BANARAS HINDU UNIVERSITY
SCHOOL OF BIOTECHNIOLOGY
M.Sc. Biotechnology (4 Semesters)
(Effective from 2018-2019 session onwards)
OUTLINE OF THE SYLLABUS

Semester I:

Course Code	Subject	Number of Credits
BTM101	Microbiology	3
BTM102	Biochemistry & Biophysics	3
BTM103	Cell Biology	3
BTM104	Genetics and Molecular Biology	3
BTM105	Practical: Based on BTM101, BTM102, BTM 103 and BTM104	8
	Total	**20**

Semester II:

BTM201	Enzymology & Enzyme Technology	3
BTM202	Genetic Engineering	3
BTM203	Immunology	3
BTM204	Plant Biotechnology	3
BTM205	Practical : Based on BTM201, BTM202 BTM203 and BTM204	8
*BTM206 S	MOOCs course to be selected/opted from SWAYAM portal (SWAYAM-BIOTECH-1)	2
	Total	**22**

Semester III:

BTM301	Animal Cell Culture	3
BTM302	Environmental Biotechnology	3
BTM303	Practical : Based on BTM301 and BTM302	4
BTM304	Research Project: Review & Lab. Techniques and Seminar	8
*BTM305 S	MOOCs course to be selected/opted from SWAYAM portal (SWAYAM-BIOTECH-II)	2
	Total	**20**

Semester IV:

BTM401	Bioprocess Engineering & Technology	3
BTM402	Bioinformatics & Biostatistics	3
BTM403	Practical: Based on BTM401 and BTM402	4
BTM404	Research Project : Project works-Dissertation and Seminar	8
	Total	**18**
	Total Credits of 4 Semesters	**80**

*M.Sc. Biotechnology students will select Massive Open Online Course (MOOCs)-SWAYAM course in the II and III semester available at http://ugcmoocs.inflibnet.ac.in/courses.php in consultation with Coordinator.

Semester I

BTM 101: Microbiology **Credits 3**

1. Microbiolog; History, different branches of microbiology
2. Microbial world; Brief account of bacteria, Cyanobacteria, Rickettsias, Mycoplasmas and Archaebacteria
3. Cultivation of Bacteria; Isolation, Purification, Enrichment techniques and maintenance. Culture Collection
4. Growth: Phases of growth, measurement and growth yield
5. Identification of bacteria; Nomenclature, classification- new approaches including molecular parameters (16S rRNA sequencing and phylogentic tree)
6. Modes of Nutrition: sources and mode of nitrate reduction, nitrifying and denitrifying bacteria, Biological N_2 fixation and microbes used as bifertilizer
7. Viruses: Classification, morphology and composition of viruses in general, viroids and prions
8. Extremophilic microbes-their biotechnological potentials. Microbes-role in human welfare

BTM102 : Biochemistry & Biophysics **Credits 3**

1. Carbohydrates; Glycolysis, Gluconeogenesis, Krebs' Cycle, Electron transport chain, Oxidative Phosphorylation
2. Fatty acids; general properties and ß- oxidation
3. Amino acids (general properties); Amino acid sequencing and composition; end group analysis
4. Proteins: Protein structure (primary, secondary, tertiary & quartenary), Globular, Fibrous proteins; Ramachandran plot, Circular Dichroism, Hydrophobic and hydrophilic interactions. PAGE, SDS-PAGE, Diagonal Electrophoresis, MALDI.
5. Protein folding (Introduction / Tools to study folding – unfolding phenomenon)

BTM 103: Cell Biology **Credits 3**

1. Cell membranes: methods to study organization of membranes
2. Transport across biomembranes: facilitated transport, group translocation, Active transport, Na+-K+ATPase pump
3. Cytoskeleton: Composition, organization and functions of Microfilaments, microtubules, intermediate filaments and associated proteins
4. Basic concept of signal transduction
5. Cell adhesion; cell junctions, cell adhesion molecules.
6. Cell cycle and its control
7. Biology of cancer cells and process of oncogenesis

BTM 104: Genetics and Molecular Biology **Credits 3**

1. Introduction to cell division, Mendelian Laws and physical basis of inheritance, dominance and its molecular basis
2. Basics of gene interaction, cis-trans-test and complementation test, lethal genes, polygenic traits, linkage and gene maps
3. DNA double helix: Physico-chemical considerations
4. Organization of prokaryotic and eukaryotic genomes, supercoiling, repetitive DNA
5. DNA replication: Mechanism of replication of Prokaryotic & Eukaryotic Chromosome
6. Mutation: Types and molecular mechanisms of mutations, mutagens, DNA Repair
7. Transposition: Mechanisms of transposition, transposon mutagenesis
8. Recombination: Homologous and site - specific recombination
9. Gene expression in eukaryotes: Transcription, general and specific transcription factors, regulatory elements and mechanism of regulation, processing of transcripts
10. Gene expression in bacteria: Transcription and its regulation; operons, attenuation, anti-termination and anti-sense controls
11. Prokaryotic translation machinery, mechanism and regulation of translation, Post translational modifications

BTM 105 : Practical Course No. 105:
Based on BTM101, BTM102, BTM 103 and BTM104 **Credits 8**

Semester II

BTM 201: Enzymology & Enzyme Technology **Credits 3**

1. History
2. Classification and nomenclature of enzymes
3. Isolation and purification of enzymes
4. Coenzymes and Cofactors
5. Steady state kinetics: Methods for estimation of rate of enzyme catalyzed reaction with special reference to Michaelis-Menten equation. Effects of substrate, temperature, pH and inhibitors on enzyme activity and stability
6. Active site, chemical modification and regulation (Zymogens and Isozymes)
7. Enzyme engineering
8. Immobilization of Enzymes and cells

BTM 202: Genetic Engineering **Credits 3**

1. Restriction endonucleases, Modification methylases and other enzymes needed in genetic engineering
2. Cloning vectors: Plasmids and plasmid vectors, Phages and Phage Vectors, phagemids, cosmids, artificial chromosome vectors (YAC, BAC), Animal virus derived vectors - SV40 and retroviral vectors
3. Molecular cloning: Chromosomal DNA isolation (Animal, Plant and Bacteria), Transformation, construction of genomic DNA and cDNA libraries, screening of recombinants, Recombinant DNA techniques
4. Expression strategies for heterologous genes
5. DNA analysis: labeling of DNA and RNA probes. Southern and fluorescence *in situ* hybridization, DNA fingerprinting
6. Techniques for gene expression: Northern and Western blotting, gel retardation technique, DNA footprinting, Primer extension, Sl mapping, Reporter assays.
7. Sequencing of DNA, chemical synthesis of oligonucleotides; techniques of site-directed mutagenesis, gene replacement and gene targeting
8. Polymerase chain reaction and its applications
9. Applications of genetic engineering: Transgenic animals, production of recombinant pharmaceuticals, gene therapy, disease diagnosis
10. Biosafety regulation: Physical and biological containment

BTM 203: Immunology **Credits 3**

1. History of immunology
2. Nature of antigens, Antibody structure and function,Antigen - antibody reactions and applications
3. Major histocompatibility complex
4. Complement system
5. Activation of B and T-lymphocytes, Immunological tolerance.
6. Cell-mediated cytotoxicity: Mechanism of cytotoxic T cells and NK cells mediated target cell lysis, Antibody dependent cell-mediated cytotoxicity, macrophages mediated cytotoxicity
7. Hypersensitivity
8. Autoimmunity
9. Transplantation

BTM 204: Plant Biotechnology **Credits 3**

1. Tissue culture media, Initiation and maintenance of callus and suspension cultures; single cell clones
2. Totipotency: Organoganesis; somatic embryogenesis; transfer and establishment of whole plants in soil (hardening)

3. Rapid clonal propagation and production of virus -free plants
4. *In vitro* pollination; embryo culture and embryo rescue
5. Protoplast fusion, selection of hybrid cells; symmetric and asymmetric hybrids, cybrids
6. Nuclear cytology of cultured plant cells and somaclonal variations
7. Production of haploid plants and their utilization
8. Cryopreservation and slow growth for germplasm conservation.
9. Production of Biochemicals from cells and tissue cultures
10. Biochemical production
11. Gene transfer in nuclear genome and chloroplasts; *Agrobacterium*-mediated gene transfer, direct gene transfer, antibiotic marker-free transgenics
12. Transgenic plants: insect resistance, virus resistance, abiotic stress tolerance, longer shelf life (including strategies for suppression of endogenous genes), male sterility, enhanced nutrition (golden rice), edible vaccines, patent and IPR
13. Molecular markers: RFLP, RAPD, AFLP, applications of molecular markers, SNP

BTM 205: Practical Course No. 205:
Based on BTM201, BTM202, BTM 203 and BTM204 **Credits 8**

BTM 206 S : SWAYAM-BIOTECH-I **Credits 2**
(Course to be selected/opted from UGC-SWAYAM portal)

Semester III

BTM 301: Animal Cell Culture **Credits 3**

1. Introduction to the balanced salt solutions and simple growth medium. Chemical, physical and metabolic functions of different constituents of culture medium
2. Basic techniques of mammalian cell cultures *in vitro*
3. Organ, organotypic and histotypic cultures
4. Serum & protein free defined media and their applications
5. Measurements of growth, viability and cytotoxicity
6. Cell synchronization and transformation
7. Applications of animal cell culture including stem cell applications

BTM 302: Environmental Biotechnology **Credits 3**

1. Environment: Basic concepts; Environmental pollution; Types of pollution; Measurement of pollution and environmental management
2. Wastewater Treatment- Basic concept, Primary & secondary treatment, Suspended and attached culture, Trickling, Rotating and biological contactors, Nitrogen and phosphorus removal, Ponds systems
3. Water Pollution and its control: Water as a resource; Water bodies; Need for water management; Sources and Measurement of water pollution, Waste water treatment-basic concepts; Physicochemical and biological treatment processes
4. Tertiary treatment; Disinfection and disposal
5. Biological treatment processes: Biochemistry and microbiology of aerobic and anaerobic treatment processes; Suspended and attached growth type aerobic processes- activated sludge, Oxidation ditch, Aerated lagoons, Oxidation ponds and their variations
6. Anaerobic processes- Anaerobic digesters, Fixed and fluidized types of anaerobic bioreactors, UASB bioreactors, Treatment of typical industrial effluents- Diary, distillery, sugar, and antibiotic industries
7. Global environmental problems; Ozone depletion, UV-B radiation and green house gases
8. Brief account of bioremediation

BTM 303: Practical Course No. 303:
Based on BTM301 and BTM302 **Credits 4**

BTM 304: Research Project: Review & Lab. Techniques and seminar **Credits 8**

BTM 305 S : SWAYAM-BIOTECH-II **Credits 2**
(Course to be selected/opted from UGC-SWAYAM portal)

Semester IV
BTM 401: Bioprocess Engineering & Technology **Credits 3**

1. Screening and improvement of industrially important microorganisms
2. Microbial growth and death kinetics
3. Introduction to food technology
4. Air and media sterilization
5. Types of fermentation processes - Analysis of batch, Fed-batch and continuous bioreactions, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photobioreactors etc.)
6. Measurement and control of bioprocess parameters
7. Downstream processing
8. Industrial production of chemicals - Ethanol, Acids (citric, acetic and gluconic), solvents (glycerol, acetone and butanol), Antibiotics (penicillin, streptomycin and tetracycline), Semisynthetic antibiotics, Amino acids (lysine and glutamic acid), Single cell protein
9. Aeration and agitation: Requirement of oxygen in industrial processes. Concept of volumetric oxygen transfer coefficient and its determination (kLa). Factors affecting (kLa)

BTM 402: Bioinformatics & Biostatistics **Credits 3**

1. Introduction to bioinformatics
2. Searching database, Alignment of gene sequences, Local and global
3. Analysis of DNA sequence: Gene prediction and locating genes, Location of transcription start point and end point, Getting polypeptide sequence of the extracted core nucleotide sequence, Designing primers of specific gene, Generation of restriction maps
4. Analyzing phylogenetic relationship based on nucleotide and protein sequences
5. Analysis of proteins: Protein classification, homology modeling, threading, Ab-initio prediction of protein structure (secondary and 3 dimensional), tools for structure prediction, validation and visualization
6. Diagrammatic, graphical and tabular representations of data; measures of central tendency, dispersion, skewness and kurtosis
7. Pearson correlation coefficient
8. Basic concepts of hypothesis testing, two kinds of error, level significance, p value, t-Test for mean and difference between two means, partial t-test., and chi-square test for goodness of fit
9. IPR

BTM 403: Practical Course No. 403:
Based on BTM401 and BTM402 **Credits 4**

BTM 404: Research Project: Project works-Dissertation and Seminar **Credits 8**