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

(Formerly YMCA University of Science and Technology)
Accredited 'A+' Grade By NAAC
A State Govt. University established wide State Legislative Act. No. 21 of 2009
SECTOR - 6, FARIDABAD, HARYANA-121006

Department of Life Sciences

w.e.f. 2023

SCHEME AND SYLLABI

M.Sc BOTANY

J C BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA

VISION

J C Bose University of Science and Technology, YMCA aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres which transforms the life of students through integration of teaching, research and character building.

MISSION

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the art technological exposure to its scholars.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities.

DEPARTMENT OF LIFE SCIENCES

VISION

A department established with a multidisciplinary approach for exploring different dimensions of biology and its applications for imparting conceptual and technical skills to students leading to the fostering of scientific temperament.

MISSION

- To mentor students for developing conceptual understanding of the subject leading to its application in resolving societal and environment concerns.
- To provide holistic training to the student to succeed in the society
- To inculcate the thirst for learning and the zest for research.

PROGRAM OUTCOMES OF PG PROGRAM OF FACULTY OF SCIENCES

PO1	**Knowledge**	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study.
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.

PROGRAM SPECIFIC OUTCOMES (PSOs)

The program specific outcomes (PSOs) are the statement of competencies/abilities which describe the knowledge and capabilities, the post-graduate students will have obtained by the end of the program.
After successful completion of M. Sc. Botany, the students will be 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.

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

DEPARTMENT OF LIFE SCIENCES
SCHEME M.SC. BOTANY

SEMESTER-I

Sr.No.	Course Code	Subject	Teaching hours per week			Maximum marks			Credits	Category course
			L	T	P	Int	Ext	Total		
1.	MBOT-101	Biochemistry	4	0	0	25	75	100	4	DCC
2.	MBOT-102	Biostatistics and Scientific ethics	4	0	0	25	75	100	4	DCC
3.	MBOT-103	Cell and Molecular Biology	4	0	0	25	75	100	4	DCC
4.	MBOT-104	Genetics	4	0	0	25	75	100	4	DCC
5.	MBOT-105	Microbiology	4	0	0	25	75	100	4	DCC
6.	MBOT-106	Botany Lab Course - I	0	0	12	30	70	100	6	DCC
7.		MOOC								
		Total	**20**		**12**			**600**	**26**	

DCC: Discipline Core Course; MOOC: Massive online open course; L: Lecture; T: Tutorials; P: Practicals

*The students must 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 must pass a selected MOOC course within the duration of M.Sc. Sem. I to Sem. III The passing of a MOOC course is mandatory for the fulfilment of the award of the degree of concerned programme.
4. A student must register for the approved course by the department for which he/she is interested and eligible with the help of course coordinator of the concerned department.
5. M.Sc students may register only in PG MOOC courses.
6. 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 must 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.

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DEPARTMENT OF LIFE SCIENCES
SCHEME M.SC. BOTANY

SEMESTER-II

Sr.No.	Course Code	Subject	Teaching hours per week			Maximum marks			Credits	Category course
			L	T	P	Int	Ext	Total		
1.	MBOT-201	Plant Biotechnology	4	0	0	25	75	100	4	DSC
2.	MBOT-202	Biotechniques	4	0	0	25	75	100	4	DCC
3.	MBOT-203	Ecology and Environmental Biotechnology	3	0	0	25	75	100	3	DSC
4.	MBT-204	Genetic Engineering and Introductory Bioinformatics	4	0	0	25	75	100	4	DCC
5.	MBT-205	Plant Physiology	4	0	0	25	75	100	4	DSC
6.	MBT-206	Botany Lab Course-II	0	0	12	30	70	100	6	DSC
7.		AUDIT COURSE	2	0	0	25	75	100		
		Total	**21**		**12**			**700**	**25**	

DSC: Discipline Specific Course; AUD: Audit Course

*Audit course will be offered as per courses offered by various departments in the University

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DEPARTMENT OF LIFE SCIENCES
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SEMESTER-III

Sr.No.	Course Code	Subject	Teaching hours per week			Maximum marks			Credits	Category course
			L	T	P	Int	Ext	Total		
1.	MBOT-301	Metabolism	4	0	0	25	75	100	4	DCC
2.	MBOT-302	Advances in Archaegoniates	3	0	0	25	75	100	3	DSC
3.	MBOT-303	Developmental Biology	4	0	0	25	75	100	4	DCC
4.	MBOT-304	Taxonomy of Angiosperms	3	0	0	25	75	100	3	DSC
5.		Discipline Elective-I • Advances in Phycology (MBOT-DE001) • Biology of Archegoniates (MBOT-DE002)	3	0	0	25	75	100	3	DSE
6.	MBOT-305	Botany Lab Course- III	0	0	12	30	70	100	6	DSC
7.		Open Elective Course	3	0	0	25	75	100	3	OEC
		Total	**20**		**12**			**700**	**26**	

DSE: Discipline Specific Elective Course

*Open Elective course will be offered as per courses offered by various departments in the University

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DEPARTMENT OF LIFE SCIENCES
SCHEME M.SC. BOTANY

SEMESTER-IV

Sr.No.	Course Code	Subject	Teaching hours per week			Maximum marks			Credits	Category course
			L	T	P	Int	Ext	Total		
1.	MBOT-401	Evolutionary Biology	4	0	0	25	75	100	4	DSC
2.	MBOT-402	Plant Anatomy and Resource utilization	4	0	0	25	75	100	4	DSC
3.	MBOT-403	Plant Pathology	3	0	0	25	75	100	3	DSC
4.		Discipline elective II • Molecular interactions in plants (MBOT-DE003) • Genomics and Proteomics (MMT-DE001) • Pharmaceutical and Herbal Technology (MBT-DE003)	3	0	0	25	75	100	3	DEC
5.	MBOT-404	Botany Lab Course-III	0	0	12	30	70	100	6	DSC
6.	MBOT-405	Dissertation	0	0	8			100	4	DSC
		Total	**14**		**20**				**24**	

DEC: Discipline Elective Course

M.Sc. BOTANY SEMESTER I
CODE: MBOT-101
SUBJECT NAME: BIOCHEMISTRY

Credits	L	P		
4	4	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objective:
To provide students with a strong foundation in the molecular and chemical processes that govern biological systems, and prepare them for further study or research in related fields such as biotechnology, physiology, pharmacology, and medicine.

Unit I
- Water – properties of water, essential role of water for life on earth pH, buffer, maintenance of blood pH and pH of gastric juice
- Carbohydrates: Structure, occurrence and biological importance of monosaccharides, oligosaccharides and polysaccharides; Glycosaminoglycans; Lectins

Unit II
- Common structural features, classification and properties of amino acids
- Classification and structure of proteins (Primary, secondary, tertiary & quaternary); Ramachandran Plot; Protein folding and role of chaperons in protein folding, Determination of amino acid sequence.
- Classification, structures and properties of fatty acids; Acylglycerols; Structure and properties of different types of phospholipids and sphingolipids (sphingomyelins, cerebrosides & gangliosides)

UNIT III
- Nucleotides; Nucleic acid as genetic material-experimental evidences; Chargaff's Rule; Double helical model of DNA structure; Structural polymorphism of DNA (A, B and Z-DNA); RNA; Biological functions of nucleotides
- Vitamins: general characteristics and properties

Unit IV
- General characteristics and nomenclature of enzymes; Mechanism of enzyme catalysis.
- Enzyme kinetics: Michaelis-Menten kinetics, Lineweaver-Burk, Hanes-Woolf, Woolf Augustinsson-Hofstee, Eadie-Scatchard; Direct linear plot
- Types of inhibition, Abzymes, Zymogens, Catalytic antibodies

References
1) Biochemistry by Berg.J.M, Tymoczko.J.L, Stryer, L.9 ed. W.H. Freeman, 2019.
2) Bioenergetics at a glance byD.A. Harris. John Willey and Sons Ltd, 1995.
3)Lehninger's Principle of Biochemistry by NelsonD.L, Cox. M. M. 8 ed. W.H.Freeman, 2021

4)Principles of Biochemistry by D. Voet, J. Voet and C.W.Pratt. Biochemistry. 5th ed., John Wiley, 2018.
5) Harper's Illustrated Biochemistry by P. Kennelly, K. Botham, O.McGuiness, V. Rodwell and P.A.Weil

Course Outcome:

After the successful completion of the course the student would be able to:
CO.1. Comprehend the importance of chemical foundation in living organisms.
CO.2. Develop an understanding of various biomolecules in the cell and their functions
CO.3. Utilization of the concepts in various biochemical studies, research and analysis.

M.Sc. BOTANY SEMESTER I
CODE: MBOT-102
SUBJECT NAME: BIOSTATISTICS AND SCIENTIFIC ETHICS

Credits	**L**	**P**	**Sessional**	**25**
4	**4**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objective: The course focuses on developing concepts about types of experimental biological data, processing and analysis to further formulate hypothesis in experiments.

Unit I

- Application of statistics in Biology**,** Types of Biological data, Collection, Frequency Distributions, Cumulative Frequency Distributions, Population and Samples, Outliers
- Measures of central tendency: Mean, Median, Mode, Quartile, and Percentile. Measures of Dispersion: Range, Variance, Standard deviation, Coefficient of Variation, Correlation and Regression
- Probability and its applications: Laws of Addition and Multiplication, Compound Probability, Bayes theorem. Probability distributions: Binomial, Poisson and Normal distributions and their applications.

Unit II

- 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.
- 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

Unit-III

- Technical writing skills: types of reports, layout of a formal report. Plagiarism, software for plagiarism.

- Scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references. Drafting titles and framing abstracts.
- Publishing scientific papers: peer review process and problems, recent developments such as open access and non-blind review; bibliometric analysis; Scientific misconduct.

References

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, Session: 2020-21 18 CRC Press.
3. Zar, J. H. (1999). Biostatistical analysis. Pearson Education Inc.
4. Sokal, R. R., Rohlf, F. J., & Rohlf, J. F. (1995). Biometry. Macmillan.
5. Valiela, I. (2001). Doing Science: Design, Analysis, and Communication of Scientific Research. Oxford: Oxford University Press.
6. On Being a Scientist: a Guide to Responsible Conduct in Research. (2009). Washington, D.C.: National Academies Press.
7. Gopen, G. D., & Smith, J. A. The Science of Scientific Writing. AmericanScientist, 78 (Nov-Dec 1990), 550-558.

Course Outcomes (COs):

After successful completion of this course, a student will be able to:

CO1. Understand the concept and scope of statistics in biological data generation, collection and sampling.

CO2. Develop skills for writing scientific paper and understanding of plagiarism and scientific misconduct.

CO3. Apply the acquired skill in data interpretation, record keeping and scientific document generation.

M.Sc. BOTANY SEMESTER I
CODE: MBOT-103
SUBJECT NAME: CELL AND MOLECULAR BIOLOGY

Credits	L	P		
4	4	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objective: To provide students with a basics of cellular organization and underlying molecular mechanism.

Unit I

- Bio membranes: Molecular composition and arrangement, functional consequences, different mechanisms of transport across membrane
- Cell-cell interactions: adhesion junctions, tight junctions, gap junctions, plasmodesmata, Calcium dependent and Calcium independent adhesion
- 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

Unit II

- Genome organization
- Cell cycle: The eukaryotic cell cycle, Regulators of cell cycle progression, events of M phase, cytokinesis, Meiosis
- Cell signaling: GPCR and role of second messenger (cAMP), Receptor protein tyrosine kinase, regulation of blood glucose level, calcium as an intracellular messenger
- Apoptosis (Programmed Cell Death), brief idea of cancer (p53 and pRb)

Unit III

- DNA Replication: Prokaryotic and eukaryotic DNA replication, Mechanisms of DNA replication, enzymes and accessory proteins involved in DNA replication and DNA repair.
- Transcription: Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, Modifications in RNA: 5'-Capping, 3'-end processing and polyadenylation, Splicing, Editing, Nuclear export of mRNA, mRNA stability

Unit IV

- 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.
- Regulation of gene expression in prokaryotes and eukaryotes: lac, trp and ara operons, enhancers and silencers.

References

1. Molecular Cell Biology by J. Darnell, H. Lodish and D. Baltimore Scientific American Book, Inc.,USA.
2. Molecular Biology of the Cell by 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. The Cell: A molecular approach by Geoffrey Cooper, 8th ed, OUP USA Publishers
5. Cell and molecular biology by Gerald Karp and James G Patton, 7th ed, John Wiley & Sons

Course Outcome (COs):

After successful completion of this course, a student will be able to:

CO1. Develop conceptual understanding of cell cycle and various cellular interactions.

CO2. Generate concepts of genome replication and regulation.

CO3. Apply the knowledge to analyze cellular behaviour.

M.Sc. BOTANY SEMESTER I
CODE: MBOT-104
SUBJECT NAME: GENETICS

Credits	L	P		
4	4	0	Sessional	25
			Theory Exam	75

Total: 100

Course Objective: To develop an understanding of the concepts of inheritance and various principles and mechanisms involved in heredity at cellular level.

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
- Geneinteractions- 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 Para centric inversion, Inversion heterozygotes, Inversion homozygotes. Reciprocal and non-reciprocal translocation, Homozygotes as well as Heterozygote Translocants. 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
- Population genetics and its applications, Natural selection and random genetic drift.

References

1. Principles of Genetics by E. J. Gardner, M.J. Simmons, D. P. Snustand, 8th, John Wiley &Sons Ltd.
2. Principles of Genetics by R.H.Tamarin, 7th ed. Tata McGraw-Hill Publishing Comp. Ltd..
3. Genetics – A conceptual approach by B.A. Pierce. 6th ed. WH Freeman Company.
4. Lewin's Genes by J.E. Krebs, E.S. Goldstein and S.T. Kilpatrick. 12th ed. Jones and Bartlett Publishers Inc.
5. Concepts of Genetics by W.S. Klug, M.R.Cummings, C.A. Spencer, M.A.Palladino and D. Killian, 11th ed. Pearson Education

Course Outcomes (COs):

After successful completion of this course, a student will be able to:
CO1- To generate conceptual understanding of mendelian genetics, cytogenetics, epigenetics and population genetics.
CO2- To develop the skills for genetic mapping and interpreting hereditary diseases, their inheritance patterns, and pedigree analysis.
CO3- To apply the knowledge and skills acquired for genetic inheritance studies in plants, animals and prokaryotes.

M.Sc. BOTANY SEMESTER I
CODE: MBOT-105
SUBJECT NAME: Microbiology

Credits	**L**	**P**	**Sessional**	**25**
4	**4**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objectives: To develop understanding of microbial diversity along with tools and techniques used in microbiology.

Unit I
- History of microbiology with special reference to contributions of A.V. Leeuwenhoek, Louis Pasteur, Edward Jenner, Robert Koch, Sergei Beijerinck, Winogradsky, Alexander Fleming, Joseph Lister and Paul Ehrlich.
- Introduction to microbial taxonomy: brief outline classification of eubacteria, archaea, fungi and protists; classical and molecular approaches in microbial taxonomy.
- Structure and morphology of eubacterial and archaeal cells. Structure and morphology of fungal cell

Unit II
- Nutrition: requirements, categories, uptake and media
- Growth: bacterial growth curve and mathematical model, isolation and maintenance of pure culture, factors affecting growth, measurement of growth.
- Reproduction in bacteria with emphasis on binary fission and budding; different strategies of reproduction in fungi

Unit III
- Sterilization techniques, disinfection and antisepsis.
- Mode of action of antibiotics, MIC assay, factors affecting antimicrobial action.
- Host pathogen interaction, types of toxins and their mode of action

Unit IV
- Brief history of virology, structure and composition of virus, classification (Baltimore and ICTV), cultivation of virus and enumeration assays.
- General life cycle of virus, one step growth cycle
- Morphology and lifecycle of T4, lambda, caulimovirus, banana bunchy top virus, reovirus, picornavirus and retroviruses. Molecular control of lysogeny

References

1. Jacquelyn G. Black. Microbiology-Principles and explorations 8 th edition: Publisher John Wiley & Sons 2012.
2. J.M. Willey, L.M. Sherwod and C.J. Wolverton. Prescott, Harley and Klein's Microbiology, McGraw Hill International Edition, 11th Edition.
3. Brock, Biology of Microorganisms, Pearson International Edition. 15th edition
4. M.J. Pelczar Jr., E.C.S.Chan, N.K. Krieg. Microbiology/ Tata McGraw Hill. 5th edition
5. R.Y. Stannier, J.L.Ingraham, M.L.Wheelis and P.R. Painter. Genereal Microbiology. Fifth Edition.Macmillan Press Ltd.
6. Atlas RM. Principles of Microbiology. 2ndedition. 1997

Course Outcomes (COs)

After successful completion of this course, a student will be able to:

CO1: To develop conceptual understanding of microbial diversity, taxonomy and ultrastructure.

CO2: To acquire skills in various techniques used in microbial study

CO3: To apply the skills and knowledge in diagnostics, industrial biotechnology, microbial interactions and other related areas.

M.Sc. BOTANY SEMESTER I
CODE: MBOT-106
SUBJECT NAME: BOTANY LAB COURSE-I

Credits	**L**	**P**	**Sessional**	**30**
6	**0**	**12**	**Theory Exam**	**70**
			Total:	**100**

Course Objectives: To develop skills in various biochemical, microbiological, genetics and statistical techniques.

Practicals

1. Estimation of protein concentration in a given sample by Lowry's method
2. Estimation of reducing sugars by DNSA method
3. Analysis of oils-iodine number of given samples
4. Analysis of saponification value of given sample
5. Extraction and estimation of Urease/Acid phosphatase from germinating mung bean seeds
6. To determine K_m and V_{max} of the enzyme Urease/Acid phosphatase
7. To perform separation of chloroplast by sucrose density gradient centrifugation
8. Preparation of temporary slides of mitosis using onion root tips
9. Estimation of DNA by Diphenylamine (DPA) method
10. Separation of amino acids using paper chromatography
11. Systematic tabular summarization of data (before analysis), measures of central tendency, measures of dispersion (using calculators)

12. 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
15. To perform simple staining and gram staining of given bacterial strains
16. Lactophenol cotton blue staining of given fungal samples
17. Isolation of microbes from soil sample
18. Turbidostatic estimation of bacterial growth curve
19. Preparation of metaphase chromosome
20. Study of sex chromatin from epithelial hair, buccal cells
21. Gene mapping exercises
22. Exercises on population genetics

*A minimum of sixteen practical 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 (COs)

After successful completion of this course, a student will be able to:
CO1: To develop hands on training in various biochemical and enzymological techniques.
CO2: To acquire skills in microbial handling and cell cycle studies.
CO3: To analyze and interpret the data by applying statistical techniques

M.Sc. BOTANY SEMESTER II
CODE: MBOT-201
SUBJECT NAME: PLANT BIOTECHNOLOGY

Credits	**L**	**P**	**Sessional**	**25**
4	**4**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objectives : The course aims at developing an understanding of different techniques and tools devised for improving plant variety and propagation.

Unit-I

- Plant genome organization, Organization and expression of chloroplast genome and mitochondrial genome, Inter genomic interaction.
- Plant Breeding: Maintenance and conservation of germplasm, Cryopreservation, Mass selection and Pure line selection, Heterosis and hybrid seed production, Cytoplasmic male sterility 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

Unit-II

- History of Plant Tissue Culture, Sterilization methods, media preparation, Plant Growth Regulators, Micropropagation, Callus culture, Cell Culture, Protoplast Culture and Fusion, Organogenesis, Somatic embryogenesis, Synthetic seed, Somatic hybrids, and Cybrids.

- Application of tissue culture for crop improvement in agriculture, horticulture and forestry. Seed storage proteins, Methods for Plant Conservation, Haploid production: - Anther, Pollen, Embryo and ovule culture and their applications, Somaclonal variations.

Unit-III

- Secondary metabolite: Basic biosynthetic pathways, Role of Sec. Metabolites: Defense Communication in insects, plants, animals,
- Chemical Ecology, Interaction between organism using secondary metabolites, Production of bioactive secondary metabolites by plant tissue culture

Unit-IV

- Genetic engineering of plants for bacteria, fungi, virus, pest and herbicide resistance.
- Production of viral antigens and peptide hormones in plants, biodegradable plastics in plants.
- Regulatory Guidelines for Recombinant DNA Technology.

References:

1. An introduction to Plant Tissue culture M.K. Razdan, 3rd ed. Oxford & IBH Publishing Co, New Delhi.
2. Plant Biotechnology and Genetic Engineering by Govil CM, Aggarwal A, Sharma J, 1st ed. PHI Learning Pvt. Ltd.
3. Plant Biotechnology: The Genetic Manipulation of Plants by A. Slater, N. Scott, M. Fowler.2nd Ed Oxford University Press.
4. Biochemistry & Molecular Biology of Plants by B.B. Buchanan, W. Gruissem, R.L. Jones 2nd Ed. John Wiley & Sons.
5. Plant cell culture: A Practical approach by R.A. Dixon, R.A. Gonzales. 2ndEdition, Oxford University Press
6. Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis by A.J. Harborne, 3rd ed. Springer

Course Outcomes (COs)

After successful completion of the cours, a student will be able to

CO1: Develop an understanding of the plant genome and its influence on breeding techniques.
CO2: Generate skills and concepts of the various tools and techniques used for plant cell and tissue culture.
CO3: Acquire the concepts and understanding regarding the plant bioactive molecules and their applications along with the safety guidelines in handling modified plant varieties.

M.Sc. BOTANY SEMESTER II
CODE: MBT-202
SUBJECT NAME: BIOTECHNIQUES

Credits	L	P		
4	4	0	Sessional	25
			Theory Exam	75

Total: 100

Course Objective: To learn various techniques used in biological sciences and their applications in different research 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&TEM), Cryogenic Electron Microscopy, Confocal Microscopy, Atomic Force Microscopy
- Centrifugation Techniques: Principle of centrifugation, types of rotors, ultracentrifugation, analytical centrifugation, preparative centrifugation.

Unit II

- Spectrophotometric Techniques: Beer sLambert's Law. Photometry, UV/VIS Spectrophotometry, Infrared spectroscopy, Raman Spectroscopy, Circular dichroism(CD), Xray crystallography and brief idea of NMR.
- Gas and liquid chromatography-based mass spectrometry, and surface plasma resonance methods.

Unit III

- Radioisotope technique, use in biological and molecular imaging
- Filtration techniques: Gross filtration, steri-pad filtration, membrane filtration (macro-filtration, micro-filtration, ultra-filtration), reverse osmosis, dialysis, their applications in industry. Merits and limitations

Unit IV

- Principles and applications of Chromatography. Ion exchange chromatography, Gel filtration chromatography, Hydrophobic interaction chromatography, Affinity chromatography, HPLC.
- Electrophoresis-Agarose Gel electrophoresis, Polyacrylamide Gel Electrophoresis (Native, SDS PAGE), 2-Dimensional Gel electrophoresis

References

1. WilsonandWalker'sPrinciplesandTechniquesofBiochemistryandMolecularBiology by A. Hofmann and S.l Clokie ,8th Ed.
2. NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry by Harald Ganther, 3rdEd.
3. Crystallography Made Crystal Clear by GaleRhodes, Academic Press, 3rdEd.
4. Molecular Biology and Biotechniques: the fundamental approach- A.S. Sameer, 2ndEd.
5. Biotechniques-Theory and Practice, S.V.S Rana, Rastogi Publication (1stEdition).
6. Principles of Immuno detection and Immuno techniques: Preview and Emerging Applications by Shelza Thakur, Navnit Kumar Mishra, Hardeep Singh Tuli, Anil K. Sharma(1stEdition)
7. Analytical Biochemistry & Separation Techniques by Dr. P. Palanivelu, IV Edition - Lab manual (IV Edition, 2009), Twenty first Century Publications 5. Techniques and Methods in Biology, Ghatak K.L. Prentice Hall India Learning Private Limited (2011)

Course Outcomes:

After successful completion of this course, a student will be able to:

CO1- To impart knowledge and application of various bioanalytical techniques

CO2- To develop an understanding of usage of different microscopic and spectroscopic techniques for various biological sample analysis.

CO3- To acquire skills for using various electrophoretic and chromatographic techniques for biological studies.

M.Sc. BOTANY SEMESTER II
CODE: MBT-203
SUBJECT NAME: ECOLOGY AND ENVIRONMENTAL BOTANY

Credits	**L**	**P**		
3	**3**	**0**	**Sessional**	**25**
			Theory Exam	**75**
			Total:	**100**

Course Objectives: To generate an understanding of role, significance and interaction of biotic and abiotic factors and its applications in remediation and other biotechnological interventions

Unit I

- Introduction to ecology, environmental concepts – laws, limiting factors and ecological models.
- Nature of ecosystem, production, food webs, energy flow through ecosystem, resilience of ecosystem
- Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning
- Characteristics of a population; population growth curves; population dynamics and regulation; life history strategies (*R* and *K* selection), age structured populations.

Unit II

- Interspecific interactions: interspecific competition, herbivory, carnivory, pollination, symbiosis
- Ecological Impact of microbial interactions (special emphasis on nitrogen fixation and ruminants)
- Succession: types; mechanisms; changes involved in succession; concept of climax; models of succession (primary and secondary)
- Waste water treatment: sources, characterization, primary, secondary (aerobic and anaerobic) and tertiary treatment.
- Water quality assessment, bioindicators

Unit III

- Solid waste treatment : sources, treatment strategies (landfills, composting, vermicomposting)
- Radioactive waste characterization and disposal.
- Air quality monitoring and control

- Biodegradation of xenobiotics and recalcitrant molecules: simple aromatics, chlorinated polyaromatic petroleum products and pesticides. Role of degradative plasmids
- Bioremediation of oil spills, heavy metals
- Biofuels: biodiesel, biogas, bio hydrogen, bioethanol

References

1. Ecology: From Individuals to Ecosystems by Michael Begon, Colin R. Townsend, John L. Harper, Wiley-Blackwell (3rd Edition).
2. Ecology: Principles and Applications by J. L. Chapman and Michael Reiss, Cambridge University Press, U.K. (1st Edition).
3. Fundamentals of Ecology by E. P. Odum and G. W. Barrett, Brooks/Cengage Learning India Pvt. Ltd., New Delhi (5th Edition).
4. Concepts of Ecology by E. J. Kormondy, Prentice Hall of India, New Delhi (4th Edition).
5. Environmental Biotechnology-Theory and Applications by G M Evans, Furlong JC, 1st ed. JohnWiley& Sons.
6. Environmental biotechnology: Concepts and Applications by H-J. Jordening, J. Winter,1st ed. John–Wiley and Sons.
7. Environmental biotechnology: Basic Concepts and Applications by I.S. Thakur (2011), I.K. InternationalsPvtLtd. 2nded.

Course Outcomes:

After successful completion of this course, a student will be able to:

CO1- To understand and assimilate the concepts and specific terminology of environmental biotechnology and ecology

CO2- To develop concepts of pollution types, sources, effects and remediation methods

CO 3- To generate skills for developing green sustainable techniques.

M.Sc. BOTANY SEMESTER II
CODE: MBT-204
SUBJECT NAME: GENETIC ENGINEERING AND INTRODUCTORY BIOINFORMATICS

Credits	L	P		
4	4	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objective : The course aims to develop an understanding of the techniques used in gene manipulation and the tools utilized for computational analysis.

Unit I

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

Unit III

- Introduction to primary Databases: Nucleotide sequence databases-GenBank, EMBL, DDB; Protein Sequence Databases- UniProtKB, UniProt, TrEMBL, Swiss-Prot; Literature Databases- PubMed, PLos, BioMed Central
- Introduction to Secondary or Derived Databases- PDB, CSD, MMDB, SCOP, CATH, FSSP, CSA, KEGG ENZYME, BRENDA
- Sequence motifs Databases: Prosite, ProDom, Pfam, InterPro; Organism specific database (OMIM/OMIA, SGD, WormBase, PlasmoDB, FlyBase, TAIR)

Unit IV

- 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.

References

1. Gene Cloning and DNA Analysis: An Introduction by T.A. Brown, 7th ed Wiley Blackwell Press.
2. Principles of Gene Manipulation and Genomics by S.B Primrose and R. Twyman, 7th ed, Blackwell Press.
3. Molecular Cloning: a laboratory manual , vol 1-4, M.R. Green and J.Sambrook, 4th ed, Cold Spring Harbour Laboratory Press,
4. Introduction to Bioinformatics by A.M.Lesk, 3rd ed., Oxford Press
5. Bioinformatics: Sequence and Genome Analysis by D.W. Mount, 2nd ed., Cold Spring Harbour Laboratory Press

Course Outcomes:

After completion of this course, the student will be able to

CO-1- To understand the use of tools and techniques for manipulation and analysis of genomic sequences.

CO-2- To develop basic concepts of Bioinformatics and its significance in biological data analysis

CO-3- To apply the skills acquired in performing experiments and research.

M.Sc. BOTANY SEMESTER II
CODE: MBT-205
SUBJECT NAME: PLANT PHYSIOLOGY

Credits	L	P		
4	4	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objectives: The course aims towards developing the understanding of plant metabolism and pathways responsible for growth, adaptive responses and reproduction.

Unit-I

- Introduction and scope of plant physiology
- 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.
- Photosynthetic pigments, role of photosynthetic pigments, antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration, C4 pathway; Crassulacean acid metabolism; Factors affecting CO_2 reduction.

Unit- II

- Sensory Photobiology**:** Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; scotomorphogenesis and photomorphogenesis.
- Natural products (secondary metabolites), their range and ecophysiological functions.
- Biochemical mechanisms of plants' chemical war against other plants and animals.
- Plant responses to herbivory; constitutive defense mechanisms; induced phytochemical responses; biochemical mechanisms of allelopathy.

Unit- III

- 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 plant 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.

Unit-IV

- Concept of Programmed Cell Death and its types in plants during vegetative and reproductive stages. Developmental and stress-induced PCD.
- Plant senescence and its characteristics. Leaf and flower senescence. Altered metabolism during senescence and its regulation. Hormonal modulations. Environmental, genetic and molecular regulations in senescence
- Introduction to stress plant physiology, Plant responses to abiotic and bioticstresses, Mechanisms of abiotic stress tolerance in plants: water deficit, drought, salinity and heavy metals tolerance.
- Nitrosative and oxidative stress- causes and effects, nitric oxide biosynthesis and metabolism, NO mediated signaling, markers of nitrosative stress, NO crosstalk with other hormones, cross talk between SA and JA in plants.

References:

1. Biochemistry and Molecular Biology of Plants by Buchanan, B., Gruissem, G. and Jones, R. American Society of Plant Physiologists, USA.
2. Plant Hormones: Biosynthesis, Signal Transduction, Action by P.J. Davies, 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.
3. The Molecular Biology and Biotechnology of Flowering by B.R. Jordan, 2nd Edition, CAB International, U.K.
4. Plant Physiology by L. Taizand E. Zeiger, E 5th Edition. Sinauer Associates, USA.
5. Plant Biochemistry by H.W. Heldt, and B. Piechulla, 4th Edition. Academic Press, NY.
6. Lehninger's Principle of Biochemistry by Nelson D.L, Cox. M. M. 8 ed. W. H. Freeman, 2021

Course Outcomes (COs)

After successful completion of the course, a student will be able to:

CO1: Acquire understanding of cell transport and the process of photosynthesis.

CO2: Develop an understanding of the pathways and processes involved in production of different secondary metabolites and the responses shown by plants to different stimuli

CO3: Apply the knowledge towards generating experimental setups and data analysis.

M.Sc. BOTANY SEMESTER II
CODE: MBT-206
SUBJECT NAME: BOTANY LAB COURSE-II

Credits	**L**	**P**		
6	**0**	**12**	**Sessional**	**30**
			Theory Exam	**70**
			Total:	**100**

Course Objective: The course aims at generating hands-on -training in various experiments in analytical, plant tissue culture, molecular biology and plant biochemistry.

Practicals

1. Determination of total hardness of water sample
2. Determination of alkalinity of water sample
3. To estimate BOD and COD values of waste water
4. Bacteriological analysis of water sample
5. To perform shoot tip culture
6. To prepare embryo culture from germinated mung bean seed
7. To prepare synthetic seed
8. Determination of total chlorophyll and carotene from spinach leaves
9. Separation and analysis of photopigments by TLCV/paper chromatography
10. Detection of nitrate reductase in leaf tissue sample
11. Determination of starch in plant tissues
12. Determination of total soluble sugars by ferricyanide method
13. Quantitative determination of free amino acid content in germinating seeds
14. Estimation of beta carotene in carrots by spectrophotometry

15. Estimation of ascorbic acid in lemon juice by calorimetric method
16. Extraction of genomic DNA and its estimation using spectrophotometer
17. Plasmid isolation by alkaline lysis method and detection using electrophoresis
18. Preparation of competent cells
19. Restriction digestion of plasmid DNA and detection of digestion profile using electrophoresis.
20. Transformation of *E. coli* with plasmid and calculation of transformation efficiency
21. Database search: use and analysis of BLAST tool for DNA and protein sequences
22. Primer designing and *in silico* PCR

Course Outcomes (COs) :

After successful completion of this course, a student will be able to

CO1: Develop the skills for various environmental and plant cell and tissue culture techniques

CO2: Acquire skills for devising research strategy needed in plant based experiments.

CO3: Demonstrate the use and application of various tools and techniques used in molecular biology and bioinformatics.

M.Sc. BOTANY SEMESTER III
CODE: MBT-303
SUBJECT NAME: METABOLISM

Credits	**L**	**P**	**Sessional**	**25**
4	**4**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objective:

To provide students with a comprehensive understanding of the biochemical processes that underlie the conversion of nutrients into energy and the synthesis of biomolecules.

Unit-I

- Glycolysis, citric acid cycle, pentose phosphate pathway, gluconeogenesis, glycogenesis and glycogenolysis, Disorders of carbohydrate metabolism.
- Oxidative phosphorylation; importance of electron transfer in oxidative phosphorylation; F1-F0 ATP Synthase.

Unit-II

- Catabolism of amino acids (urea cycle), glucogenic and ketogenic amino acids; disorders of amino acid metabolism.
- Fatty acid metabolism; Alpha, Beta and omega-oxidation of Fatty acids, Ketone bodies metabolisms. Disorders of lipid metabolism.
- Fatty acid synthesis, biosynthesis of cholesterol and mevalonate pathway.

Unit-III

- Nucleotide metabolism: de novo synthesis and breakdown of purine and pyrimidine nucleotides, regulation, salvage pathway
- Inhibitors of nucleotide metabolism, Disorders of nucleic acid metabolism
- Production of ROS and role of NADPH and glutathione protection from ROS.

References:

1. Biochemistry and Molecular Biology, Elliott and Elliott, Oxford University press, New York, USA (4th edition).
2. Harper's Illustrated Biochemistry, Murray, Granner and Rodwell, McGraw Hill, New York, USA. (28th edition)
3. Biochemistry, Voet and Voet, John Wiley (4th edition).
4. Nelson DL Cox, MM Lehninger's Principal of Biochemistry (7th edition)

Course Outcomes:

After successful completion of this course, a student will be able to:

CO-1- To develop conceptual understanding of various catabolic and anabolic processes in living system.

CO-2- To understand the significance of different pathways in maintaining homeostasis.

CO-3- To apply the concepts obtained to design experiments and data analysis

M.Sc. BOTANY SEMESTER III
CODE: MBT-302
SUBJECT NAME: ADVANCES IN ARCHAEGONIATES

Credits	L	P		
3	3	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objectives : The course aims towards generating insights in the current developments of the different types of archaegoniates.

Unit-I

- Spore germination, protonema development and Hormonal regulation of gametophyte development
- Bryophytes with microorganisms and animals, Responses of bryophytes to climate change, Structure and function of bryophyte dominated Peatlands
- Genome sequence and insights into bryophytes biology, evolution, genomics, Model bryophytes for molecular genomic studies (*Physcomitrella patens*), Photoreceptors and photomorphogenesis in *P. patens,* Molecular insights into developmental cascades, Abiotic (dessication tolerance) and biotic stress responsive mechanisms in bryophytes (*Physcomitrella, Tortula*)

Unit-II

- Phenology and habitat specificity, Fern adaptation to xeric environment, Development of fern gametophyte, Genetics and reproductive biology of ferns, Problem ferns, their impact and management, Biology of Azolla

- Genome sequence and insights into Pteridophyte biology, evolution, genomics, Pteridophytes as model plants (*Ceratopteris*, *Selaginella*), Molecular mechanism of sex determination (*Ceratopteris*), Photoreceptors and photomorphogenesis (*Adiantum*, *Ceratopteris*, *Onoclea*), Stress responsive mechanisms in Pteridophytes (*Selaginella*) Ceratopteris, Trichomanes, Osmunda and Marsilea as model system

Unit-III

- Evolution of Pollination mechanism, Seed and seedling biology and regeneration potential, Conifer plantation as seed trap
- Genome sequence and insights into Gymnosperm biology, evolution, genomics
- Acclimatization and adaptive responses of conifers to environmental stresses.

References:

1. Bryophyte biology by B. Goffinet, A.J. Shaw (Edited) 2nd ed. Cambridge University Press, Cambridge. ISBN 978-0-521-69322-6.
2. Introduction to Bryology by W.B. Schofield Macmillan. ISBN, 0029496608, 9780029496602.
3. Introduction to Bryophytes by A. Vanderpoortenand B. Goffinet, Cambridge University Press, Cambridge. ISBN 978-0-521-70073-3.
4. Experimental Biology of Bryophytes by A.F. Dyer and J.G. Duckett, Academic Press. Orlando.
5. Working with Ferns: Issues and Applications by H.Fernández, A. Kumar, and M.A. Revilla, (eds.), Springer Science+Business Media, LLC20
6. Biology and Evolution of Ferns and Lycophytes by T.A Ranker and C.H. Haufler, Cambridge University Press, Cambridge
7. Fern Ecology by K. Mehlereter, L.A. Walker, L.A. and Sharpe, J.M. Cambridge University Press, Cambridge
8. Gymnosperms by Bhatnagar, S.P. and Moitra, A. New Age International P Limite. Publishers, New Delhi.

Course Outcomes (COs)

After successful completion of this course, a student will be able to:

CO1: Develop the understanding of advances in bryophyte, pteridophyte and gymnosperm research and significance

CO2: Generate concepts on the adaptive strategies of the archaegoniates

CO3: Demonstrate the use and application of archaegoniates in botanical research.

M.Sc. BOTANY SEMESTER III
CODE: MBT-303
SUBJECT NAME: DEVELOPMENTAL BIOLOGY

Credits	**L**	**P**		
4	**4**	**0**	**Sessional**	**25**
			Theory Exam	**75**
			Total:	**100**

Course Objectives: The course aims towards acquiring concepts of the morphological and anatomical variations occurring in angiosperms which can influence the life cycle and differentiation of various tissues.

Unit-I

- Vegetative development: Processes basic to plant development; Competence, determination, commitment, specification, induction, differentiation, dedifferentiation and redifferentiation.
- Morphogenetic gradients, cell fate and cell lineages, Polarity and symmetry, Juvenility and transition to adult phase
- Programmed cell death, aging and senescence.

Unit II

- Meristems types and activities of meristems. Organization of shoot and root apical meristems. Regulation of meristem size, lateral organ initiation from root and shoot meristems.
- Leaf development, plastochron, phyllotaxy, development of trichomes and stomata.
- Vascular elements – differentiation of xylem, phloem, Secondary growth – cambium, structure of wood, Secretory tissues – Nectaries, laticifers, resin ducts

Unit-III

- Reproductive development - Transition from vegetative to reproductive phase – morphological and histochemical changes in shoot apex, floral meristems and floral development.
- Development of stamen, anther, sporogenous tissue, tapetum, microsporogenesis, pollen and male gametophyte.
- Development of carpel, ovule, placenta, sporogenous tissue, integuments, megasporogenesis, female gametophyte

Unit IV

- Programic phase - Interaction between pollen and pistil, pollen tube guidance, self-incompatibility, incongruity, double fertilization and triple fusion, role of synergids, endosperm development.
- Stages of embryogenesis, structure and organization of embryo, structure of seed, germination, fruit development. Apomixis, polyembryony, somatic embryogenesis.

References:

1. Plant Tissue Culture: Theory and Practice byBhojwani, S.S., and Razdan, M.K., Elsevier
2. An Introduction to Plant Structure and Development by C.B Beck,. II edition
3. Plant Developmental Biology-Biotechnological perspectives byE-C. Pua, and M.R. Davey
4. Plant, Growth and Development: A Molecular Approachby D.E. Fosket, Academic Press.
5. The Green World: Plant DevelopmentbyW.G. Hopkins, Chelsea House Publication
6. Molecular Genetics of Plant Development by S.H. Howell, Cambridge University Press.
7. Mechanism of Plant Development by O. Leyser, and S. Day, Blackwell Press
8. Molecular Embryology of Flowering Plants by V. Raghavan. Cambridge. University Press.
9. Developmental Biology of Flowering Plants by V. Raghavan, Springer, Netherlands

Course Outcomes (COs):

After successful completion of the course, a student will be able to

CO1: Develop an understanding of vegetative and reproductive biology of higher plants with special emphasis on anatomical development.

CO2: Generate concepts of the pathway and relevance of differentiation in plant tissue and organ formation.

CO3: Apply the understanding of plant biology to research.

M.Sc. BOTANY SEMESTER III
CODE: MBT-304
SUBJECT NAME: TAXONOMY OF ANGIOSPERMS

Credits	**L**	**P**		
4	**4**	**0**	**Sessional**	**25**
			Theory Exam	**75**
			Total:	**100**

Course Objectives: The course aims at exploring the concepts of plant classification and their use in study of angiosperm diversity.

Unit-I

- Introduction to plant systematics, taxonomic keys
- Comparative study of classification of angiosperms by Bentham and Hooker, Hutchinson, Cronquist and APG system
- Brief idea of Numerical taxonomy and Chemotaxonomy with their advantages and disadvantages
- Plant Molecular Systematics**:** DNA sequence data, Types of sequence data, DNA barcoding and its practical implications

Unit-II

- International Code of Botanical nomenclature, principles, Rules andrecommendations; Priority; Typification; Rules of effective and valid publication, Conservation of names
- Methods of collecting plants, Herbaria and data information systems: Herbarium specimens, Data Information Systems; Role of Botanic Gardens in the conservation of biodiversity

Unit III

- Taxonomic and phylogeny study of the following families

Magnoliales: Magnoliaceae
Alismatales: Aracaceae
Asparagales: Orchidaceae
Arecales: Arecaceae
Poales: Poaceae
Ranunculales: Ranunculaceae
Caryophyllales: Caryophyllaceae
Malphigiales: Euphorbiaceae
Fabales: Fabaceae
Cucurbitales: Cucurbitaceae
Brassicales: Brassicaceae

Boraginales: Boraginaceae
Gentianales: Apocyaneae
Lamiales: Lamiaceae, Scrophulariaceae
Solanales: Solanaceae
Apiales: Apiaceae
Asterales: Asteraceae

References:

1. 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.
2. Plant Molecular Systematics by D.J. Crawford, Cambridge University Press, Cambridge, UK.
3. Plant Systematics: A Phylogenetic Approach byW.S.Judd, C.S. Campbell, E. A. Kellogg, P. A. Stevens, and M.J. Donoghue. Sinauer Associates, Inc., Massachusetts.
4. Plant systematics – Theory and Practices by G. Singh. Oxford and IBH Publishing Co, New Delhi, 3rd Edition.
5. Plant Systematics by M.G. Simpson. Elsevier, Amsterdam.
6. Plant Taxonomy: The systematic Evaluation of Comparative Data by T.F.Stuessy. Columbia University Press, New York. 2nd Edition.
7. Plant Systematics: The origin, interpretation, and ordering, of plant biodiversity by T.F. Stuessy, D.J. Crawford, D.E. Soltis, and P.S. Soltis. Koeltz Scientific Books, Konigstein, Germany.

Course Outcomes (COs)

After successful completion of this course, a student will be able to
CO1: Develop an understanding of the methods used in classification and their principles.
CO2: Generate concepts of the guiding methodology in giving botanical nomenclature.
CO3: Apply the concepts learned in identification of different angiospermic families.

M.Sc. BOTANY SEMESTER III
CODE: MBT-305
SUBJECT NAME: BOTANY LAB COURSE-III

Credits	L	P		
6	0	12	Sessional	30
			Theory Exam	70
			Total:	100

Course objectives: The course aims at generating skills in study of plant anatomy, biochemisty and taxonomy.

1. Study of apical meristems with the help of dissections, whole mount preparations, sections and permanent slides.
2. Study of epidermal structures (trichomes, glands and lenticels).

3. Study of xylem and phloem elements using maceration, staining, light and electron micrographs (xerophytes, hydrophytes and halophytes).
4. Study of secretory structures (nectaries and laticifers).
5. Study of secondary growth (normal and unusual) of selected woods with the help of wood microtome and permanent slides.
6. Study of the stages of pollen and ovule development in the wild and mutant plants using permanent slides, electron micrograph and available phenotypes.
7. Taxonomic description of locally available plants of families (at least 5).
8. Plant collection: Identification, preservation and submission of at least 30 herbarium sheets, survey of local flora and preparation of report.
9. Study of structural modification in Marchantiales, Jungermanniales, Isobryales and Hypnobryales.
10. Male and female cone and pollen study in gymnosperms
11. Estimation of cholesterol
12. Production and estimation of lactic acid
13. Extraction and quantification of DNA
14. Extraction and quantification of RNA

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

Course Outcomes (COs) :

After successful completion of the course, a student will be able to
CO1: Develop skills in preparation of anatomical mounts of plant parts.
CO2: Apply concepts of taxonomy in plant family identification
CO3: Develop skills in biomolecule extraction and quantification

M.Sc. BOTANY SEMESTER III
CODE: MBOT-DE001
SUBJECT NAME: ADVANCES IN PHYCOLOGY

Credits	**L**	**P**	**Sessional**	**25**
3	**3**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objective: The course aims towards developing interest and concepts in the field of algal biology with generating awareness of its value to society.

Unit I

- Organization of the photosynthesis apparatus in algae, photosynthetic pigments and light harvesting, Light absorption, Light dependent and independent reaction, RUBISCO activity and its interaction with light and oxygen
- GS-GOGAT cycle, GDH cycle, Nitrogenase, Heterocyst differentiation,
- Structural significance, physiological and biochemical adaptation for Nitrogen fixation
- Nitrate reduction and assimilation in algae, assimilation of organic nitrogen in algae: urea, amino acids and amides.

Unit II

- Tolerance and detoxification mechanisms of HMs in algae**:**Effective methods of culturing the potent algae for efficient phycoremediation of HMs,
- Algal biomass : characteristics, culture and applications
- Seaweed farming trends and importance

Unit III

- Algal application infood, pigments, antioxidants, proteins and carbohydrate.
- Use of algae in biofuels and energy
- Biotechnological advancements in algal research: Genetic engineering in algae, Mutagenesis for strain improvement, engineering efforts for advancement in culturing techniques, Integrated multitrophic aquaculture.

References:

1. egyankosh.ac.in/bitstream/123456789/16683/1/Unit-7.pdf
2. Carmichael, W.W. (ed.) (2013). The Water Environment: Algal Toxins and Health. Plenum Press,NY. ISBN 13: 978-1-4613-3269-5. 490pp.
3. Phycology by Robert Edward Lee, 5th edition, Cambridge University Press
4. Handbook of Algal Science, by Beenish Saba and Ann D. Christy, 2020, Academic Press London
5. Algal Anatomy, Biochemistry and Biotechnolgy, by Laura Barsanti and Paolo Gualtieri, 2nd Edition, CRC Press.

Course Outcomes (COs)

After successful completion of the course on Advances in Phycology, a student will be able to

CO1: Develop an understanding of certain aspects of algal physiology

CO2: Generate concepts of utilization of algae in different environmental and biotechnological applications.

CO3: Apply the knowledge gained in developing research or applications using algae.

M.Sc. BOTANY SEMESTER III
CODE: MBOT-DE002
SUBJECT NAME: BIOLOGY OF ARCHAEGONIATES

Credits	**L**	**P**	**Sessional**	**25**
3	**3**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objectives: The course aims at generating understanding of the diversity of Archaegoniates and their impact on ecosystem

Unit-I

- Comparative morphology and developmental anatomy of Anthocerophyta, Marchantiophyta and Bryophyta.
- Vegetative and reproductive innovations, Breeding system in bryophytes.

Unit II

- Plant substratum relationship, Growth Forms and life strategies, Bryophytes as site indicators.
- Role of Bryophytes in Ecosystem Dynamics and in global carbon budget, Bryogeography and conservation of bryophytes.

Unit-III

- Meristem organization and organ diversity in Pteridophytes, Comparative anatomy of vegetative and reproductive organs of Pteridophytes.
- Fern Classification, Biogeography, Diversity of Ferns - an ecological perspective, biogeography, Gametophyte ecology, Nutrient ecology.

Unit-IV

- Comparative morphology and developmental anatomy of Gymnosperms.
- Reproductive Biology of Gymnosperms.
- Impact of coniferous forest on human life.

References:

1. Introduction to Bryology byW.B. Schofield, Macmillan. ISBN, 0029496608, 9780029496602.
2. Introduction to Bryophytes byA. Vanderpoorten, and B.Goffinet, Cambridge University Press, Cambridge . ISBN 978-0-521-70073-3.
3. Bryophyte biology by B. Goffinet, and Shaw, A. J. (Edited). 2nd ed. Cambridge University Press, Cambridge. ISBN 978-0-521-69322-6.
4. Biology and Evolution of Ferns and Lycophytes by T.A. Rankerand C.H. Haufler. Cambridge University Press, Cambridge
5. Fern Ecology by K.Mehlereter, L.A. Walker and J.M. Sharpe. Cambridge University Press, Cambridge
6. Gymnosperms by S.P. Bhatnagar and A. Moitra.New Age International P Limited. Publishers, New Delhi.

Course Outcomes (COs)

After successful completion of this course, a student will be able to

CO1: Develop an expansive understanding of diverstity and vegetative features of different Archaegoniates

CO2: Understand the reproductive strategies along with their life cycle.

CO3: Acquire knowledge of the ecological impacts of bryophytes, pteridophytes and gymnosperms.

M.Sc. BOTANY SEMESTER IV
CODE: MBOT-401
SUBJECT NAME: EVOLUTIONARY BIOLOGY

Credits	L	P		
4	4	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objectives: The course aims at expanding the knowledge of students in understanding the course of plant evolution and speciation.

Unit-I

- Introduction - Pattern and process components of scientific theories: biological variation and evolutionary change (evidence for evolution).Darwin and Wallace – natural selection, adaptation. Microevolution, macroevolution.
- Evolutionary history: reading trees, monophyly, Tree of life. Evolutionary trends: maximum parsimony, origin and evolution of traits across life and green plants.

Unit-II

- The fossil record. Geological fundamentals. Phylogeny and the fossil record. Evolutionary trends. Rates of evolution.
- The geography of life. Major patterns of distribution. Historical biogeography, phylogeography.

Unit-III

- The Modern Synthesis: Population Genetics. Forces of evolution: Genetic drift – Sampling error; Mutation. Migration/Gene Flow. Adaptation – Fitness, coefficient of selection.
- Non adaptive traits. Molecular evolution. Neutral theory. Molecular clock. Testing for selection. Modes of selection.

Unit-IV

- Species concepts and processes of speciation. Reproductive isolation and other drivers of speciation.
- Geographic patterns. Evolutionary mechanisms. Post-zygotic and pre-zygotic isolation in allopatry and sympatry, reinforcement, character displacement.
- Hybrid speciation, hybrid zones. Adaptive Radiation.

References:

1. Evolutionary Biology by D. J. Futuyma. 3rd Ed. Sinauer Associates.
2. Evolution by M. Ridley. 3rd Ed, Blackwell.
3. Molecular Evolution: A Phylogenetic Approach by R. D. M. Pageand E. C. Holmes Blackwell.
4. Evolutionary Analysis by J. C. Herron and S. C. Freeman, 5th Ed. Prentice Hall. ISBN-13:978-0321616678. ISBN-10: 0321616677.
5. Strickberger's Evolution by B. K. Hall and B. Hallgrimsson. 4th Ed. Jones & Bartlett.

Course Outcomes (COs)

After successful completion of the course on Evolutionary biology, a student will be able to

CO1: Identify the different processes of evolution.

CO2: Develop the concepts of patters of evolution and speciation.

CO3: Acquire the understanding to differentiate between patterns of speciation and their effect on diversity.

M.Sc. BOTANY SEMESTER IV
CODE: MBOT-402
SUBJECT NAME: PLANT ANATOMY AND RESOURCE UTILIZATION

Credits	L	P		
4	4	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objective: This course aims towards expanding the concepts, and understanding of angiosperm anatomy and histology along with exploring the commercial value of plants in agriculture, horticulture and pharmacognosy.

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).

References:

1. Integrative Plant Anatomy byW.C. Dickison. Cambridge, U.K.,Harcourt Academic Press.
2. Esau's Plant anatomy: Mersitems, Cells, and tissues of the Plant Body: their structure, function and development by R.F.Evert, S.E. Eichhorn. New Jersey, U.S.,Wiley-Liss.
3. Plant Anatomy by J.D. Mauseth. San Francisco, California, The Benjammin Cummings Publisher
4. Economic Botany in Tropics by S.L. Kochhar New Delhi, India, MacMillan & Co.
5. Economic Botany: Principles & Practices byG.E.Wickens.The Netherlands, Kluwer Academic Publishers.
6. Plants, Genes and Agriculture by M.J. Chrispeelsand D.E. Sadava, Jones & Bartlett Publishers.
7. A Textbook of Modern Economic Botany by AVSS SambamurtyandN.S. Subrahmanyam. 1st Edition, Paperback . CBS Publishers & Distributors Pvt.Ltd.; 1st edition.

Course Outcomes (COs)

After successful completion of this course, a student will be able to

CO1: Understand the tissue organization in different plant parts and their function.

CO2: Generate an understanding of the role of cambium, periderm and epidermal systems

CO3: Develop knowledge regarding the diversity of plant utilization for human benefit.

M.Sc. BOTANY SEMESTER IV
CODE: MBOT-403
SUBJECT NAME: PLANT PATHOLOGY

Credits	**L**	**P**	**Sessional**	**25**
3	**3**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objective: The course aims at developing detailed understanding of plant diseases, their spread and control

Unit-I

- Introduction to plant pathology,Classification of plant disease, Mechanism of infection, penetration and entry by plant pathogens, the role of enzymes and toxins in plant disease.

- Overview of plant disease epidemiology, Importance of disease forecasting, methods used in plant disease forecasting, Dispersal of plant pathogens; Direct transmission and indirect transmission.
- Management of plant diseases: Cultural, chemical, biological, biopesticides, breeding for resistant varieties,plant quarantine, integrated pest management

Unit-II

- Plant diseases by fungi: general symptoms, disease cycle, detection and management
  a) Rhizopus soft rot of fruits and vegetables
  b) Powdery mildew
  c) Panama disease of banana
  d) Downy mildew of cucurbits
  e) Tikka disease of groundnut
  f) Ergot of bajra
  g) Red rot of sugarcane
- Plant diseases by bacteria: general symptoms, disease cycle, detection and management

a) Blight of rice
b) Ring rot of potato
c) Citrus canker
d) Soft rot of vegetables
e) Bacterial wilt of crucifers

Unit-III

- Plant diseases by virus: general symptoms, disease cycle, detection and management

a) Yellow vein mosaic of bhindi
b) Tomato spotted wilt virus
c) Tomato yellow leaf curl

- Plant diseases by nematodes: general symptoms, disease cycle, detection and management

a) Root knot disease
b) Cyst of soybean
c) Slow wilt of pepper and cocnut
d) toppling disease of banana

References

1. Plant Pathology by R.S. Mehrotra and A. Aggarwal. TataMcgraw Hill, New Delhi.
2. Plant Pathology by G.N Agrios, 6th Ed. Elsevier Academic Press, Amsterdam.
3. Introduction to Fungi by J. Webster and R. Weber. 3rd Ed.Cambridge University Press. Cambridge and New York.
4. Molecular Plant Pathologyby M. Dickinson, Ist Ed. Bios Scientific Publishers, London.
5. Plant Pathology by S.Burchett and S. Burchett, Ist Ed. Garland Science, US.
6. Integrated Pest Management: Potential, constraints and challenges by O. Koul,G.S. Dhaliwaland G.W. Cuperus, CABI Press, UK

Course Outcomes (COs)

After successful completion of the course, a student will be able to
CO1: Develop the concepts of disease epidemiology.

CO2: Acquire detailed understanding of various pathogens causing plant diseases and their symptoms.
CO3: Apply the information gained to generate plant disease management methodology.

M.Sc. BOTANY SEMESTER IV
CODE: MBOT-404
SUBJECT NAME: BOTANY LAB COURSE- IV

Credits	**L**	**P**	**Sessional**	**30**
6	**0**	**12**	**Theory Exam**	**70**
			Total:	**100**

Course Objective: The course aims towards generating skills in plant handling, observation and diversity studies.

Practical

1. Study of plant diseases caused by Fungi, virus, bacteria and nematodes.
2. Isolation and identification of rhizosphere soil fungi, seed borne fungi
3. 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) Root: monocot, dicot, secondary growth.
   d) Stem: monocot, dicot - primary and secondary growth; phloem wedges in Bignonia, included phloem in Leptadenia/Salvadora; periderm; lenticels.
   e) Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
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. Biological diversity - Interspecific variation: Species. Phylogenetic trees, reading and using trees. Floral evolution and MADS-box. Angiosperm fossil record. Biogeography. Morphometrics (Computer exercises).
15. Microevolution: Phenotypic variation and the environment: Intraspecific variation (e.g., stomatal size and density in sun and shade leaves). Hypothesis testing. t-test. Genetic variation: Computer simulations. Fitness measurements: in field, laboratory.
16. Macroevolution: Inferring Phylogenies, comparative analyses. Field, laboratory and computer exercises.

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

Course Outcomes (COs)

After successful completion of the course, a student will be able to

CO1: Identify diseases on the basis of different symptoms

CO2: Prepare temporary mounts of sections for anatomical studies

CO3: Acquire skills in study of plant diversity and evolution

M.Sc. BOTANY SEMESTER IV
CODE: MBOT-405
SUBJECT NAME: DISSERTATION WORK

Credits	L	P	
4		8	
			Total: 100

Course Objective: This aims towards developing in depth review of literature on a research topic focused towards detailed understanding and its presentation as a comprehensive criticism.

Course Outcome: Upon completion of the course the student shall be able to:

CO1: Develop literature searching and database searching skills

CO2: Acquireskills incompiling and interpreting research data

CO3: Acquire skills in writing research documents

M.Sc. BOTANY SEMESTER IV
CODE: MBOT-DE003
SUBJECT NAME: MOLECULAR INTERACTIONS IN PLANTS

Credits	L	P		
3	3	0	**Sessional**	25
			Theory Exam	75
			Total:	100

Course Objectives: The course aims at exploring and evaluating the positive and negative interactions of plants at cellular and molecular level towards other organisms.

Unit-I

- Introduction to biotic interactions of plants.

- Stages of pathogenesis, Structural and biochemical host defense mechanisms against pathogens and pests, Basal resistance, Non-host resistance, Pattern triggered immunity and Effector Triggered Immunity.
- Distinction between necrotrophic and biotrophic pathogens, Plant defense against necrotrophs and biotrophs.

Unit-II

- Genetic and molecular basis of disease resistance. Classes of resistant genes, adapted and non adapted host resistance
- Systemic acquired resistance, Induced systemic resistance. Induced resistance, signaling pathways, cross-talk between SA and JA-dependent defense responses, pathogenesis related protein**.**Molecular determinants of plant pathogenicity.
- **E**ffectors, elicitors, defensins, phytoalexins, phenolics, host specific an d non specific toxins, hormones and signalling.

Unit-III

- Gene-for-gene concept, Models for perception of effector proteins by plants, Cloning of resistance genes (R genes) and avirulence genes (Avr genes) from plants and pathogens, Adapted and non adapted host resistance, Induced responses to herbivory
- Recent advances in symbiotic interactions with plant with special references to mycorrhizae and root nodule symbiosis.

References:

1. Mathew's Plant Virology by R.Hull. Academic Press, NY.
2. Introduction to Plant Pathology by R.N. Strange. John Wiley & Sons, USA.33
3. Molecular Plant Pathology by M. Dickinson. Bios Scientific Publishers, London.
4. Plant Pathology by S.BurchettandS. Burchett. Garland Science, USA
5. Plant Pathology byR.S. Mehrotra. 3rd Edition, McGraw-Hill Education, New Delhi.

Course Outcomes (COs)

After successful completion of the course, a student will be able to

CO1: Develop the concepts of biotic interactions and their mechanisms.

CO2: Generate an understanding of the cellular mechanisms influencing the outcome of interactions.

CO3: Correlating the outcomes of the interactive mechanisms with parasitism, pathogenesis and symbiosis.

M.Sc. BOTANY SEMESTER IV
CODE: MMT-DE001
SUBJECT NAME: GENOMICS & PROTEOMICS

Credits	**L**	**P**	**Sessional**	**25**
3	**3**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objectives : The course aims towards generating knowledge in application of different strategies for studies of genome and protein diversity

Unit I

- Introduction to Genomics, Anatomy of prokaryotic and eukaryotic genome,
- content of genome, C-value paradox, Cot curve analysis, repetitive DNA, tools to study genome
- Applied Genomics Strategies for major genome sequencing projects, approaches and assembly methods, NGS methods and advantages, gene analysis and annotation.

Unit II

- Transcriptomics and expression profiling Genome expression analysis, RNA content and profiling, genetic mapping, Microarray (cDNA and protein microarray)
- Introductory proteomics-Importance of proteomics, strategies in analysis of proteome: 2-DPAGE. Mass spectrometry, Protein sequencing method (Edman degradation, MALDI TOF/TOF).
- Protein solubility and interaction with solvents and solutes, activity of proteins.

Unit III

- Quantitation proteomics–ICAT, SILAC, iTRAQ, applications of quantitation proteomics.
- Proteomic profiling for host-pathogen interaction, Understanding proteomics for post translational modifications.
- Application of proteomics for drug discovery. Biomarkers and drug targetsidentification. Validation of drug targets and assessment of its toxicology

References:

1. Proteomics by T. Palzkill, 1st EdKluwer Academic Publishers, New York, USA.
2. Protein Microarray Technology by D. Kambhampati, 1st Ed.Wiley-VCH Verlag GmbHWeinheim,Germany.
3.Introduction to Genomics by A.M. Lesk, 3rd Ed. Oxford University press,UK.3rdEdition
4. Metabolome Analysis: An Introduction by S.G. Villas-Boas, 1st Ed. Wiley-Blackwell, USA.
5. Concepts in Plant Metabolomics by B.J.Nikolau and E.S.Wurtele. 1st Ed.Springer, USA.
6. A Primer of Genome Science by G.Gibson and S.V. Muse. 3rd Ed.Sinauer Associates.
7. Genome by T.A. Brown .4th Ed.Garland SciencePublishers.4th Edition

Course Outcomes (COs)

After successful completion of this course, a student will be able to:

CO1: Develop an understanding of the basics of genomics and proteomics.

CO2: Generate an understanding of the tools and techniques for generating data

CO3: Analyze the information generated for potential applications.

M.Sc. BOTANY SEMESTER IV

CODE: MBT-DE003

SUBJECT NAME: PHARMACEUTICAL & HERBAL TECHNOLOGY

Credits	L	P		
3	3	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objectives: The course aims at developing knowledge and skills in utilization of plants and plant production in medical formulations.

Unit I

- Particulate Technology: Particle Size, Size reduction, Size Separation, Powder Flow, and Compaction.
- Unit Operations: Mixing, Evaporation, Filtration, Centrifugation, Extraction, Distillation, Sterilization, and Drying
- Regulatory Practices, Quality assurance, and Validation
- Introduction about IP, BP & USP. Drug & Cosmetic Act & Rules, Government regulatory practices and policies, FDA perspective. Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry. Regulatory aspects of quality control. Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification.

Unit II

- Pre-Clinical research, Clinical research, Pharmacovigilance, Pharmacokinetic, Pharmacodynamic and Toxicological considerations in drug development, market research.
- Introduction to different dosage forms, Preparation and evaluation methods of Ayurvedic medicines i.e. Asavas and Aristas, Arkas, Avalehas, Churnas, Ghritas and Tailas, Guggulu preparations, Ksara, Lauha kalpas, Lepas, Vatika and Bhasmas.

Unit III

- Standardization of polyherbal formulations: syrups, powders, ointments and other semisolid preparations, tablets and capsules.
- Extraction, isolation, purification estimation and uses of following phytoconstituents:
  Alkaloids: Caffeine, Atropine, Berberine, Piperine
  Glycosides: Sennosides, Digoxin
  Flavonoids: Rutin, Hesperidin
  Terpenoids: Taxol, Andrographolide
  Saponins: Diosgenin, Glycyrrhizin
- Pharmaceutical Aids: Study of Pharmaceutical aids like talc, diatomite, kaolin, bentonite, gelatin, and natural colors.
- Nutraceuticals: Study of some plant constituents and their products in the international market, study of lycopene, proanthocyanidin and grape products, ornithine, flaxseed and flax oil, melatonin, and ornithine.

References:

1. Quality control and Evaluation of Herbal Drugs by P.K.Mukherjee, 1st ed. Elsevier
2. A Text Book of Herbal Drug Technology by N.D.S.Sreekanth, Notion Press
3. Herbal Drugs Industry by V.Rajpal and D.P.S. Kohli, 2nd Ed. Business Horizons.
4. Handbook of Nutraceuticals and Natural Products: Biological, medicinal and nutritional properties and applications by P. Balakrishnan and S. Gopi. John Wiley and Sons.

Course Outcome (COs) After successful completion of this course, a student will be able to:

CO1: Students will be able to understand basics of pharmaceuticals preparations

CO2: Students will be able to recognize the different techniques used in pharmaceuticals preparations

CO3: Students will be able to imply the pharmaceutical behaviour of the different drug formulation practices