutualism and commensalism, prey-predator interactions, Species interactions; Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis; Mechanisms of litter fall decomposition and climatic factors associated with decomposition.

UNIT III

Community ecology: Nature, structure and attributes of community, analysis of communities (analytical and synthetic characters), levels of species diversity and its measurement, edges and ecotones, ecological succession: types, mechanisms, changes involved in succession, concept of climax, models of succession, ecological adaptations.
Ecosystem ecology: Structure and function, energy flow through ecosystems, food webs, biogeochemical cycles, resilience of ecosystem, primary production and methods of measurement, global pattern and controlling factors, ecosystem management/restoration.

UNIT IV

Environment and Development: Environmental Challenges faced by India and the world; Climate change and global warming, different types of pollution – air, water and soil, energy crisis and resource conservation, National and global environmental education programs and organisations, Environment Impact Assessment (EIA), Environmental Laws and policies.
Biodiversity: Assessment, international conventions, changing environment. conservation and management, biodiversity act and related sustainable development, natural resource management in changing environment

Course Outcomes:

CO-1- Students will be exposed to the fundamental aspects of ecology.

CO-2- They will get idea about the interactions and interdependence of abiotic and biotic factors in nature. They will also learn about the impact of anthropogenic activities on the environment and need for conservation

CO-3- Student will develop an understanding of the ecological principles that link individuals at populations, community and ecosystem levels.

CO-4- Students will learn about the environmental issues faced by India and world, various national and global organisations working towards environment protection and biodiversity conservation.

Suggested Readings:

1. Ecology: From Individuals to Ecosystems, Michael Begon, Colin R. Townsend, John L. Harper, Wiley-Blackwell (3rd Edition).
2. Ecology: Principles and Applications, J. L. Chapman and Michael Reiss, Cambridge University Press, U.K. (1st Edition).
3. Ecology and Environment, P.D. Sharma, Rastogi Publications, India (13th Edition).
4. A text book of Ecology, R. S. Ambasht and N. K. Ambasht, CBS Publ. & Distr. New Delhi. (15th Edition).
5. Fundamentals of Ecology, E. P. Odum and G. W. Barrett, Brooks/Cengage Learning India Pvt. Ltd., New Delhi (5th Edition).
6. Concepts of Ecology, E. J. Kormondy, Prentice Hall of India, New Delhi (4th Edition).
7. Ecology, N. S. Subrahmanyam and A.V.S.S. Sambamurty, Narosa Publishing House, New Delhi (2nd Edition).
8. Ecology: Theory and Applications, P. Stiling, PHI Learning Pvt. Ltd. New Delhi (4th Edition).
9. Essentials of Ecology and Environmental Sciences, S V. S. Rana, PHI Learning Pvt. Ltd. New Delhi (4th Edition).

Semester-II

Course Code-MLS -206

Subject: Lab Course-I (Based on MLS 201-202)
No. of Credits-3

L	P
0	6

1. Isolation of total protein by acetone precipitation from biological sample and its quantitation by Bradford method.
2. Analysis of proteins. Native PAGE and SDS PAGE, Visualization of protein bands by Coomassie staining
3. Determination of molecular weight of a given protein by Gel filtration
4. To check the validity of Lambert-Beer's law
5. Determination of concentration and purity of DNA by spectrophotometer
6. Estimation of RNA by orcinol method
7. Estimation of DNA by DPA method
8. Determination of starch in plant tissues
9. Determination of total soluble sugars by ferricyanide method
11. Quantitative determination of free amino acid content in germinating seeds
12. Estimation of beta carotene in carrots by spectrophotometry
13. Estimation of ascorbic acid in lemon juice by calorimetric method

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

Semester-II

Course Code-MLS -207
Subject: Lab Course-II (Based on MLS 203-205)
No. of Credits-3

L	**P**
0	**6**

1. PCR amplification of DNA from unknown source
2. Preparation of restriction enzyme digests of DNA samples
3. Determination of nucleotide sequence of DNA by dideoxy chain termination method
4. To study physical and chemical characteristics of soil and water samples collected from different locations
5. Assessment of density, frequency and abundance of plants/ animals in a community using various techniques i.e., transect, quadrate etc.
6. To determine the dissolved oxygen/free carbon dioxide/nutrients, hardness, alkalinity pH and conductivity of water samples collected from different locations
7. To record the biotic and abiotic components of water in different ecosystems
8. Determination of species diversity index and importance value index of local vegetation
9. Retrieve sequences from different Nucleic acid and protein databases
10. Data mining for sequence analysis by use of Bioinformatics' tools
11. Pair wise and multiple alignments of sequences using different softwares
12. Evolutionary studies / phylogenetic analysis of DNA and protein sequences

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

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

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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	√	√	√