SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat-Barrackpore Road, Bara Kanthalia, WB - 700121

School of Life Sciences

M.Sc. in Biotechnology

Programme Structure 2025

(As per UGC CBCS Template)

Programme duration: 2 years (Semester I-IV)
Total credits: 24 x 4 = 96;
Total marks: 600 x 4 = 2400

Semester – I

Course Code	Course Name	L-T-P	Course Type	Credits	Total Marks
MBTC101	Cell Biology	2-0-0	Core Course	2	50
MBTC191	Cell Biology Lab	0-0-4	Core Course	2	50
MBTC102	Enzymes & Reaction Kinetics	2-0-0	Core Course	2	50
MBTC192	Enzymes & Reaction Kinetics Lab	0-0-4	Core Course	2	50
MBTC103	Molecular Biology	2-0-0	Core Course	2	50
MBTC104	Biophysical Chemistry & Instrumentation	2-0-0	Supportive Course	2	50
MBTC194	Biophysical Chemistry & Instrumentation	0-0-4	Supportive Course	2	50
MBTS101	Quality Assurance (QA) and Quality Control (QC)	2-0-0	Core Course	2	50
MBTS102	Microbiology	2-0-0	Supportive Course	2	50
MBTS192	Microbiology Lab	0-0-4	Supportive Course	2	50
MBTS181	Seminar-I	0-0-8	Skill Dev	4	100
	Total			**24**	**600**

SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat-Barrackpore Road, Bara Kanthalia, WB - 700121

School of Life Sciences

M.Sc. in Biotechnology

Programme Structure 2025

(As per UGC CBCS Template)

Semester – II

Course Code	Course Name	L-T-P	Course Type	Credits	Total Marks
MBTC201	Metabolism	2-0-0	Core Course	2	50
MBTC291	Metabolism Lab	0-0-4	Core Course	2	50
MBTC202	Recombinant DNA Technology	2-0-0	Core Course	2	50
MBTC292	Recombinant DNA Technology Lab	0-0-4	Core Course	2	50
MBTC203	Immunology	2-0-0	Core Course	2	50
MBTC293	Immunology Lab	0-0-4	Core Course	2	50
MBTC204	Biostatistics	2-0-0	Core Course	2	50
MBTS201	Ecology and Environmental Studies	2-0-0	Supportive Course	2	50
MBTS202	Clinical Data Management (CDM)	2-0-0	Supportive Course	2	50
MBTS203	Active Pharmaceutical Ingredient (API) Production	2-0-0	Supportive Course	2	50
MBTS281	Seminar-II	0-0-8	Skill Dev	4	100
	Total			**24**	**600**

SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat-Barrackpore Road, Bara Kanthalia, WB - 700121

School of Life Sciences

M.Sc. in Biotechnology

Programme Structure 2025

(As per UGC CBCS Template)

Semester – III

Course Code	Course Name	L-T-P	Course Type	Credits	Total Marks
MBTC301	Genomics	2-0-0	Core Course	2	50
MBTC391	Genomics Lab	0-0-4	Core Course	2	50
MBTC302	Proteomics and Protein Engineering	2-0-0	Core Course	2	50
MBTC392	Proteomics and Protein Engineering Lab	0-0-4	Core Course	2	50
MBTE301	A. Biological Imaging B. Application of AI/ML in Biology and Biopharma	4-0-0	Elective Course	4	100
MBTE302	A. Drug Discovery & Development B. Environmental Biotechnology	4-0-0	Elective Course	4	100
MBTS381	Summer Project	0-0-8	Supportive Course	4	100
MBTS382	Seminar-III	0-0-8	Skill Dev	4	100
	Total			**24**	**600**

SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat-Barrackpore Road, Bara Kanthalia, WB - 700121

School of Life Sciences

M.Sc. in Biotechnology

Programme Structure 2025

(As per UGC CBCS Template)

Semester – IV

Course Code	Course Name	L-T-P	Course Type	Credits	Total Marks
MBTC401	Bioprocess Engineering & Microbial Technology	4-0-0	Core Course	4	100
MBTC402	Plant Biotechnology	4-0-0	Core Course	4	100
MBTS492	Plant Biotechnology Lab	2-0-0	Supportive Course	2	50
MBTS401	Medical Scribing and Medical Coding	0-0-4	Supportive Course	2	50
MBTS402	Computational Aptitude & Bioinformatics	2-0-0	Supportive Course	2	50
MBTS492	Computational Aptitude & Bioinformatics Lab	0-0-4	Supportive Course	2	50
MBTS481	Summer Project	0-0-8	Supportive Course	4	100
MBTS482	Seminar-IV & Grand Viva	0-0-8	Supportive Course	4	100
	Total			**24**	**600**

Topics for Project/Dissertation for SEM-III & IV

1. Mushroom Hybrid Production & Cultivation Technology
2. Biofuel Production
3. Water Recycling and Irrigation
4. Microbial Technology
5. Bioprocess Technology
6. Enzymology
7. Metabolic Engineering
8. Plant Biotechnology
9. Molecular Breeding
10. Molecular Genetics
11. Economically Important Microbes and Applications
12. Industrial & Food Biotechnology
13. Animal Biotechnology
14. Nanobiotechnology
15. Cancer Genetics
16. Plant Diversity and Medicinal Applications
17. Plant Tissue Culture & Nursery Management
18. Bioengineering
19. Industrial Microbiology
20. Waste Management
21. Microbial Diversity
22. Entrepreneurship Development

Important features: Mandatory

Internal assessment and evaluation of each course will be made as per the University Standard.

SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat-Barrackpore Road, Bara Kanthalia, WB - 700121

School of Life Sciences

M.Sc. in Biotechnology

Programme Structure 2025

(As per UGC CBCS Template)

Detail Syllabus of Semester – I

Course Name: Cell Biology
Course Code: MBTC101
Contact: 2L
Credits: 2
Contact Hours: 24 Hours

Module-I [5H]
Membrane : membrane constituents- phospholipids, glycolipids, cholesterol, membrane proteins; receptors and phospholipases; Phospholipid bilayer- structure, asymmetry, fluid mozaic model of random diffusion of membrane components, domains in membranenatural and artificial membranes passive movements of solutes; membrane cytoskeleton.

Module-II [10H]
Transport: membrane transport of small molecules, carrier proteins and active membrane transport; ion channels; intracellular compartments and protein sorting; compartmentalization of cells;.transport of proteins into mitochondria and chloroplasts; peroxisomes; the endoplasmic reticulum. membrane anchorage of proteins. Vescicular traffic in the secretary and endocytic pathway; transport from the ER through the Golgi apparatus; transport from the Trans Golgi Network; Transport from Plasma membrane via Endosomes; endocytosis;transcytosis; transport from the Trans Golgi Network to the cell surface; Exocytosis; the molecular mechanisms of vesicular transport and maintenance of compartmental diversity.

Module-III [2H]
Cell signaling: signaling via G-protein-linked cell surface receptors; signaling via Enzymelinked cell surface.

Module-IV [2H]
Cytoskeleton: The nature of cytoskeleton; Intermediate Filaments; Microtubules; Cilia and Centrioles.

Module-V [2H]
Cell cycle and cell division- general strategies of the cell cycle; yeast and molecular genetics of cell- cycle control; cell-division control in multicellular animals .

Module-VI [3H]
Methods of studying the cell surface: re-constitutional studies; fluorescence assisted methods e.g. flow cytometry; membrane active peptides;

Course Name: Cell Biology Lab
Course Code: MBTC191
Contact: 4P
Credits: 2
Contact Hours: 48 Hours

1. Subcellular fractionations of tissue by centrifugation,
2. Microscopy: Bright field, Phase Contrast & Fluorescence.
3. Animal tissue culture,
4. Cell counting,

5. Cell viability,
6. Cell cycle by flow cytometer,
7. Immunofluorescence by florescence microscope and confocal microscope

Learning outcome:
1. Students will learn about various cellular aspects of different living organisms.
2. Students will learn different techniques to study the cellular organization of the biotic components of life.

Course Name: Enzymes & Reaction Kinetics
Course Code: MBTC102
Contact: 2L
Credits: 2
Contact Hours: 24 Hours

Module-I [4H]
Introduction: Nomenclature, classification, general properties isoenzyme, active site, substrate, coenzyme, cofactor.

Module-II [12H]
Enzyme kinetics: single and two substrate kinetics, deviation from linear kinetics; ligand binding studies; rapid kinetics; association and dissociation constants; use of isotopes in enzyme kinetics mechanism analysis; effect of pH, temperature and isotopically labeled substrates on enzyme activity;

Module-III [4H]
Enzyme regulation: allosteric model, substrate induced conformational change in enzyme.

Module-IV [4H]
Enzyme inhibitors: competitive, un-competitive and non-competitive inhibitors.

Course Name: Enzymes & Reaction Kinetics Lab
Course Code: MBTC192
Contact: 2P
Credits: 2
Contact Hours: 48 Hours

1. Qualitative tests for enzyme detection
2. Effects of pH on enzyme activity
3. Effects of temperature on enzyme activity
4. Determination of Unknown enzyme concentration
5. Determination of optimum enzyme concentration to identify Vmax
6. Determination of Km
7. Determination of Effects of inhibitors on enzyme
8. Determination of Effects Heavy metals on enzyme activity

Learning outcome:
1. Students will learn about different mechanism of enzyme kinetics.
2. Students will learn different regulatory mechanisms and modification systems related to enzyme activities and functions.

SWAMI VIVEKANANDA UNIVERSITY
Telinipara, Barasat-Barrackpore Road, Bara Kanthalia, WB - 700121
School of Life Sciences
M.Sc. in Biotechnology
Programme Structure 2025
(As per UGC CBCS Template)

Course Name: Molecular Biology
Course Code: MBTC103
Contact: 2L
Credits: 2
Contact Hours: 24 Hours

Module-I [4H]
DNA synthesis and their processing: General features and enzymology; detailed mechanisms of initiation, elongation and termination; experiments underlying each step and role of individual factors; telomerases: mechanism of replication, maintenance of integrity and role in cancer,

Module-II [8H]
DNA repair and recombination: factors affecting DNA bases, identification and molecular characterization of repair enzymes in photoreactivation, excision, recombination, and SOS pathways, recombination and transposition, models for homologous recombination- the Holliday, Meselson-Radding and RecBCD pathways and their experimental supports; meiotic recombination- mechanism, the double-stranded DNA breaks; site-specific recombination and transposition).

Module-III [8H]
RNA synthesis and their processing: RNA polymerase subunits, different sigma factors related to stress, viral infections etc., initiation, elongation and termination (rho dependent and independent) of RNA synthesis; anti-termination, attenuation and other influences of transnational apparatus on the process of transcription; eukaryotic promoters, enhancers, transcription factors, RNA polymerases; various protein motifs involved in DNA-protein interactions during transcription.

Module-IV [4H]
Protein synthesis and their processing: formation of initiation complex, initiation factors and regulation, elongation and elongation factors, termination, aminoacylation of tRNA, tRNAidentity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, post-translational modification of proteins.

Learning outcome:
1. Students will learn about the central dogma of life, which are the main aspects of metabolism.
2. Students will learn about the molecular mechanism of synthesis of nucleic acids and proteins.

Course Name: Biophysical Chemistry & Instrumentation
Course Code: MBTS104
Contact: 2L
Credits: 2
Contact Hours: 24 Hours

Module-I [8H]
Thermodynamics: extensive and intensive variables; mathematical description of a system with two or more variables, exact and partial differential; first law of thermodynamics, isothermal process, entropy and second law of thermodynamics, reversible and irreversible process, free energy and chemical potential; Gibb's free energy; Application of thermodynamics in biological systems.

Module-II [8H]
Spectroscopy Techniques: Principles and application following spectroscopy in biological systems: Absorption Spectroscopy (UV-visible), Fluorescence and Phosphorescence, Circular Dichroism (CD), Infrared spectroscopy (IR), Resonance Raman spectroscopy; Electron spin resonance (ESR),

Module-III [8H]
Instrumentation: Liquid Scintillation counter; pH meter; Ultracentrifuges, optical microscopy; phase, ultraviolet and interference microscope-their applications in cell biology; fluorescence microscope, confocal microscope, fluorescence activated cell sorter (FACS). Electron microscopy, scanning electron microscope, application of electron microscopy in cell and molecular biology; embedding and section cutting.

Course Name: Biophysical Chemistry & Instrumentation Lab
Course Code: MBTS194
Contact: 2P
Credits: 2
Contact Hours: 48 Hours

1. General laboratory practices and handling of instruments;
2. Training on centrifugation, microscopy and spectroscopy.

Learning outcome:
1. Students will learn about various techniques and instrumentation of important application-based methods.
2. Students will learn about different applications of thermodynamics in biological systems.

Course Name: Quality Assurance (QA) & Quality Control (QC)
Course Code: MBTS101
Contact: 2L
Credits: 2
Contact Hours: 24 Hours

Unit 1: Introduction to QA and QC (1 Credit)
- Definitions, Scope, and Importance of QA and QC in Biotech and Pharma
- Key Concepts: Good Manufacturing Practices (GMP), Good Laboratory Practices (GLP), and ISO Standards
- QA/QC Systems: Objectives, Components, and Workflow
- Risk Assessment and Management in Quality Processes

Unit 2: Regulatory Guidelines and Compliance (1 Credit)
- Overview of Regulatory Authorities: USFDA, EMA, CDSCO, WHO
- Regulatory Guidelines: ICH Q8, Q9, Q10, and Q11
- Documentation Practices: Standard Operating Procedures (SOPs), Batch Records, and Validation Protocols
- Audits and Inspections: Types, Preparation, and Handling Non-Compliance

Unit 3: Quality Control Techniques and Tools (1 Credit)
- Analytical Methods for QC: Chromatography (HPLC, GC), Spectroscopy (UV-Vis, FTIR), and Mass Spectrometry
- Microbial and Sterility Testing in Biotech Products

- Validation Techniques: Process, Analytical, and Cleaning Validation
- Statistical Tools for Quality Control: Six Sigma, Control Charts, and Process Capability Analysis

Unit 4: Applications and Case Studies (1 Credit)

- QA/QC in Biopharmaceuticals: Monoclonal Antibodies, Vaccines, and Biosimilars
- QA/QC in Food and Nutraceuticals: Standards and Testing
- Case Studies: Real-World Examples of Quality Failures and Lessons Learned
- Emerging Trends in QA/QC: AI in Quality Monitoring, Real-Time Release Testing (RTRT)

Learning Outcomes

Upon completing this course, students will:

1. Understand the fundamental principles of QA and QC in biotechnology and pharma.
2. Be familiar with global regulatory standards and their application in quality management.
3. Gain hands-on knowledge of QA/QC techniques and tools used in testing and validation.
4. Apply QA/QC principles to biomanufacturing processes and compliance audits.

Course Name: Microbiology
Course Code: MBTS102
Contact: 2L
Credits: 2
Contact Hours: 24 Hours

Module-I [6H]

Microbial world: Discovery and importance of microorganism in Biotechnology Role of microorganisms in transformation of organic matter and in the causation of diseases. Distribution and classification of bacteria, fungi, anaerobes, cyan bacteria and protozoa. Cultivation, propagation and preservation of microorganisms, sterilization and disinfectants.

Module-II [4H]

Methods in Microbiology: Pure culture techniques; Theory and practice of sterilization, principles of Microbial nutrition: Construction of culture media. Maintenance of microbial cultures of biotechnological importance. Causes of culture degeneration.

Module-III [4H]

Microbial Growth: The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; continuous culture; growth as affected environmental factors.

Module-IV [4H]

Bacterial cell structure and fine structure: Structure-function Cell walls of eubacteria (peptidoglycan) and related molecules, Outer-membrane of Gram negative bactreria, Cell wall and cell membrane synthesis, Flagella and motility, Cell inclusions like endospores capsules, slime layer pili. Quorum sensing and biofilm formation.

Module-V [2H]

Microbial Taxonomy: New approach to bacterial taxonomy and classification including ribotyping and rRNA sequencing.

Module-VI [2H]
Host-Parasite Relationships: Normal micro flora of skin: oral cavity, gastrointestinal tract. Entry of pathogens into the host; Colonization and factors predisposing to infections, Types of toxic (Exo- Endo-Entero-) and their structure, Mode of actions.

Module-VII [2H]
Chemotherapeutic Antibiotics: Antimicrobial agents, Sulfa drugs. Antibiotics Penicillin and cephalosporins. Board-spectrum antibiotics, mode of action of important antibiotics. Resistance to antibiotics.

Course Name: Microbiology Lab
Course Code: MBTS192
Contact: 2P
Credits: 2
Contact Hours: 48 Hours

1. Preparation of liquid and solid media for growth of microorganism,
2. Isolation and maintenance of organism by plating, streaking and serial dilution methods,
3. Slant and stab cultures,
4. Storage of microorganism.
5. Isolation of pure cultures,
6. Growth curve,
7. Microscopic examination of bacteria, yeast and molds,
8. Gram stain,
9. Assay of Antibiotics,
10. Microbiological analysis of drinking water.

Learning outcome:
1. Students will learn about the different microorganisms and their classification.
2. Students will learn about various techniques to study the characteristics of various microorganisms.

Course Name: Seminar-I
Course Code: MBTS181
Contact: 4P
Credits: 4
Contact Hours: 48 Hours

Students will present PowerPoint presentation of any topic having good impact to improve their presentation skills.

SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat-Barrackpore Road, Bara Kanthalia, WB - 700121

School of Life Sciences

M.Sc. in Biotechnology

Programme Structure 2025

(As per UGC CBCS Template)

Detail Syllabus of Semester – II

Course Name: Metabolism
Course Code: MBTC201
Contact: 2L
Credits: 2
Contact Hours: 24 Hours

Module-I [3H]
Carbon cycle, bioenergetics and metabolism.

Module-II [7H]
Carbohydrate metabolism: glycolysis, the citric acid cycle, the glyoxylate cycle, electron transport, oxidative phosphorylation and regulation of ATP production, the Cori Cycle, gluconeogenesis, glycogen metabolism and metabolism of different sugars.

Module-III [7H]
Membranes –its structure and role in ATP generation oxidative degradation of fatty acids and amino acids in animal tissues correlation between carbohydrate, amino acids and fatty and degradation,

Module-VI [7H]
Metabolism of nitrogen compounds protein turnover, metabolic regulation of enzymes, nitrogen fixation - mechanisms and control he nitrogen cycle as the source of cellular biosynthetic intermediates.

Course Name: Metabolism Lab
Course Code: MBTC291
Contact: 4P
Credits: 2
Contact Hours: 48 Hours

1. Estimation of cholesterol from blood,
2. Estimation of glucose from blood serum,
3. Alkaline phosphatase assay from blood serum,
4. Estimation of liver function test enzyme assay enzyme (SGPT & SGOT).

Learning outcome:
1. Students will learn about the metabolism of different important biomolecules.
2. Students will learn to estimate various biomolecules by different techniques.

Course Name: Recombinant DNA Technology
Course Code: MBTC202
Contact: 2L
Credits: 2
Contact Hours: 24 Hours

Module-I [7H]
Principles and methods of recombinant DNA technology- hybridization, cloning, sequencing, polymerase chain reaction, genome projects; gene manipulations; cloning in E.coli, plasmids, bacteriophages and cosmid vectors, cloning strategies, genomic and cDNA library; expression of cloned genes in E. coli, products made in E. coli by genetic engineering;

Module-II [7H]
Cloning in yeast: transformation in yeast, yeast vector development: Yep, YRp, YCp and YIp, 2m plasmid, yeast artificial chromosome (YAC), retrovirus like vector (Ty) in yeast/shuttle vector; features of yeast promoter and expression of cloned genes; yeast 2- hybrid system; plasmid shuffling to explore interactive domains of multimeric proteins; the cassette model for mating type switches and silencing of genes.

Module-III [10H]
Genetic engineering of plants: transformation of plants, manipulating gene expression in plants, selectable markers and reporter genes, Agrobacterium tumefaciens; Genetic elements present on the Ti plasmid, genetic engineering of the Ti plasmid, vectors used to introduce foreign DNA into plant cells- binary cloning vector, disarmed Ti plasmid, cointegrate cloning vector; comparison of methods for transfer of DNA to plants, manipulation of gene expression in plants; production of transgenic plants without reporter or marker genes

Course Name: Recombinant DNA Technology Lab
Course Code: MBTC292
Contact: 4P
Credits: 2
Contact Hours: 48 Hours

1. Isolation of plasmid DNA,
2. Transformation, restriction enzyme digestion, ligation ,
3. Southern blotting,
4. Northern blotting,
5. Overexpression of proteins,
6. PCR analysis,
7. Protein - DNA interactions.

Learning outcome:
1. Students will learn about the various aspects of recombinant DNA technology like cloning, sequencing etc.
2. Students will learn various techniques used to carry out the major biomolecule based reactions.

Course Name: Immunology
Course Code: MBTC203
Contact: 2L
Credits: 2
Contact Hours: 24 Hours

Module-I [8H]
Blood & Blood cells, Bone Marrow, Reticulo-Endothelial system & ABO Blood groups. Tissue fluid, Lymph, Lymphatics, Lymph nodes and Spleen. Cardiovascular System (Heart, ECG, Blood Pressure, Sino - Aortic mechanism, Regional & Capillary circulation.

Module-II [12H]
Immunoglobins, organization and expressions of Ig genes; B cell maturation, activation and differentiation; MHC/ HLA; antigen processing and presentation; T-cells, T-cell receptors, Tcell maturation, activation and differentiation; cytokines; cell mediated and humoral effector responses, auto immunity, immunodeficiency diseases, transplantation immunology, cancer and immune system.

Module-III [4H]
Monoclonal and polyclonal antibodies, monoclonal antibody technique.

Course Name: Immunology Lab
Course Code: MBTC293
Contact: 4P
Credits: 2
Contact Hours: 48 Hours

1. Blood film preparation and identification of cells,
2. Determination of blood groups,
3. Immuno-electrophoresis,
4. Western Blotting (Immuno-blotting),
5. Immunostaining/Immunofluorescence,
6. ELISA,
7. Immunodiagnostics (using commercial kits)

Learning outcome:
1. Students will learn about various aspects of immune system and their mechanism of action.
2. Students will learn different techniques of immunology to study antigen-antibody inerations.

Course Name: Biostatistics
Course Code: MBTC204
Contact: 2L
Credits: 2
Contact Hours: 24 Hours

Module-I [8H]
Probability and statistics; population, variables, collection, tabulation and graphical representation of data, frequency distribution, central tendency and skewness, binomial,

Module-II [8H]
Poisson and Gaussian distributions, additive and multiplicative laws of probability, concept and correlation; regression;

Module-III [8H]
Methods of least squares; chi-square tests, random number generation- testing and use; probability density and cumulative distribution function; systematic and random sampling.

Learning outcome:
1. Students will learn various methods of statistics required to implement in the field of biology.
2. Students will learn the quantitative analysis of experimental data through biostatistical methods.

Course Name: Ecology and Environmental Studies
Course Code: MBTS201
Contact: 2L
Credits: 2
Contact Hours: 24 Hours

SWAMI VIVEKANANDA UNIVERSITY
Telinipara, Barasat-Barrackpore Road, Bara Kanthalia, WB - 700121
School of Life Sciences
M.Sc. in Biotechnology
Programme Structure 2025
(As per UGC CBCS Template)

Module-I [4H]
Introduction to environmental studies: Multidisciplinary nature of environmental studies; Scope and importance; Concept of sustainability and sustainable development.

Module-II [3H]
Ecology and Ecosystems: Concept of ecology and ecosystem, Structure and function of ecosystem; Energy flow in an ecosystem; food chains, food webs; Basic concept of population and community ecology; ecological succession. Characteristic features of the following: a) Forest ecosystem b) Grassland ecosystem c) Desert ecosystem d) Aquatic ecosystems (ponds, streams, lakes, wetlands, rivers, oceans, estuaries).

Module-III [5H]
Biodiversity and Conservation: Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots, India as a mega-biodiversity nation; Endangered and endemic species of India, Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Module-IV [3H]
Environmental Pollution:
Environmental pollution: concepts and types, Air, water, soil, noise and marine pollutioncauses, effects and controls, Concept of hazards waste and human health risks • Solid waste management: Control measures of Municipal, biomedical and e-waste.

Module-V [4H]
Environmental Policies and Practices: Climate change, global warming, ozone layer depletion, acid rain and their impacts on human communities and agriculture Environment Laws: Wildlife Protection Act; Forest Conservation Act. Water (Prevention and control of Pollution) Act; Air (Prevention & Control of Pollution) Act; Environment Protection Act; Biodiversity Act. International agreements: Montreal Protocol, Kyoto protocol and climate negotiations; Convention on Biological Diversity (CBD). Protected area network, tribal populations and rights, and human wildlife conflicts in Indian context

Course Name: Clinical Data Management (CDM)
Course Code: MBTS202
Contact: 2L
Credits: 2
Contact Hours: 24 Hours

Unit 1: Introduction to Clinical Data Management (1 Credit)
- Definition and Importance of CDM
- Overview of Clinical Trials and CDM in the Drug Development Lifecycle
- Key Stakeholders: Sponsors, CROs, and Regulatory Authorities
- Standard Operating Procedures (SOPs) and Good Clinical Data Management Practices (GCDMP)

Unit 2: Regulatory Guidelines and Ethical Considerations (1 Credit)
- International Guidelines: ICH-GCP, US FDA, EMA, and Indian CDSCO
- Data Privacy and Protection: HIPAA, GDPR, and Indian IT Act
- Ethical Issues in Data Collection and Management

- Audits and Inspections in Clinical Data Management

Unit 3: CDM Process and Tools (1 Credit)
- Data Collection and Case Report Forms (CRFs): Design and Standards
- Data Entry and Validation: Processes and Best Practices
- Overview of CDM Systems and Software (e.g., Oracle Clinical, Medidata RAVE, EDC tools)
- Data Cleaning, Query Management, and Database Lock

Unit 4: Advanced Topics and Applications (1 Credit)
- Integration of CDM with Biostatistics and Data Analysis
- Handling Adverse Event Data and Serious Adverse Events (SAEs)
- Real-World Data (RWD) and Real-World Evidence (RWE)
- Emerging Trends: Artificial Intelligence and Machine Learning in CDM

Learning Outcomes: Upon completion of the course, students will be able to:
1. Design and implement a clinical data management plan for clinical trials.
2. Demonstrate proficiency in using CDM tools and software.
3. Ensure compliance with ethical and regulatory standards for data management.
4. Analyze clinical data and generate comprehensive reports for regulatory submissions.
5. Understand emerging technologies in CDM and their applications in clinical research.

Course Name: Active Pharmaceutical Ingredient (API) Production
Course Code: MBTS202
Contact: 2L
Credits: 2
Contact Hours: 24 Hours

Unit 1: Introduction to APIs and Manufacturing Processes (1 Credit)
- Definition and Classification of APIs: Small Molecules, Biologics, and Peptides
- Overview of API Manufacturing Workflows: Raw Material Procurement, Synthesis, and Purification
- Key Techniques: Chemical Synthesis, Biocatalysis, and Fermentation
- Role of APIs in Drug Development and Therapeutics

Unit 2: Process Development and Optimization (1 Credit)
- Principles of Process Design: Reaction Kinetics, Reactor Design, and Yield Optimization
- Scale-Up Considerations: Lab-Scale to Pilot-Scale and Commercial Production
- API Purification Techniques: Crystallization, Filtration, and Drying
- Process Analytical Technology (PAT) and Continuous Manufacturing

Unit 3: Quality Assurance, Regulatory Compliance, and Safety (1 Credit)
- Good Manufacturing Practices (GMP) in API Production
- Regulatory Requirements: USFDA, EMA, WHO, and ICH Guidelines
- Quality Assurance and Quality Control in API Manufacturing
- Safety and Environmental Considerations in API Production

Unit 4: Emerging Trends and Case Studies (1 Credit)

- Green Chemistry in API Manufacturing: Sustainable Processes and Waste Reduction
- AI and Machine Learning in API Process Optimization
- Biopharmaceutical APIs: Production of Monoclonal Antibodies, Vaccines, and Biosimilars
- Case Studies: Success Stories and Challenges in API Manufacturing

Learning Outcomes: Upon completing this course, students will:
1.Acquire knowledge of the science and engineering behind API production.
2.Understand process design, optimization, and scale-up in API manufacturing.
3.Demonstrate an understanding of quality assurance, compliance, and safety in API production.
4.Apply emerging technologies to optimize and innovate API production processes.

Course Name: Seminar-II
Course Code: MBTS281
Contact: 4P
Credits: 4
Contact Hours: 48 Hours

Students will present PowerPoint presentation of any topic having good impact to improve their presentation skills.

SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat-Barrackpore Road, Bara Kanthalia, WB - 700121

School of Life Sciences

M.Sc. in Biotechnology

Programme Structure 2025

(As per UGC CBCS Template)

Detail Syllabus of Semester – III

Course Name: Genomics
Course Code: MBTC301
Contact: 2L
Credits: 2
Contact Hours: 24 Hours

Module-I [8H]

Genomics: genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, chromosome microdissection,

Module-II [8H]

Molecular markers in genome analysis; RAPD and AFLP analysis, molecular markers linked to disease resistant genes, application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal etc. Genome sequencing: genome sizes, organelle genomes, genomic libraries, strategies for genome sequencing, packaging, transfectionand recovery of clones, application of sequence information for identification of defective genes.

Module-III [8H]

Pharmacogenetics, genetics of globin triplet repeat disorders, cancer genetics; immunogenetics; mapping of human genome; somatic cell genetics; DNA polymorphism in mapping; structure and function; biochemical genetics; polygenic inheritance, Microarray.

Course Name: Genomics Lab
Course Code: MBTC391
Contact: 4P
Credits: 2
Contact Hours: 48 Hours

1. analyze assembly of sequences
2. analysis of sequences from already sequenced genomes to annotate promoter, ORF, analyse putative promoters
3. show them yeast two hybrid screen
4. arrangement with established facility to learn the process of sequencing and annotation

Learning outcome:

1. Students will learn about various aspects of genomics and its applications.
2. Students will learn about different techniques for proper analysis and study of genome.

Course Name: Proteomics and Protein Engineering
Course Code: MBTC302
Contact: 2L
Credits: 2
Contact Hours: 24 Hours

Module-I [10H]

Proteomics: Sample preparation, Gel-based proteomics - two-dimensional gel electrophoresis (2-DGE), two-dimensional fluorescence difference in-gel electrophoresis (DIGE), Staining methods, PF-2D, Tandem FPLC, Mass spectroscopy: basic principle, ionization sources, mass analyzers, different types

of mass spectrometers (MALDI-TOF Q-TOF, LC-MS) Multidimensional proteomics: SELDI-TOF. Quantitative proteomics - stable isotope labeling by amino acids in cell culture (SILAC), isotope-coded affinity tag (ICAT), isobaric tagging for relative and absolute quantitation (iTRAQ); Label-free proteomics., Nuclear magnetic resonance spectroscopy (NMR), basic principles, chemical shift, spin-spin interaction, NOE, 2D-NMR, NOESY, COSEY.

Module-II [6H]
X- ray Crystallography: Principle of X-ray diffraction, scattering vector, structure factor, phase problem, reciprocal lattice and Ewald sphere, Miller indices, Zone axes, crystal lattice, Lane Equations, Bragg's law, special properties of protein crystals, model building, refinement and R-factor.

Module-III [8H]
Protein Engineering: Protein sources, Industrial and medical application of proteins, different expression of proteins for large scale purifications, protein engineering strategy, rational and random mutagenesis. Applications of protein engineering protein in Chemical and Medical Industries: Generation of heat stable, pH stable enzymes, application in vaccine development, drug development, sensor development.

Course Name: Proteomics and Protein Engineering Lab
Course Code: MBTC392
Contact: 4P
Credits: 2
Contact Hours: 48 Hours

1. Protein electrophoresis-1D+2D,
2. HPLC,
3. FPLC,
4. MALDI-TOF & LC-MS

Learning outcome:
1. Students will learn about different aspects of proteomics and its applications.
2. Students will learn about various techniques for protein estimation.

Course Name: Biological Imaging
Course Code: MBTE301A
Contact: 4L
Credits: 4
Contact Hours: 48 Hours

Module-I [10H]
Widefield fluorescent microscopy: One of the most basic techniques for live-cell imaging is widefield fluorescent microscopy. Standard inverted research grade microscopes can yield valuable results if you are imaging adherent cells, large regions of interest (such as organelles) or very thin tissue sections (less than 5 micrometer). In widefield, a CCD camera is usually used to capture images and the epi-fluorescence illumination source can be a mercury lamp, xenon lamp, LED's, etc. Each of light sources require carefully matched interference filters for specific excitation and emission wavelengths of your fluorophore of interest. With widefield microscopy, your specimen is only exposed to excitation light for relatively short time periods as the full aperture of emission light is collected by the objectives.

Widefield fluorescence microscopy can be used in combination with other common contrast techniques such as phase contrast and differential interference contract (DIC) microscopy. This combination is useful when performing live-cell imaging to examine general cell morphology or viability while also imaging regions of interest within cells.

Module-II [10H]

Confocal laser scanning microscopy (CLSM): CLSM has ability to eliminate out-of-focus light and information. It is also possible to obtain optical serial sections from thicker specimens. A conjugate pinhole in optical path of confocal microscope prevents fluorescence from outside of focal plane from being collected by photomultiplier detector or imaged by camera. In CLSM, a single pinhole (and single focused laser spot) is scanned across specimen by scanning system. This spot forms a reflected epifluorescence image back on original pinhole. When specimen is in focus, fluorescent light from it passes through pinhole to detector. Any out-of-focus light is defocused at pinhole and very little of this signal passes through to detector meaning that background fluorescence is greatly reduced. The pinhole acts as a spatial filter for emission light from the specimen.

Module-III [10H]

Spinning disc confocal microscopy (SDCM): This method utilises a 'Nipkow Disc' which is a mechanical opaque disc which has a series of thousands of drilled or etched pinholes arranged in a spiral pattern. Each illuminated pinhole on disc is imaged by microscope objective to a diffraction-limited spot on region of interest on specimen. The emission from fluorophores passes back though Nipkow disc pinholes and can be observed and captured by a CCD camera. The effect of spinning disc is that many thousands of points on specimen are simultaneously illuminated. Using SDCM to examine a specimen means that real-time imaging (30-frames-per-second or faster) can be achieved, which is extremely useful if you are looking at dynamic changes within living cells over a wide spectrum of time-scales.

Module-IV [8H]

Light-sheet fluorescence microscopy (LSFM, or SPIM): This method enables one to perform live-cell imaging on whole embryos, tissues and cell spheroids in vivo in a gentle manner with high temporal resolution and in three dimensions. One is able to track cell movement over extended periods of time and follow development of organs and tissues on a cellular level. The next evolution of light-sheet fluorescence microscopy, termed lattice light-sheet microscopy as developed by Eric Betzig (Nobel Prize Laureate 2014 for PALM super-resolution microscopy) will even allow live-cell imaging with super-resolved in vivo cellular localization capabilities.

Module-V [6H]

Super-resolved fluorescence microscopy: Super-Resolution in a Standard Microscope: From Fast Fluorescence Imaging to Molecular Diffusion Laws in Live Cells; Photoswitching Fluorophores in Super Resolution Fluorescence Microscopy; Image Analysis for Single-Molecule Localization Microscopy Deconvolution of Nanoscopic Images; Super-Resolution Fluorescence Microscopy of the Nanoscale Organization in cells; Correlative Live-Cell and SuperResolution Microscopy and Its Biological Applications; SAX Microscopy and Its Application to Imaging of 3D-Cultured Cells; Quantitative Super-Resolution Microscopy for Cancer Biology and Medicine.

Module-VI [4H]

Re-scan confocal microscopy: Structured Illumination Microscopy; Correlative Nanoscopy: AFM Super-Resolution (STED/STORM); Stochastic Optical Fluctuation Imaging.

SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat-Barrackpore Road, Bara Kanthalia, WB - 700121

School of Life Sciences

M.Sc. in Biotechnology

Programme Structure 2025

(As per UGC CBCS Template)

Learning outcome:

1. Students will learn about various imaging techniques for characterization of biomolecules.
2. Students will learn various methods for studying morphology and other details of various biomolecules.

Course Name: Application of AI / ML in Biology and Biopharma
Course Code: MBTE301B
Contact: 4L
Credits: 4
Contact Hours: 48 Hours

Unit 1: Fundamentals of AI/ML in Biology (1 Credit)

- Introduction to AI and ML: Definitions, Types (Supervised, Unsupervised, Reinforcement Learning)
- Key Concepts: Neural Networks, Deep Learning, and Natural Language Processing (NLP)
- Biological Data Types: Genomic, Transcriptomic, Proteomic, and Clinical Data
- Overview of AI/ML Tools: Python Libraries (Scikit-learn, TensorFlow, PyTorch), R Programming

Unit 2: AI/ML in Drug Discovery and Development (1 Credit)

- Applications in Drug Target Identification and Validation
- AI in Virtual Screening, Molecular Docking, and ADMET Prediction
- Accelerating Drug Discovery Pipelines with Generative AI Models
- Case Studies: AI-Driven Drug Development (e.g., AlphaFold, BenevolentAI)

Unit 3: AI/ML in Biopharma Process Optimization (1 Credit)

- Process Monitoring and Optimization in Bioreactors
- Predictive Models for Yield Optimization and Quality Control
- AI in Supply Chain and Manufacturing Processes
- Integration of AI in Biopharma 4.0 Frameworks

Unit 4: Emerging Trends and Ethical Considerations (1 Credit)

- AI in Personalized Medicine and Precision Therapeutics
- Role of AI/ML in Synthetic Biology and Genetic Engineering
- Challenges in Data Privacy, Bias, and Interpretability in AI/ML Models
- Regulatory and Ethical Guidelines for AI Applications in Biopharma

Learning Outcomes

Upon completion of this course, students will:

1.Understand the principles of AI/ML and their applications in biology and biopharma.
2.Develop skills to analyze biological data using AI/ML techniques.
3.Apply AI/ML models to real-world problems in drug discovery and biopharma process optimization.
4.Critically evaluate ethical and regulatory considerations in AI/ML applications.

SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat-Barrackpore Road, Bara Kanthalia, WB - 700121

School of Life Sciences

M.Sc. in Biotechnology

Programme Structure 2025

(As per UGC CBCS Template)

Course Name: Drug Discovery & Development
Course Code: MBTE302A
Contact: 4L
Credits: 4
Contact Hours: 48 Hours

Module-I [10H]

Target identification and molecular modelling: Identification of target or drug leads associated with a particular disease by a number of different techniques including combinations of molecular modeling, combinatorial libraries and high-throughput screening (HTS); Conceptualizing the automation of the HTS process and the importance of bioinformatics and data processing in identification of lead compounds; Rational drug design, based on understanding the three-dimensional structures and physicochemical properties of drugs and receptors; Modelling drug/ receptor interactions with the emphasis on molecular mechanisms, molecular dynamics simulations and homology modelling; Conformational sampling, macromolecular folding, structural bioinformatics, receptor-based and ligand-based design and docking methods, in silico screening of libraries, semi-empirical and ab-initio methods, QSAR methods, molecular diversity, design of combinatorial libraries of drug-like molecules, macromolecular and chemical databases.

Module-II [8H]

Lead optimization: Identification of relevant groups on a molecule that interact with a receptor and are responsible for biological activity; Understanding structure activity relationship; Structure modification to increase potency and therapeutic index; Concept of quantitative drug design using Quantitative structure–activity relationship models (QSAR models) based on the fact that the biological properties of a compound are a function of its physicochemical parameters such as solubility, lipophilicity, electronic effects, ionization, stereochemistry, etc.; Bioanalytical assay development in support of in vitro and in vivo studies (LC/MS/MS, GC/MS and ELISA).

Module-III [8H]

Preclinical development: Principles of drug absorption, drug metabolism and distribution - intestinal absorption, metabolic stability, drug-drug interactions, plasma protein binding assays, metabolite profile studies, Principles of toxicology, Experimental design for preclinical and clinical PK/PD/TK studies, Selection of animal model; Regulatory guidelines for preclinical PK/ PD/TK studies; Scope of GLP, SOP for conduct of clinical & non clinical testing, control on animal house, report preparation and documentation Integration of non-clinical and preclinical data to aid design of clinical studies.

Module-IV [6H]

Drug manufacturing: Requirements of GMP implementation, Documentation of GMP practices, CoA, Regulatory certification of GMP, Quality control and Quality assurance, concept and philosophy of TQM, ICH and ISO 9000; ICH guidelines for Manufacturing, Understanding Impurity Qualification Data, Stability Studies.

Module-V [6H]

Clinical trial design: Objectives of Phase I, II, III and IV clinical studies, Clinical study design, enrollment, sites and documentation, Clinical safety studies: Adverse events and adverse drug reactions, Clinical PK, pharmacology, drug-drug interaction studies, Statistical analysis and documentation.

Module-VI [10H]
Fundamentals of regulatory affairs and bioethics: Global Regulatory Affairs and different steps involved, Regulatory Objectives, Regulatory Agencies; FDA guidelines on IND and NDA submissions, Studies required for IND and NDA submissions for oncology, HIV, cardiovascular indications, On-label vs. off-label drug use GCP and Requirements of GCP Compliance, Ethical issues and Compliance to current ethical guidelines, Ethical Committees and their set up, Animal Ethical issues and compliance.

Learning outcome:
1. Students will learn about various aspects of drug discovery and development.
2. Students will study various clinical trial designs and clinical safety designs.

Course Name: Environmental Biotechnology
Course Code: MBTE302B
Contact: 4L
Credits: 4
Contact Hours: 48 Hours

Module-I [10H]
Introduction to environment: Introduction to environment; pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes; strain improvement; Biodiversity and its conservation; Role of microorganisms in geochemical cycles; microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, relevant microbiological processes, microbial ecology.

Module-III [8H]
Role of microorganism- isms in bioremediation: Application of bacteria and fungi in bioremediation: White rot fungi vs specialized degrading bacteria: examples, uses and advantages vs disadvantages; Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltration phytostabilization).

Module-IV [10H]
Biotechnology and agriculture: Bioinsecticides: Bacillus thuringiensis, Baculoviruses, uses, genetic modifications and aspects of safety in their use; Biofungicides: Description of mode of actions and mechanisms (e.g. Trichoderma, Pseudomonas fluorescens); Biofertilizers: Symbiotic systems between plants – microorganisms (nitrogen fixing symbiosis, mycorrhiza fungi symbiosis), Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application.

Module-V [12H]
Biofuels: Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifiers; Paper production: use of xylanases and white rot fungi.

Learning outcome:
1. Students will learn various biotechnological application related to environment.
2. Students will study different principles of important processes related to environment like biodegradation, biofuels etc.

SWAMI VIVEKANANDA UNIVERSITY
Telinipara, Barasat-Barrackpore Road, Bara Kanthalia, WB - 700121
School of Life Sciences
M.Sc. in Biotechnology
Programme Structure 2025
(As per UGC CBCS Template)

Course Name: Summer Project
Course Code: MBTS381
Contact: 8P
Credits: 4
Contact Hours: 96 Hours

Students will submit the project proposal and synopsis to the departmental HOD or project coordinator. Initial classes will be on selection of topics, supervisor/guide, template for project proposal writing etc. Students may start actual lab/theory work in due course.

Course Name: Seminar-III
Course Code: MBTS382
Contact: 8P
Credits: 4
Contact Hours: 48 Hours

Students will present PowerPoint presentation of any topic having good impact to improve their presentation skills.

SWAMI VIVEKANANDA UNIVERSITY

Telinipara, Barasat-Barrackpore Road, Bara Kanthalia, WB - 700121

School of Life Sciences

M.Sc. in Biotechnology

Programme Structure 2025

(As per UGC CBCS Template)

Detail Syllabus of Semester – IV

Course Name: Bioprocess Engineering & Microbial Technology
Course Code: MBTC401
Contact: 4L
Credits: 4
Contact Hours: 48 Hours

Module-I [14H]

Introduction to Bioprocess Engineering: Bioreactors and membrane Bioreactors and Membrane Bioreactors, Isolation Preservation and Maintenance of Industrial Microorganisms, Kinetics of microbial growth and death, Media and medial sterilization for Industrial Fermentation, Air quality Management and Air sterilization, Types of fermentation processes. Analysis of batch, Fedbatch and continuous bioreactors, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed fluidized, photobioreactors etc). Fermentation kinetic and monitoring, Measurement and control of bioprocess parameters.

Module-II [20H]

Downstream processing: Introduction, Removal of microbial cells and solid matter, foam reparation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process. Drying and crystallization, Effluent treatment D.O.C. and C.O.D. treatment and disposal of effluents. Whole cell Immobilization and their Industrial Applications, Immobilized enzymes in aqueous and non-aqueous media, bioconversion and Biotransformation. Industrial Production of chemicals: Alcohol (ethanol). Acids (citric, acetic and gluconic), Solvents (glycerol, acetone, butanon), Antibiotics (penicillin, streptomycinl, tetracy6cline), microlodes, anticancer antibiotic, Amino acids (lysine, glutamic acid), Single Cell Protein, single Cell Lipids. Use of microbes in mineral beneficiation and oil recovery. Introduction to Food technology elementary idea of canning and packin-Fat-Based Edible products, Sterilization and Pasteurization of food Products. Fast-based Nutraceuticals Technology of Typical Food/ food products (bread, cheese, idli, Agro-products (oilseeds) Food preservation, Food colors, Flavors, and Antioxidants. Introduction to Bioprocesses Technology, Hydrogenation, Oxidation, Esterification, Polymerization, Introduction of Microbial Biotechnology-Fine Chemicals (e.g. Biosurfactants, Spirulina, Yeast), oleo chemicals (Fatty acids, Glycerol, Methol-petrochemicals-perfumery chemicals Drugs and pharmaceuticals.

Module-III [14H]

Biology of Industrial Microorganisms: (Saccharomyces, Aspergillus, penicillia, spore forming bacteria etc); Idea of Fermentation, Cell growth, Regulation of Metabolism, Substrate Assimilation/Product Secretion.; Different fermentative system; Batch and Continuous Process, Fermentor Design, Surface and submerged liquid substrate fermentation; Solid Substrate Fermentations, Fermentation raw materials, Downstream processing, Bio-mass production (alcohol, lactic acid, cheese making, bread making, soya based foods, meat fermentation, vinegar, industrial chemical, bio-polymer, bioinsecticides, food additive (amino acids, nucleosides, vitamins, fats and oils), health care products (antibiotics, steroids, vaccines), Production of Industrial solvents (alcohol, acetone, butanol etc.); Industrial Enzymes (amylase, proteases, lipases), concepts of immobilized enzymes.

SWAMI VIVEKANANDA UNIVERSITY
Telinipara, Barasat-Barrackpore Road, Bara Kanthalia, WB - 700121
School of Life Sciences
M.Sc. in Biotechnology
Programme Structure 2025
(As per UGC CBCS Template)

Learning outcome:
1. Students will learn about different principles and methods of bioprocess control and engineering.
2. Students will learn various mechanisms and principles of microbial technology.

Course Name: Plant Biotechnology
Course Code: MBTC402
Contact: 2L
Credits: 2
Contact Hours: 24 Hours

Module-I [6H]
Plant cell tissue and organ cultures: Introduction to cell and tissue culture techniques; tot potency; Morphogenesis in vitro; Organogenesis and somatic embryogenesis; Micropropagation and clonal propagation. Synthetic seeds; Germplasm preservation in vitro; Production of haploids and triploids (anther, microspore and endosperm culture); Protoplast culture and somatic hybridization; nuclear and cytoplasmic hybrids. Somaclonal variation in plant cell culture and regenerated plants; Cryopreservation and germplasm conservation

Module-II [10H]
Transgenic plant technology: Gene transfer (vertical) by classical methods; horizontal gene transfer; methods of genetic transformation in plants; methods of nuclear transformation; Organelle transformation; advantages; Direct transformation of plant systems using physical methods; Agrobacterium mediated plant transformation; manipulating gene expression in plants, selectable markers and reporter genes, Agrobacterium tumefaciens; Genetic elements present on the Ti plasmid, genetic engineering of the Ti plasmid, vectors used to introduce foreign DNA into plant cellsbinary cloning vector, disarmed Ti plasmid, cointegrate cloning vector; comparison of methods for transfer of DNA to plants, manipulation of gene expression in plants; production of transgenic plants without reporter or marker genes.

Module-III [8H]
Application of plant transformation for productivity and performance: Herbicide resistance; Insect resistance; Bt genes; long shelf life of fruits and flowers; molecular farming, benefits and risks; Transgene stability and gene silencing; Strategies to avoid gene silencing and improve gene expression in transgenic plants; ethics and plant genetic engineering; metabolic engineering and industrial products; plant secondary metabolites, control mechanisms and manipulations of phenylpropanoid pathway; alkaloids etc.

Course Name: Plant Biotechnology Lab
Course Code: MBTC492
Contact: 4P
Credits: 2
Contact Hours: 48 Hours

1. Basic techniques in plant cell, tissue and organ culture;
2. Excised embryo culture;
3. Organogenesis and somatic embryogenesis;
4. Stages of micro propagation;

5. Callus and cell suspension culture;
6. Isolation and culture of protoplasts;
7. Basic techniques in genetic transformation in plants;
8. Transformation with wild type and disarmed strains of Agrobacterium.

Learning outcome:
1. Students will learn different principles of plant transformation and its applications.
2. Students will learn different techniques of plant biotechnology.

Course Name: Medical Scribing & Medical Coding
Course Code: MBTS401
Contact: 4L
Credits: 4
Contact Hours: 48 Hours

Unit 1: Fundamentals of Medical Scribing (1 Credit)
- Introduction to Medical Scribing: Role and Responsibilities
- Anatomy and Physiology Overview for Medical Scribes
- Medical Terminology and Abbreviations
- Electronic Health Records (EHRs): Systems and Workflow
- Real-Time Medical Documentation: Patient History, Symptoms, and Treatments

Unit 2: Principles of Medical Coding (1 Credit)
- Overview of Medical Coding: Purpose and Applications
- ICD-10-CM and ICD-11 Coding: Structure and Guidelines
- CPT and HCPCS: Procedure and Services Coding
- Coding for Different Specialties: Cardiology, Orthopedics, Oncology, etc.
- Error Minimization and Quality Assurance in Coding

Unit 3: Technology and Software in Medical Scribing and Coding (1 Credit)
- Introduction to Medical Scribing Tools and Transcription Software
- Coding Software Platforms: 3M CodeFinder, EncoderPro, etc.
- Integration of Artificial Intelligence and Automation in Scribing and Coding
- Data Security and Confidentiality in Medical Records
- Case Studies: Implementing Technology in Real-Life Scenarios

Unit 4: Ethical, Legal, and Regulatory Aspects (1 Credit)
- Health Insurance Portability and Accountability Act (HIPAA) Compliance
- Documentation Standards and Legal Considerations in Medical Records
- Billing and Reimbursement Processes in Healthcare
- Ethical Issues in Medical Scribing and Coding
- Global Coding Standards: Regional Variations and Challenges

Learning Outcomes
By the end of this course, students will:

1.Develop the ability to document medical encounters accurately and efficiently.
2.Gain competency in using ICD, CPT, and HCPCS coding systems for various medical procedures and diagnoses.
3.Demonstrate proficiency in medical coding software and EHR systems.
4.Understand the ethical and regulatory requirements for handling medical data.
5.Be prepared for careers in medical scribing, coding, and related roles in healthcare and

biotech industries.

Course Name: Computational Aptitude & Bioinformatics
Course Code: MBTS402
Contact: 2L
Credits: 2
Contact Hours: 24 Hours

Module-I [2H]
Concept of homology, paralogy, orthology, analogy and xenology

Module-II [8H]
Comparison of sequences of biological macromolecules – Pairwise alignment: local and global alignment; Concept of indel, affine gap penalty; Database search algorithm, significance of hits, Karlin Altschul equation; Multiple sequence alignment, concept of consensus, interpretation with regular expression, concept of protein profile and PSSM, algorithm of PSI-BLAST

Module-III [6H]
Concept of tree, reading and interpreting phylogenetic trees, distance-based and character-based methods for the construction of phylogenetic trees, judging strength of clades (with BS or PP values) in a tree.

Module-IV [4H]
Kyte-Doolittle plot and Hopp-Woods plot- prediction of localization of a protein, prediction of TMD

Module-V [4H]
Secondary, tertiary and quaternary structure prediction –concept of propensity in ChouFasman method; Homology modeling, threading and ab initio method; Docking – rigid and flexible, protein-protein and protein-ligand.

Module-VI: Introduction to Computational Thinking (1 Credit)
•Basics of Computational Thinking: Logical Reasoning and Problem-Solving
•Algorithm Design: Steps in Problem Formulation and Solution Design
•Understanding Flowcharts and Pseudocode for Logical Representation
•Applications of Computational Thinking in Biotechnology

Module-VII: Programming Fundamentals (1 Credit)
•Introduction to Programming Languages: Python and R
•Basic Syntax, Variables, Data Types, and Operators
•Control Structures: Loops (for, while) and Conditional Statements (if-else)
•Functions, Modules, and Libraries for Efficient Coding

Module-VIII: Algorithms and Data Structures (1 Credit)
•Fundamental Algorithms: Sorting, Searching, and Recursion
•Data Structures: Arrays, Lists, Dictionaries, and Stacks
•Algorithm Optimization: Time and Space Complexity
•Case Studies: Biological Sequence Alignment and Phylogenetic Tree Construction
Module-IX: Applications in Biotechnology (1 Credit)
•Data Analysis and Visualization using Python and R

•Applications in Genomics and Proteomics: Sequence Analysis and Protein Modeling
•Introduction to Machine Learning: Basics of Supervised and Unsupervised Learning
•Tools for Computational Biology: Biopython, BioPerl, and R Bioconductor

Course Name: Computational Aptitude & Bioinformatics Lab
Course Code: MBTS492
Contact: 4P
Credits: 2
Contact Hours: 48 Hours

1. Pairwise alignment- local and global alignment using Smith-Waterman and Needleman-Wunsch algorithm respectively. Comparison of the results with reference to percentage identity, percentage gaps.
2. Comparison of the different BLOSUM matrices.
3. Cross dot plot to identify regions of similarity/identity and self-dot plot to identify repeats.
4. Two BLAST searches - one using a house keeping protein and another using a rare protein and comparison of the results.
5. Study of the CATH and SCOP database to write a report followed by classification of a given protein.
6. Hydropathy plot of a globular and a membrane protein followed by a comparison of the two plots
7. Identification of consensus sequence through multiple sequence alignment
8. Using the multiple sequence alignment for the construction of phylogenetic tree

Learning outcome:
1. Students will learn structure-function studies of biomolecular mechanism.
2. Students will learn various bioinformatic tools for characterization of important biomolecules.

Course Name: Summer Project
Course Code: MBTS481
Contact: 8P
Credits: 4
Contact Hours: 96 Hours
Students will completely utilize the credit hours in lab work to finish their summer project.

Course Name: Seminar-IV & Grand Viva
Course Code: MBTS482
Contact: 4P
Credits: 4
Contact Hours: 48 Hours
Students will present PowerPoint presentation of their project details and followed by viva voce.