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. July 2023

SCHEME AND SYLLABI

M.Sc. BIOTECHNOLOGY

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 LIFE 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 of work
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 that describes the knowledge and capabilities of the post-graduate will have by the end of program studies.
After successful completion of M.Sc. Biotechnology, the students will be able to

PSO1	The detailed functional knowledge of theoretical concepts and experimental aspects of Biotechnology.
PSO2	To integrate the gained knowledge with various contemporary and evolving areas in Life sciences like Genetic Engineering, Forensic sciences etc.
PSO3	To understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in Biotechnology
PSO4	Provide opportunities to excel in academics, research or Industry

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

DEPARTMENT OF LIFE SCIENCES
SCHEME M.Sc. BIOTECHNOLOGY

SEMESTER-I

S. No.	Course Code	Subject	Teaching hours per week			Maximum marks			Credits	Category course
			L	T	P	Int	Ext	Total		
1.	MBT-101	Biochemistry	4	0	0	25	75	100	4	DCC
2.	MBT-102	Biostatistics and Scientific ethics	4	0	0	25	75	100	4	DCC
3.	MBT-103	Cell and Molecular Biology	4	0	0	25	75	100	4	DCC
4.	MBT-104	Genetics	4	0	0	25	75	100	4	DCC
5.	MBT-105	Microbiology	4	0	0	25	75	100	4	DCC
6.	MBT-106	Biotechnology Lab Course I	0	0	12	30	70	100	6	DSC
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 as specified below: Programme Duration for 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 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 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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SEMESTER-II

S. No.	Course Code	Subject	Teaching hours per week			Maximum marks			Credits	Category course
			L	T	P	Int	Ext	Total		
1.	MBT-201	Bioprocess and Fermentation Technology	4	0	0	25	75	100	4	DSC
2.	MBT-202	Biotechniques	4	0	0	25	75	100	4	DCC
3.	MBT-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	Immunology	4	0	0	25	75	100	4	DSC
6.	MBT-206	Biotechnology Lab course-II	0	0	12	30	70	100	6	DSC
7.		AUDIT COURSE*	2	0	0	25	75	100	0	AUD
		Total	**21**	**0**	**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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SEMESTER-III

S. No.	Course Code	Subject	Teaching hours per week			Maximum marks			Credits	Category course
			L	T	P	Int	Ext	Total		
1.	MBT-301	Metabolism	4			25	75	100	4	DSC
2.	MBT-302	Food Biotechnology	4			25	75	100	4	DCC
3.	MBT-303	Plant and Animal Biotechnology	4			25	75	100	4	DSC
4.	MBT-304	OMICS	4			25	75	100	4	DSC
5.		Discipline Elective • Bioethics and Biosafety (MBT-DE001) • Biophysics (MBT-DE002) • Pharmaceutical and Herbal Technology (MBT-DE003) • Virology (MMT-DE002) • Environmental Toxicology (MZO-DE-006)	3			25	75	100	3	DEC
6.	MBT-305	Biotechnology Lab Course- III			12	30	70	100	6	DSC
7.		Open Elective Course*	3			25	75	100	3	OEC
		Total	**22**		**12**			**700**	**28**	

DEC: Discipline Elective Course

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

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SEMESTER-IV

S. No.	Course Code	Subject	Teaching hours per week			Maximum marks			Credits	Category course
			L	T	P	Int	Ext	Total		
1.	MBT-401	Dissertation Project	0	0	40		100	100	20	DSC
2.		Reading Elective • Conservation Biology (MBT-RE 001) • IPR in biotechnology (MBT-RE 002)	0	0	0		100	100	2	DEC
		Total			**40**			**200**	**22**	

M.Sc. BIOTECHNOLOGY SEMESTER I
CODE: MBT-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 by D.A. Harris. John Willey and Sons Ltd, 1995.
3) Lehninger's Principle of Biochemistry by Nelson D.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 learner 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. BIOTECHNOLOGY SEMESTER I
CODE: MBT-102
SUBJECT NAME: BIOSTATISTICS AND SCIENTIFIC ETHICS

Credits	L	P		
4	4	0	Sessional	25
			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:

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. BIOTECHNOLOGY SEMESTER I
CODE: MBT-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:

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. BIOTECHNOLOGY SEMESTER I
CODE: MBT-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
- 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 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:

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. BIOTECHNOLOGY SEMESTER I
CODE: MBT-105
SUBJECT NAME: Microbiology

Credits	L	P		
4	4	0	Sessional	25
			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:

CO 1: To develop conceptual understanding of microbial diversity, taxonomy and ultrastructure.
CO 2: To acquire skills in various techniques used in microbial study
CO 3: To apply the skills and knowledge in diagnostics, industrial biotechnology, microbial interactions and other related areas.

M.Sc. BIOTECHNOLOGY SEMESTER I
CODE: MBT-106
SUBJECT NAME: BIOTECHNOLOGY LAB COURSE-I

Credits	L	P		
6	0	12	Sessional	30
			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. BIOTECHNOLOGY SEMESTER II
CODE: MBT-201
SUBJECT NAME: BIOPROCESS AND FERMENTATION TECHNOLOGY

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

Course Objectives: To develop skills in fermentation and bioprocessing for application in various biotechnological industries.

Course Outcomes (COs)

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

CO1: To understand the cell growth behaviour and culture conditions

CO2: To acquire the knowledge of bioreactor designing.

CO3: To apply the acquired skills in the production of microbial metabolites

Unit I

Strain Improvement and Microbial Growth Kinetics: Screening for new metabolites - primary and secondary metabolites.

Strain development through selection, mutation, genetic recombination and metabolic engineering methods.

Maintenance & preservation of industrially important microorganisms using metabolic active and in-active methods, Stock cultures – primary & working stock cultures, Microbial growth and death kinetics, Batch, Fed-batch, Synchronous and Continuous bioprocess (Chemostat and Turbidostat), yield coefficient, doubling time, specific growth rate, metabolic and biomass productivities.

Unit II

Bioreactor Design and Control: Introduction to Bioreactor, Design of a typical bioreactor (CSTR, Airlift, Packed bed, Photobioreactor), Different components of Bioreactors (peripherals and accessories such as pH, dissolved oxygen, temperature, foam, gas exchange sensors, biomass probe, aeration and agitation, and cooling components), modifications in design for plant and animal cell cultures, computational and remote control (SCADA and other data logging and analysis software's), bioprocess automation and application of computers in bioprocessing

Unit III

Media Formulation and Upstream Processing: Fermentation media formulation-Ideal properties, Constituent's characteristics (carbon, nitrogen (organic and inorganic), growth factors, buffers, minerals, addition of precursors and regulators to media etc), Fluid Rheology and Reynolds's number

Sterilization: Batch and continuous sterilization by different methods (Heat (D, Z, F value, Del factor calculation) and filtration methods)

Inoculum preparation (Bacteria, Yeast and Mycelial inocula) & scale-up of culture for a fermentation process, gas exchange and mass transfer.

Unit IV

Downstream Processing & Product Polishing: Basics of Downstream processing, extracellular and intracellular (disintegration of cells by physical, chemical or biological) recovery of microbial metabolites, separation of solid and liquid phases, isolation and purification techniques for proteins and other products based on different physico-chemical properties, eg., precipitation, adsorption, chromatographic separations, bio-affinity based methods, product polishing (spray drying, freeze drying and carrier based formulations).

References

1. Principles of Fermentation Technology by Peter F Stanbury and Allan Whitaker, Butterworth-Heinemann
2. Modern Industrial Microbiology and Biotechnology by Nduka Okafor, CRC Press
3. Bioprocess Engineering by Micheal Shuler and Fikret Kargi, Prentice Hall.

M.Sc. BIOTECHNOLOGY 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, Brightfield, Phasecontrast, 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: BeerLambert'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. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology 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 Gale Rhodes, 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 Immunotechniques: 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. BIOTECHNOLOGY SEMESTER I
CODE: MBT-203
SUBJECT NAME: ECOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY

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. John Wiley & 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. Internationals Pvt Ltd. 2nd ed.

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. BIOTECHNOLOGY 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. BIOTECHNOLOGY SEMESTER II
CODE: MBT-205
SUBJECT NAME: IMMUNOLOGY

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

Course Outcomes (COs)

Course Objective: This course aims at developing conceptual understanding of the human immune system, regulation and its various responses.

Course Outcomes:

CO1-To develop the concept of immunity and various mechanisms for immune responses regulation and tolerance.

CO2-To understand the reasons for immunization, vaccination and role of immune system in transplantation.

CO3-To acquire the skills of techniques based on antigen-antibody interactions.

Unit I

Cells and organs of immune system. Primary, secondary and tertiary lymphoid organs. Types of immunity - Innate and adaptive, Humoral and cell-mediated, Active and passive.

Pathogen associated molecular pathway: Toll like receptor, Clonal selection theory. Immunological memory, Antigens and immunogens, B and T cell epitopes; Haptens.

Structure and functions of antibodies. Classes of immunoglobulins. CDRs, Valence, affinity and avidity. Antibody variants - Isotypes, Allotypes and Idiotypes.

Unit II

The immunoglobulin genes: organization and assembly; generation of immunological diversity; Allelic exclusion. Major histocompatibility complex (MHC): structure and organization of MHC.

Antigen processing and antigen presentation. T cell Receptor: Superantigens. B cell activation and maturation. T cell development and activation. Cytotoxic T cell mediated killing.

Complement system and mechanism of its fixation. Complement deficiencies.

V(D)J recombination, somatic hypermutation and class switch recombination of immunoglobulins: mechanism and regulation

Unit III

Immunological tolerance. Autoimmunity and associated disorders (Grave's disease, Myasthenia gravis, Multiple sclerosis and Rheumatoid arthritis).

Allergy and hypersensitivity, types of Hypersensitivity. Transplantation immunology - Graft rejection, graft versus host reaction.

Immune response to infectious diseases – viral (influenza, AIDS), bacterial (tuberculosis), protozoal (malaria)

Techniques of antigen-antibody interactions: RIA, ELISA, ELISPOT assay, immunofluorescence microscopy

Unit IV

Role of cytokines, lymphokines and chemokines.

Vaccine and its different types with emphasis on COVID-19 vaccines.

Hybridoma Technology: Production of murine monoclonal antibodies (MoAbs)-Fusion strategies, HAT Selection

Strategies for production of human MoAbs-Humanization and antigenization of MoAbs-Chimeric, CDR-grafted

References

1. Punt J, Stranford SA, Jones PP, and Judith AO (2019) Kuby immunology. WH Freeman. 8th edition.

2. Abbas AK, Lichtman AH, and Pillai S (2016) Cellular and Molecular Immunology. Saunders. 9th edition.

3. Male DK, Brostoff J, Roth D, and Ivan R (2012) Immunology. Gower Medical Publishing London. 8th edition.

4. Gupta SK (2010) Essentials of Immunology. Arya Publication. 2nd edition.

5. Khan FH (2009) The Elements of Immunology. Pearson Education India. 1st edition

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

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

Course Objectives: To develop skills in various analytical, molecular, immunological, bioprocess techniques and bioinformatics tools

Course Outcomes (COs)

After successful completion of the course a student will be able to
CO1: To develop hands on training in various analytical and bioprocess techniques.
CO2: To acquire skills in immunological and molecular techniques.
CO3: To analyze and interpret the data by applying bioinformatics tools

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. Production of Amylase/Peroxidase and its immobilization
6. Production of Protease and its spectrophotometric estimation
7. Study of fermenters
8. Production of alcohol and its estimation by potassium dichromate method
9. Bio conversion of gallic acid by *Aspergillus*
10. Estimation of K_{La} by sodium sulfite method
11. To perform Differential Leucocyte Count
12. To perform Ouchterlony Double Diffusion assay to the study of antigen-antibody reaction.
13. ABO Blood group testing of the provided sample
14. Determination of antibiotic titer using ELISA
15. ABO Blood group testing of the provided sample
16. To perform Widal test
17. Extraction of genomic DNA and its estimation using spectrophotometer
18. Plasmid isolation by alkaline lysis method and detection using electrophoresis
19. Preparation of competent cells
20. Restriction digestion of plasmid DNA and detection of digestion profile using electrophoresis.
21. Transformation of *E. coli* with plasmid and calculation of transformation efficiency
22. Database search: use and analysis of BLAST tool for DNA and protein sequences
23. Primer designing and *in silico* PCR

M.Sc. BIOTECHNOLOGY SEMESTER III
CODE: MBT-301
SUBJECT NAME: METABOLISM

Credits	L	P		
4	4	0	Sessional	25
			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:

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. BIOTECHNOLOGY SEMESTER III
CODE: MBT-302
SUBJECT NAME: FOOD BIOTECHNOLOGY

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

Course Objective:
The objective of a course on food biotechnology is to provide students with a comprehensive understanding of the principles, techniques, and applications of biotechnology in the food industry.

Course Outcomes:
CO.1. To understand the concepts of food processing, safety and legislation
CO.2. To gain knowledge of techniques used in the food industry based on fermentation and enzyme technology.
CO.3. To apply the acquired knowledge and skills in in development of nutraceuticals and novel food

Unit- I
Introduction to Food Biotechnology
Intrinsic and extrinsic factors affecting microbial growth in food, type & mode of food fermentations (solid and liquid), Hurdle Technology in food processing, pasteurization, canning, food sterilization; batch & continuous sterilization in food (Decimal reduction time, ultra-high temperature, cleaning in place (CIP).
Food legislation: Enforcement and Govt. Regulatory practices and policies. FDA, CODEX alimentarius, HACCP, FSA, APHA, FSSAI act, Quality systems (BS5750 & ISO9000 series), GRAS status microorganisms.
Microbial starters and Food Enzymes, Starter (primary and secondary) and, adjunct microbial culture, mono, mixed cultures, fermented dairy products
Role of metabolic engineering in starter culture improvement.

Unit- II
Fermentative production of α-amylase, glucose oxidase, β-glucanase, lipase and pectinase used in food industry
Role of enzymes in baking, meat and meat processing.
Biotechnological production and fermentation techniques to produce Yogurt, Acidophilus milk, Curd, Kefir, Kumiss, Cheese productions
Plant based fermented food products; soya sauce, tofu, tempeh, miso, natto.
Brine Fermentations-Dill pickles, Kimchi, olives and sauerkraut. Sausageand fermented meats, meat analogues.

Unit-III
Functional Foods & Single Cell Products: Probiotics (strain selection & mass productions), Food yeast (Biomass production & by-products), encapsulation of food components, apple cider productions, Kombucha fermentations, single cell products; algal, myco-protein based, Bio-fortified foods (rice & oil crops), Food for special dietary uses (mineral enriched products.

References

1. Fundamentals of Food Biotechnology, 2nd Edition by Byong H. Lee
2. Food Microbiology by Adams & Moss, New Age International Publishers
3. Food Microbiology by Frazier, McGraw Hill Education.
4. A Comprehensive Dairy Microbiology by J S Yadav, Sunita Grover, V K Batish, Metropolitan Book Co. New Delhi
5. Outlines of Dairy Technology by De SuKumar, Oxford.

M.Sc. BIOTECHNOLOGY SEMESTER III
CODE: MBT-303
SUBJECT NAME: PLANT AND ANIMAL BIOTECHNOLOGY

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

Course Objective: The course aims to generate and foster an understanding of the developments in plant and animal based technological applications.

Course Outcomes:

CO 1: To develop an understanding of the fundamental concepts and techniques used in animal and plant biotechnology.

CO2: To acquire knowledge of application of biotechnology in the genetic modification, breeding, and improvement of plants and animals.

CO3: To apply the skills of animal and plant cell cultures for establishing a successful cell lines.

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, 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.

Genetic engineering of plants for bacteria, fungi, virus, pest and herbicide resistance.

Unit II

History of Plant Tissue Culture, Sterilization methods, media preparation, Plant Growth Regulators, Micropropagation, Callus culture, Cell suspension Culture, Protoplast Culture and Fusion, Organogenesis, Somatic embryogenesis, Synthetic seed, Somatic hybrids, and Cybrids. Application of tissue culture for crop improvement. Seed storage proteins, Methods for Plant Conservation, Haploid production: - Anther, Pollen, Embryo and ovule culture and their applications, Somaclonal variations.

Unit III

Biology of animal cell and cell-cell interactions, growth environment and culture requirement; Disaggregation of tissue and setting up of primary culture, subculture, cell line, cell strain, cell clone.

Importance of serum and serum-free media; cell line immortalization & characterization, measurement of growth, viability and cytotoxicity

Tissue culture, organ culture; cellular markers, commercial cell lines, and insect cell culture, *in vitro* transfection of animal cells

Unit IV

Production of transgenic animals: nuclear transplantation, retroviral method, DNA microinjection method, Dolly and Polly; Development of recombinant vaccines, hybridoma technology, gene therapy

Stem cell cultures: Embryonic and adult stem cells, their isolation, culture and applications

Cancer Research, toxicology studies, Rodent and murine models in scientific research associated with cancer and neurodegenerative diseases.

References

1. Razdan M K (2019) An introduction to Plant Tissue culture. Oxford & IBH Publishing Co, NewDelhi .3rd Edition
2. CM Govil, Aggarwal A, Sharma J(2017) Plant Biotechnology and Genetic Engineering. PHI Learning Pvt. Ltd. 1stEdition
3. Slater, Scott NW, Fowler MR (2008) Plant Biotechnology: The Genetic Manipulation of Plants. Oxford University Press. 2nd Edition
4. Buchanan BB, Gruissem W, Jones RL (2015) Biochemistry & Molecular Biology of Plants. John Wiley & Sons. 2nd Edition
5. Dixon RA, Gonzales (2006) Plant cell culture, A Practical approach. Oxford University Press. 2nd Edition

M.Sc. BIOTECHNOLOGY SEMESTER III
CODE: MBT-304
SUBJECT NAME: OMICS

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

Course Objective:

The course aims to appraise the students to the vital concepts of technologies pertinent to genomics, transcriptomics, proteomics, metabolomics and their applications and demonstrate skills to apply the knowledge in scientific queries.

Course Outcomes (COs)

CO1- To understand the crucial concepts and techniques applied in genomics, transcriptomics, proteomics, and metabolomics.
CO2- To learn about the complexity of genome/proteome/transcriptome/metabolome structural and functional organization.
CO3- To be able to formulate and assess experimental design for solving theoretical and experimental problems in Genomics and Proteomics fields

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 Genome mapping- Hierarchical Shotgun Sequencing, Whole-Genome Sequencing, Haplotype Genome Sequencing
DNA sequencing- First-Generation Sequencing (Sanger method), Second-Generation Sequencing (EmPCR, Bridge PCR, 454 sequencing, SOLiD, Reversible Terminator Sequencing (Illumina), Affymetrix Microarray Technique), Third-Generation Sequencing (Ion Torrent Semiconductor Sequencing, Single-Molecule Real-Time Sequencing. Nanopore Technology)
Strategies for major genome sequencing projects, Gene annotation, Genomic databases

Unit II

Transcriptomics and expression profiling Genome expression analysis, RNA content and profiling genetic mapping, Microarray (cDNAand 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 targets identification. Validation of drug targets and assessment of its toxicology

Unit IV

Introduction to metabolomics world. Metabolic fingerprinting, and metabolic profiling. Biotechnological potentials of metabolomics. Proteomics approaches in metabolomics.
Application for cellular metabolomics for metabolic pathway structure. Size of metabolome, metabolite identification, pathway identification and pathway integration. Computational approaches for metabolite identification and translation of results into biological knowledge.

References

1. PalzkillT(2002)Proteomics.Kluwer Academic Publishers, NewYork, USA.1st Edition
2. Kambhampati D (2005) Protein Microarray Technology. Wiley-VCH Verlag GmbHWeinheim,Germany. 1st Edition
3. LeskAM(2007) Introduction to Genomics. Oxford University press, UK. 3rd Edition
4. Villas-Boas SG (2007) Metabolome Analysis: An Introduction. Wiley-Blackwell, USA. 1st Edition
5. Nikolau BJ, Wurtele ES (2007) Concepts in Plant Metabolomics. Springer, USA. 1st Edition

6. Gibson G, Muse SV(2009) A Primer of Genome Science. Sinauer Associates. 3rd Edition
7. BrownTA(2017) Genome .Garland Science Publishers. 4th Edition

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

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

Course Objective: The course aims towards generating skills in different experimental strategies aimed at microbial/plant handling for various applications along with extraction and quantification of biomolecules.

1. To perform shoot tip culture
2. Determination of cell viability using trypan blue method
3. To prepare synthetic seed
4. To study native and denatured state of protein using electrophoresis
5. To study native and denatured state of protein using UV-spectrophotometer
6. Partial purification of amylase by ammonium sulfate method
7. Chemical mediated protein denaturation and determination of thermodynamic parameters of protein stability
8. To carry out sauerkraut production
9. To perform microbiological analysis of food products: Determination of SPC, total yeast and mold count
10. To evaluate milk quality by methylene blue reductase test and phosphatase test
11. Production of lactic acid and its estimation
12. Development of starter culture using LAB
13. To isolate fungal spoilage organisms

*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: Acquire skills in extraction, purification and quantification of various bioactive molecules

CO2: Develop understanding is developing protocols and experiments for microbial and plant biotechnology

CO3: Utilize the skills is exploiting microbes for various applications

M.Sc. BIOTECHNOLOGY SEMESTER III
CODE: MBT-DE001
SUBJECT NAME: BIOETHICS AND BIOSAFETY

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

Course Objectives: The course aims towards sensitizing students of the ethical and biosafety concerns in biological research along with an understanding of the legislations developed.

Unit I

- Concerns in Biotechnology, Biopiracy,
- Convention on Biological diversity, Indian Biodiversity Act, Access and Benefit sharing.
- Definition of bioethics and need, Main principles of Bioethics, Ethical issues related to biotechnology, legal and socioeconomic impacts of biotechnology, health and safety issues.
- Conflicts of bioethics with IPR and Business ethics, Case studies – surrogacy, human cloning, xeno-transplantation.

Unit II

- Biosafety definition, categorization of risk agents, chemical and biological hazards-identification and disposal
- Cartagena Protocol, Biosafety risk assessment procedure, Food and ecological safety assessment. Case studies- Bt cotton, golden rice, transgenic soybean

Unit III

- Biological and physical containment. Biosafety levels for plant, animal and microbial researches,
- Biosafety framework in India, Seed Bill,
- Bioterrorism, Convention of Biological Weapons
- Food Adulteration Act (1955), Food Safety and Standards Bill (2005).

References

1. Bioethics and Biosafety by M.K. Sateesh. I. K. International Pvt Ltd.
2. Bioethics and Biosafety in Biotechnology by V. Sree Krishna, New Age International Publishers

Course Outcome

CO1: Students will be able to understand the role and importance of biosafety and bioethics
CO2: Students will be able to recognize the different containment levels and regulations practiced
CO3: Students will be able to imply the concept of the bioethics in gene cloning and transgenics productions

M.Sc. BIOTECHNOLOGY SEMESTER III
CODE: MBT-DE002
SUBJECT NAME: BIOPHYSICS

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

Course Objective: This course will introduce measurement and analysis of physical phenomena as they pertain to biological macromolecules including structure and energetics.

Course Outcomes:

CO 1: Students will understand strong and weak interactions as they pertain to the energetics of folding of biopolymers and the equations involved in molecular mechanics, the laws of thermodynamics to the folding of three-dimensional structures of biological macromolecules.

CO 2: Students will gain knowledge of isothermal titration and differential scanning calorimetry in the study of proteins and nucleic acids.

CO 3: Students will understand the physical parameters and equations associated with macromolecules in solution including chemical potentials and equilibria.

Unit I

Introduction to biophysics. Basic thermodynamic and biochemical concepts: States of matter, Pressure, Temperature, Volume, Mass, and Number. Properties of gases: The ideal gas laws, Gas mixtures, Kinetic energy of gases, Real gases, Phase diagrams and transitions, Chemical potential, Osmosis, Molecular basis for life.

First law of Thermodynamics, Second law of thermodynamics and applications in biological systems

Unit II

The Boltzmann distribution, Statistical thermodynamics, Statistical approaches to understand protein folding and prions.

Chemical bonds and protein interactions: Schrödinger's equation for a hydrogen molecule, Valence bonds, The Hückel model, Interactions in proteins, Peptide bonds , Steric effects, Hydrogen bonds, Electrostatic interactions, Hydrophobic effects, Secondary structure, Determination of secondary structure using circular dichroism, modelling protein structures and folding

Unit III

Understanding biological systems using physical chemistry-

Molecular imaging: Imaging in cells and bodies, Green fluorescent protein, Mechanism of chromophore formation, Fluorescence resonance energy transfer, Imaging of GFP in cells, Imaging in organisms, Radioactive decay, and Parkinson's disease.

Photosynthesis: Energy transfer and light-harvesting complexes, Electron transfer, bacterial reaction centres, and photosystem I, and water oxidation.

References

1. Allen, J. P. (2009). Biophysical chemistry. John Wiley & Sons.
2. Creighton, T. E. (1993). Proteins: structures and molecular properties. Macmillan.

3. C. R. Cantor and P. R. Schimmel, Biophysical Chemistry, Part III, W.H.Freeman and Co., 1980. . B. Gregory, ed., Protein-Solvent Interactions, Marcel Dekker,Inc., 1995.
4. B. T. Nall and K. A. Dill, ed., Conformations and Forces in Protein Folding, American Association for the Advancement of Science, 1991.
5. J. Wyman and S. J. Gill, Binding and Linkage: Functional Chemistry of Biological Macromolecules, University Sciences Books, 1990.

M.Sc. BIOTECHNOLOGY SEMESTER III
CODE: MBT-DE003
SUBJECT NAME: PHARMACEUTICAL AND HERBAL TECHNOLOGY

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

NOTE: Question paper will have two parts. Part-A is compulsory and contains 10 questions each of 1.5 marks covering the entire syllabus. Part-B has 6 questions each of 15 marks and students are required to attempt any four questions from this part.

Course Objective: To provide students with a comprehensive understanding of the principles and practices of pharmaceutical manufacturing, as well as the use of herbal products in medicine.

Course Outcomes:
CO 1: Students will understand the basic principles of pharmacology and pharmacokinetics, including drug absorption, distribution, metabolism, and excretion. Familiarity with the various dosage forms used in pharmaceuticals, including tablets, capsules, injections, and inhalants.
CO 2 Students will understand the manufacturing processes involved in the production of pharmaceuticals, including formulation development, quality control, and regulatory requirements.
CO 3: Students will gain knowledge of the chemistry, pharmacology, and therapeutic uses of herbal products, as well as the safety and efficacy of these products, current regulatory frameworks for the use of herbal products in medicine, including the assessment of quality, safety, and efficacy.
CO 4: Students will learn analytical techniques used in pharmaceutical and herbal product testing, including chromatography, spectrophotometry, and mass spectrometry.

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, Lauhakalpas, 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. Fundamentals of Food Biotechnology, 2nd Edition by Byong H. Lee
Food Microbiology by Adams & Moss, New Age International

M.Sc. BIOTECHNOLOGY SEMESTER III
CODE: MMT-DE002
SUBJECT NAME: VIROLOGY

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

Course Objective: The course aims at inculcating an in-depth knowledge of various acellular agents and their impact on human health.

Unit I

- Evolution of viruses,
- Viral tropism, factors responsible for viral tropism, Immune aversion mechanisms of virus, mechanisms in virus latency, transmission of virus
- Virus host interactions – acute, chronic/persistent, latent, transforming, abortive and null infections Virus induced cell death. Viral virulence and its alteration
- Virus induced tumours

Unit II

- Structure, genome, and life cycle of influenza virus, corona virus, parvovirus, dengue virus, flavivirus, baculovirus.
- Structure, genome, and life cycle of Giant viruses associated with protist (mama and mimi virus) and virophages (Sputnik, Mavirus).
- An introduction to archaeal and fungal viruses.
- Other infectious agents: viroids, satellites and prions

Unit III

- Advanced technologies for detecting virus,
- Recombinant viruses for gene therapy,
- Antiviral vaccines and chemotherapy
- Eukaryotic virus vectors
- Economic impact of viruses and viral epidemiology- an overview

References

1. Understanding Viruses by Teri Shors Jones. 3rd edition. Jones and Bartlett Learning, USA. 2016.
2. Principles of Virology, Molecular biology, Pathogenesis and Control by S.J. Flint, L.W. Enquist, R.M. Krug, V.R. Racaniello, A.M. Skalka. 4th edition. ASM press, USA. 2015
3. Virology: Principles and Applications by J. Carter and V. Saunders. 2nd edition. John Wiley and Sons, UK. 2013.
4. Introduction to Modern Virology by N.J. Dimmock, A.L. Easton and K.N. Leppard. 6th edition. Wiley-Blackwell Publishing. 2007.
5. Basic Virology by E.K. Wagner, M.J. Hewlett, D.C. Bloom. 3rd edition. Wiley-Blackwell Publishing. 2007.
6. Virology by J.A. Levy, H.F. Conrat and R.A. Owens. 3rd edition. Prentice Hall, USA. 2000.

Course Outcomes (COs)

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

CO1: Students will be able to understand the structure and transmission of viral particles
CO2: Students will be able to evaluate the viral cell behaviour in different diseases

CO3: Students will be able imply the use of viral cells in different immunological applications

M.Sc. BIOTECHNOLOGY SEMESTER III
CODE: MZO-DE-006
SUBJECT NAME: ENVIRONMENTAL TOXICOLOGY

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

Course Objective: To provide students with a comprehensive understanding of the effects of chemicals and pollutants on living organisms and ecosystems, and the mechanisms by which these effects occur.

Course Outcomes:

CO 1: Students will understand the basic principles of toxicology, including dose-response relationships, toxicokinetics, and toxicodynamics.

CO 2: Students will understand the mechanisms by which environmental pollutants cause toxicity, including oxidative stress, genotoxicity, and endocrine disruption.

CO 3: Students will understand regulatory frameworks for environmental toxicology, including risk assessment and management.

CO 4: Students will understand the role of environmental toxicology in public health and environmental policy, and its implications for society.

Unit I

Definition, history, scope & sub-divisions of toxicology.

Dose-effect and dose-response relationship- acute toxicity, chronic toxicity reversible & irreversible effects.

Classification of toxic agents, natural toxins, animal toxins, plant toxins,
food toxins, genetic poisons and chemical toxins.

Factors affecting toxicity – species and strain, age, sex, nutritional status,
hormones, environmental factors, circadian rhythms.

Absorption and distribution of toxicants-portals of entry-skin, gastro intestinal tract, gills and respiratory system.

Unit II

Bio-distribution, biomagnification biotransformation of xenobiotics- brief
introduction to Phase-I and Phase-II reactions.

Reactions of toxins with target molecules- Covalent binding, Non-covalent binding, Hydrogen abstraction, Electron transfer, Enzymatic reactions

Basics of organ toxicity- Target organs, Organ selectivity and specificity

Brief idea of cutaneous, pulmonary, hepato-renal, reproductive and endocrine toxicity.

Unit III

Mechanisms of heavy metal toxicity- Induction of metallothionein, heat shock proteins, cytoskeletal effects, heamporphyrin metabolism, lipid peroxidation

Toxicity of trace elements- Iodine, iron, zinc, copper, manganese, selenium, molybdenum, and cobalt

Characteristics and mechanism of action of Organochlorines,
Organophosphorus insecticides, Carbamates, Pyrethroids, other plant
origin bio-insecticides

Properties of few individual insecticides i.e. DDT, HCH (BHC), Lindane,
Endosulfan, Parathion, Malathion

Method of testing chemicals on insect and evaluation of toxicity.

References

1. Toxicology and Risk Assesssment: A Comprehensive Introduction, GreimH.,and Snyder, R. (ed), John Wiley and Sons, UK.
2. The Complete Book of pesticide management, Whitford, F., Wiley Interscience,John Wiley and Sons, UK

M.Sc. BIOTECHNOLOGY SEMESTER IV
CODE: MBT-401
SUBJECT NAME: DISSERTATION PROJECT

Credits	L	P		
20	0	40	Sessional	0
			Theory Exam	100
			Total:	100

Course Objective: This course aims to generate awareness towards biodiversity and its ecological significance

Biodiversity: concept; national & global status; endemism, speciation and extinction

Levels of biodiversity, hotspots and hottest hotspots; study of Indian biodiversity hot spot RAMSAR sites, ICUN categories of threat; Red Data Books.

Ecological and economic importance of forests, afforestation, deforestation and social forestry; endangered plants, invasive species; habitat fragmentation and degradation, desertification and wasteland reclamation, energy plantations;

Restoration and resurrection, ex-situ conservation, Principles of conservation, major approaches to management, Biodiversity Conservation strategies, Role of botanical gardens, seed banks, *invitro* repositories and cryobanks in biodiversity conservation.

References

1. Cardinale, B.J., et al., Effects of biodiversity on the functioning of trophic groups and ecosystems. Nature, 2006. 443(7114): p. 989-992.
2. Stachowicz, J., J.F. Bruno, and J.E. Duffy, Understanding the effects of marine biodiversity on
communities and ecosystems. Annual Review of Ecology, Evolution and Systematics, 2007. 38(1):p. 739-766
3. Hooper, D.U., et al., Effects of biodiversity on ecosystem functioning: A consensus of current knowledge. Ecological Monographs, 2005. 75(1): p. 3-35.
4. Loreau, M., et al., Biodiversity and ecosystem functioning: Current knowledge and future challenges. Science, 2001. 294(5543): p. 804-808.
5. Naeem, S., Ecosystem consequences of biodiversity loss: The evolution of a paradigm. Ecology, 2002. 83(6): p. 1537-1552.
6. Tilman, D., The ecological consequences of changes in biodiversity: a search for general principles. Ecology, 1999. 80: p. 1455-1474.
7. Cardinale, B.J., et al., Biodiversity loss and its impact on humanity. Nature, 2012. 486(7401): p. 59-67
8. Conservation Biology:Foundations, concepts and applications by Fred Van Dyke , Rachel L. Lamb, Springer
9. Fundamentals of Conservation Biology, 4th EditionMalcolm L. Hunter Jr., James P. Gibbs, Viorel D. Popescu Wiley publishing

M.Sc. BIOTECHNOLOGY SEMESTER IV
CODE: MBT-RE002
SUBJECT NAME: IPR IN BIOTECHNOLOGY

Credits	L	P		
2	0	0	Sessional	0
			Theory Exam	100
			Total:	100

Concept of IPR and its scope in biotechnology. Patents, copyright, geographical indicators, trademarks and tradesecrets,

Process of patent filing in India, types of patent applications.

Classification of patents according to India and WIPO, Budapest treaty, Patent Cooperation Treaty, Role of WIPO and WTO in IPR management. UPOV and Plant breeder's rights. Farmers right.

Case studies in IPR. Technology transfer in biotechnology. Ethical implications of IPR, Traditional knowledge.

References:

1. Biotechnology and intellectual property rights: Legal and social implications by Kshitij Kumar Singh, Springer
2. IPR, Biosafety and Bioethics. Goel and Prashar Pearson publications.