SYLLABUS

M.Sc. BIOTECHNOLOGY

(SUMMARY)

CHOICEBASED CREDIT SYSTEM (CBCS)
(w. e. f. JUNE – 2016)

Re-Accredited Grade 'A' by NAAC

DEPARTMENT OF BIOSCIENCES

SAURASHTRAUNIVERSITY

RAJKOT – 360 005

SAURASHTRA UNIVERSITY

DEGREE OF MASTER OF SCIENCE

(M. Sc. in BIOTECHNOLOGY)

AIMS OF THE PROGRAM

The M.Sc. (Biotechnology) program in Biotechnology aims at training students in the areas of modern Biotechnology. This program offer specialized curriculum in various modules of Biotechnology such as Bioprocess Technology, Molecular Biotechnology, Food and Industrial Microbiology and Plant and Animal Biotechnology. The graduates are expected to carry out both basic and applied research in the areas of Biotechnology having academic and/or industrial relevance. The students would also be trained to assist industry in developing and/or solving problems of Biotechnology. In addition, the program also aims at generating manpower capable of teaching Biotechnology at postgraduate and undergraduate level.

The above objectives assume significance in the light of the fact the vast Saurashtra region of Gujarat, has no such program at Master's level to train and develop manpower in the ever-expanding demand of Biotechnologists in India.

DURATION OF STUDY: The duration of the study for M.Sc. Biotechnology will be of four semesters spread over two years.

ADMISSION REQUIREMENTS: To be eligible for the admission in the M.Sc. program, students must have a Bachelor Degree in Biotechnology, Microbiology, Biochemistry, Zoology and Botany with at least second division.

TOTAL NUMBER OF STUDENTS: Every year 25 students will be given admission as per rules prescribed by the University. The number of the admitted students may vary as per the Saurashtra University norms and notifications.

FEES STRUCTURE: The fee structure of the programme will be as per the university approval for this programme. Its subject to change as per the Saurashtra University norms and notifications.

EDUCATIONAL STUDY TOUR

The Educational study tour (s) is compulsory and part of the Curriculum to study different ecosystems, botanical, zoological and microbiological places of interest anywhere in the country. Since the tour/tours are part of the curriculum, these can be conducted during any or all of the four semesters. The study tours can be undertaken anywhere within India to meet the academic demand. The students shall prepare Tour Reports and submit them during the IV Semester Examination for the evaluation. However, in special cases of the physical and medical conditions, alternative of the educational tour will be decided and assigned to the student concerned, by the Staff Council of the Department.

SEMINARS

Presentations of the seminars on relevant topics, mostly from syllabus (oral and / or poster), is mandatory for the enrolled student. For each seminar, a student will be given marks, which will be added to the credit.

ATTENDANCE

Admitted students have to attend all the Lectures, Practicals and Seminars. A minimum prescribed attendance as per the Saurashtra University rules is required to grant a term. Students whose term is not granted will not be allowed to appear in the examination.

EXAMINATIONS

At the theory examinations, there shall be questions from all the units and all questions are compulsory. However, any change in the format of the question papers will be adapted as and when decided by the university. Theory Examinations will be held at the end of each semester. However, Internal Examinations will be conducted by the Department during the ongoing Semester and dates of which will be decided by the Staff Council. Students are required to apply in the prescribed application form for appearing in the Semester- end Theory Examination along with the necessary examination fees on the date to be notified by the University. The semester wise distribution of the courses and papers are given below.

SEMESTERWISE DISTRIBUTION OF MARKS:

SEMESTER-I:

4 Papers	(100 Marks each*)	: 400	
1 Combined Practical		: 200	**600**

SEMESTER-II:

4 Papers	(100 Marks each*)	: 400	
1 Combined Practical		: 200	**600**

SEMESTER-III:

4 Papers	(100 Marks each*)	: 400	
1 Combined Practical		: 200	**600**

SEMESTER-IV:

2 Papers	(100 Marks each*)	: 200	
M.Sc. Dissertation		: 200	
	(Thesis: 150 & Viva 50)		
Seminar		: 100	
Tour / Field Work		: 100	**600**

Grand Total	**:**	**2400**	*70 Theory + 30 Internal

M.Sc. Biotechnology Syllabus

Choice Based Credit System (CBCS)
(Total 96 Credits)

Course	Paper Name	Hours/ Weeks	Credits
M.Sc. Biotechnology Semester I			
BT 101	Microbiology (Core)	04	04
BT 102	Enzyme Technology (Core)	04	04
BT 103	Molecular Biology (Core)	04	04
BT 104	Biochemistry (Multidisciplinary/ Interdisciplinary)	04	04
BT 105	Combined Practical	15	08
	Total		**24**
M.Sc. Biotechnology Semester II			
BT 206	Molecular Cell Biology (Core)	04	04
BT 207	Immunology (Core)	04	04
BT 208	Molecular Biotechnology-I (Core)	04	04
BT 209	Biostatistics and Analytical Techniques (Multidisciplinary/ Interdisciplinary)	04	04
BT 210	Combined Practicals	15	08
	Total		**24**
M.Sc. Biotechnology Semester III			
BT 311	Fermentation Technology (Core)	04	04
BT 312	Molecular Biotechnology-II (Core)	04	04
BT 313	Bioinformatics (Core)	04	04
	Elective Course (any one of the following)	04	04
BT 314	Environment Biotechnology (Elective I)		
BT 315	Cell Culture (Elective II)		
BT 316	Food Biotechnology (Elective III)		
BT 317	Combined Practicals	15	08
	Total		**24**
M.Sc. Biotechnology Semester IV			
BT 418	Molecular Phylogeny and Extremophiles (Core)	04	04
	Elective Course (any one of the following)	04	04
BT 419	Socio Economic Aspects & IPR (Elective I)		
BT 420	Pharmaceutical Biotechnology (Elective II)		
BT 421	Agricultural Biotechnology (Elective III)		
BT 422	Dissertation/ Project	21	12
BT 423	Seminar	04	02
BT 424	Educational Tour/ Field work		02
	Total		**24**
	GRAND TOTAL	**126**	**96**

M.Sc. Biotechnology Semester I

(CBCS)

BT 101: MICROBIOLOGY [CORE]

Unit 1: Methods in Microbiology

- Sterilization Methods, Pure culture technique, Enrichment techniques
- Preservation & Maintenance of culture
- Staining & fixation, Bacterial morphology
- Growth curve of bacteria, Measurement of microbial growth, The influence of environmental factors in growth ,Synchronous growth, Continuous growth
- Sporulation, Spore germination
- Common Nutrient Requirements, Types of media for growth of microorganisms.

Unit 2: Medical Microbiology and epidemiology

- Pathogenicity and virulence.
- Virulence factors of microorganism.
- Epidemiology

Unit 3: Bacterial Genetics

- Recombination of bacterial genes, gene targeting
- Gene transfer method- Transformation, Conjugation & Transduction
- Mutation:- Types , causes & effects of mutation

Unit 4: Viruses & Prions

- General Characteristics of viruses
- Viruses of Bacteria Lytic & Lysogeny cycle (General features, RNA & DNA viruses)
- Viruses of Plants:-General characteristics and classification, Mechanism of infection by TMV and CMV
- Animal viruses:- Overview of Animal viruses,General features of retroviruses and HIV
- Prions & Molecular basis of their pathogenecity

Unit 5: Antimicrobial agents

- Types of antimicrobial agents
- Classes of antibiotics (β-lactams, tetracyclins, aminoglycosides, macrolids, Polypeptides antibiotics & their mode of action)
- Antiviral, antifungal, antiprotozoan antibiotics
- Development of resistance to antibiotics

BT 102: ENZYME TECHNOLOGY [MULTI/INTER]

Unit 1: Enzyme – General Account

- Classification of enzymes and enzyme kinetics of single substrate and two substrate catalyzed reactions
- Factors affecting rate of enzymatic reactions: temperature pH modulators etc and significance of activation energy and free energy in biochemical reactions.

Unit 2: Enzyme Cofactors and Mechanism of Enzyme Catalysis

- Structure and biological function of a variety of enzyme cofactors. Enzyme substrate complex concept of ES complex binding sites, active site and type of enzyme specificities.
- Acid Base catalysis, Orientation and Proximity, Covalent Catalysis (Electrophilic and Nucleophilic), Strain and Distortion.
- Regulation of enzyme catalysis: Covalent modification, Allosteric regulation
- Abzymes and Isozymes

Unit 3: Enzyme immobilization and Biotransformation

- Methods and principles, Supporting matrix, advantages, and reactor-design for immobilization of enzymes.
- Biotransformation through enzymes and Microbes
- Non-aqueous enzyme technology
- Asymmetric catalysis through enzymes

Unit 4: Enzyme technology for industrial application

- Applications of enzyme technology in environment
- Medical,
- Agricultural,
- Industrial benefit**s**

BT 103: MOLECULAR BIOLOGY [CORE]

Unit 1: Organization of genetic materials

- Various models to explain the structure of the nucleus and chromosomes, Special type of chromosomes: lamp brush, salivary and B chromosomes.
- Packaging of DNA as nucleosomes in eukaryotes, Chromosomal DNA contents and C-value paradox.
- Structural changes in the chromosomes
- Multigene families in eukaryotes
- Genomic organization in prokaryotes and Archaebacteria

Unit 2: DNA replication and repair

- Enzymes & accessory proteins involved in DNA replication
- Replication process in prokaryotic & Eukaryotic DNA
- Regulations of Eukaryotic replication
- DNA Repair:- Types of DNA Repair, Mechanism of DNA Repair

Unit 3: Transcription

- Importance of DNA binding Proteins, RNA polymerase
- Mechanism of Transcription in prokaryotes & Eukaryotes
- Processing of RNA:- m-RNA processing, 5' capping, 3' polyadenylation, splicing
- r-RNA & t- RNA processing

Unit 4: Translation

- The translation machinery, role of tRNA & ribosome
- Mechanism, of translation
- Post- translational modification of proteins such as phosphorylation, adenylation, acylation and glycosylation

Unit 5: Regulation & gene expression in Prokaryotes & eukaryotes

- Operon concept (lac operon, trp operon, his operon and arabinose operon), Structural basis of DNA-Protein interaction
- Attenuation & termination
- Gene silencing:- DNA methylation,
- Chromatin modification & gene expression. Histone acetylation & deacetylation
- Environmental regulation of gene expression

BT 104: BIOCHEMISTRY [MULTI / INTER-DISCIPLINARY]

Unit 1: Carbohydrates and Lipids

- **CARBOHYDRATES:** Classification, functions, Monosaccharide, Fischer projection formula, hemiketal and hemiacetal formation, furanoses, pyranoses, anomers, epimers, disaccharides-sucrose, lactose, maltose; polysaccharide (homo and heteropolysaccharides), peptidoglycans, glycoproteins, proteoglycans
- **LIPIDS:** Definition, classification & functions of Lipids. Saturated & unsaturated fatty acids, Essential Fatty acids, Prostagladins Fat:-Hydrolysis, Saponification Value, Rancidity of fat, Biological significance Properties & function of Glycerides, Phospholipids, sphingolipids & glycolipids

Unit 2: Proteins

- Structure of all 20 amino acids, Essential & Non essential amino acids
- Classification of Proteins based on Function & Solubility
- Primary, Secondary, tertiary & Quaternary structure of proteins, Ramchandran Plot
- Structure and Function of Fibrous proteins (Keratin, Collagen & Elastin), Globular proteins (Hemoglobins , Myoglobins), Lipoprotein, Metalloproteins & nucleoproteins

Unit 3: Nucleic acids

- Structure of DNA & RNA, Different Conformations of DNA
- Denaturation & annealing of DNA Physical properties of DNA such as bending, super coiling and sequence dependent changes in DNA melting, renaturation properties
- Structure & different types of RNA
- Structure of genomic and organellar DNA in eukaryotes

Unit 4: Photosynthesis & Nitrogen fixation

- Photosynthesis and respiration. Photosynthetic electron transport and respiratory electron transport and their coupling with energetic.
- Biological nitrogen fixation, Biofertilizers, symbiotic and non-symbiotic nitrogen fixation. Mechanism of protection of nitrogenase from molecular oxygen. Nitrate assimilation

Unit 5: Carbohydrate, Protein and Lipid metabolism

- Carbohydrate metabolism: Glycolysis, TCA cycle, HMP shunt, Glyoxylate pathway and Gluconeogenesis
- Protein metabolism: Oxidative deamination and Urea cycle
- Lipid metabolism: Oxidation of fatty acids

M.Sc. Biotechnology Semester II

BT 206: MOLECULAR CELL BIOLOGY [core]

Unit 1: Cell cycle & Cell signaling

- Overview of cell cycle & It's control
- Components of Cell Cycle control systems
- Role of Protein kinase in cell cycle
- Check points in Cell Cycle regulation
- Molecular basis of signal transduction
- Signaling through G-Proteins linked cell surface receptors, Signalling through Enzyme linked cell surface receptors

Unit 2: Apoptosis

- Phenomena of apoptosis,
- Factors regulating apoptotic death in normal cells and tumorous cells
- Necrosis

Unit 3: Cytoskeleton

- Microtubules, cilia, flagella & centrioles, roles of microtubule dynamics in cell division
- Microfilaments &cell motility
- Intermediate filaments
- Actin & Myosin, Functional role of actins filaments and motor proteins.
- The cytoskeleton & cell behaviour

Unit 4: Developmental Biology and Cell Differentiation

- Establishing multicellularity, formation of blastula, embryonic germ layer, tracking of migrating cells
- Aggregation behaviour in embryonic cells and possible understanding in the positional information in developing organs.
- Events during fertilization, post fertilization, early embryonic development and in-vitro fertilization.
- Roles of different proteins in fertilization

Unit 5: Molecular Biology of Cancer

- Characteristics of cancer cells
- The genetic basis of cancer, Proto-oncogenes & its regulation
- Oncogenes & cancer, Viral oncogenes (Viruses & Cancer)
- Techniques used in cancer research (From genomics to proteomics)
- Cancer treatment present & future
- Regulation of gene expression and signal translocation on cancerous cells vs. normal cells

BT 207: IMMUNOLOGY [CORE]

Unit 1: Molecular cells & organs of Immune system

- Historical perspective, Innate Immunity:- Skin, Mucosal Surface, Physiological barrier, Inflammation, Adaptive Immunity
- Molecules of innate & Acquired immune system:- Complement, Interferon, other molecules
- Cells of Innate & Acquired Immune system
- Organs of the immune system:- Primary Lymphoid organs, Secondary Lymphoid organs, Lymphatic etc.

Unit 2: Antigens, Antibody & Ag-Ab Interaction

- Antigens: - Immunogenicity vs Antigenicity, Factors influencing Immunogenicity, Adjuvant, Epitopes & Haptens, super antigens, auto antigens
- Antibody:- Structure, classes & functions, Allotypes & Idiotypes
- Basic principles of Antigen-Antibody Interaction
- Immunological techniques: Principles & Applications:Precipitation & agglutination, Radio Immunoassay, Enzyme linked Immunosorbent Assay etc.

Unit 3: Mechanism of Immune response

- Generation of Immunological diversity
- Antigen recognition
- Lymphocyte development &activation
- Lymphocyte interaction, cytokines & lymphoid system

Unit 4: MHC & Transplantation Immunology

- MHC:- General organization, MHC molecules & genes
- Cell recognition of self & nonself
- MHC restriction
- Tolerance:- Central Peripheral & acquired tolerance
- HLA typing methods using serological and molecular techniques.

Unit 5: The Immune system in Health & Disease

- AIDS & other Immunodeficiencies
- Autoimmunity & autoimmune diseases
- Hypersensitivity
- Vaccines:- Principle & types of vaccines, Recent advances in vaccination
- Monoclonal & Recombinant antibodies

BT 208: MOLECULAR BIOTECHNOLOGY-I [CORE]

Unit 1: Molecular Tools used in Genetic Engineering

- Restriction Endonuclease and Restriction mapping
- DNA modifying enzymes:- Nuclease, Polymerase, Enzymes that modify the ends of DNA molecules, DNA ligase- joining DNA Molecules
- Adaptors, Linkers, Homopolymer tailing

Unit 2: Gene cloning vectors

- Plasmids, Cosmids, Bacteriophage
- Phagemids, BAC,YAC
- Shuttle vector, Expression Vector & other Advanced vectors

Unit 3: Cloning Strategies

- Genomic libraries, Preparation of DNA fragments for cloning
- Positional cloning, chromosome walking, Jumping.
- C-DNA Synthesis & cloning
- *In-vitro* phage packaging
- Probe preparation (Radiolabelled & non-radiolabelled)

Unit 4: Selection, Screening & analysis of recombinant

- Genetic selection of screening methods:- Use of chromatographic substrate, Insertional inactivation, Complementation of defined mutation
- Methods based on nucleic acid homology (Southern, Northern, Western Blotting, Subtractive, colony & plaque hybridization, chromosomal walk
- *In-situ* chromosomal hybridization
- Immunological screening for expressed genome
- Microarray Technique

Unit 5: Advanced Techniques.

- Nucleic acid Synthesis & Sequencing, Chemical & automated method
- Methods of gene regulation in Eukaryotes (Antisense RNA, PNA & RNAi)
- Polymerase Chain Reaction
- DNA markers:- RFLP, micro-minisatellites, SNPs, RAPDs,AFLP, Linkage analysis, genotyping & DNA fingerprinting
- Applications of genetic engineering

BT 209: BIOSTATISTICS & ANALYTICAL TECHNIQUES [MULTI/INTER]

Unit 1: Biostatistical Concepts

- Scope of Biostatistics, Samples & population & Sampling techniques, Kinds of variable, Graphical & diagrammatic representation
- Theory of errors, measure of precision, Probable errors of function, rejection of observation
- Mean (Arithmetic, Harmonic, & Geometric), Median & Mode.
- Measure of dispersion, standard deviation & standard errors
- Probability distribution:- Binomial, Poisson & normal distribution
- Regression:- Linear, Bivariate & Polynomial regression analysis
- Level of significance: F test, T test, chi square & goodness of fit, ANOVA

Unit 2: Radioisotope Techniques and Microscopy

- Radioisotopes & half life of isotopes, Units & measurement of radiation, Autoradiography, Application of radioisotopes in biological study, Interaction of radiation with matter
- Light Microscopy: - Bright field, Dark field, Fluorescent Microscopy, Phase contrast Microscopy
- Electron Microscopy :- Transmission, EM & Scanning EM, Flow Cytometry, Atomic force microcopy

Unit 3: Spectroscopy

- Spectroscopic techniques:- Beer Lambert's law, Extinction coefficient, Principles & applications of visible & U.V. spectroscopic technique
- Electromagnetic spectrum, interaction of EM radiation with matter, Physical phenomenon:- Absorption, Emission, Refraction, Diffraction, Transmission
- Absorption & Emission Spectroscopy

- X-ray diffraction & crystallization
- CD, ORD, IR & NMR, MALDI-TOF Mass spectroscopy (Matric Assisted Laser Desorption Ionization Time of Flight Mass Spectrometry

Unit 4: Chromatography, Centrifugation and Electrophoresis

- Chromatography Theory & Principles
- Key terms:- Stationary phase, mobile phase, Retention time, column efficiency, Peak shape, Rate theory
- Types of chromatography, partition, adsorption, Ion exchange, size exclusion, affinity, Paper chromatography, Hydrophobic chromatography, GC,GLC, HPLC
- Centrifugation: - Sedimentation, Relative centrifugal force, preparative and analytical centrifuge.
- Basic Principles of electrophoresis, Agarose electrophoresis, PAGE, SDS PAGE, 2D PAGE, Isoelectric focusing

M.Sc. Biotechnology Semester III

BT 311: FERMENTATION TECHNOLOGY [CORE-I]

Unit 1: Basics of Industrial fermentation and Sterilization of air, media &equipment's

- Medium formation & Raw material
- Isolation and screening of industrially useful microorganisms
- Strain Improvement
- Methods of measuring process variation
- Control system
- Computer application in fermentation technology

Unit 2: Design of fermenter

- Various Design and types of fermentors & Bioreactor
- Aeration and agitation, oxygen transfer rate, heat control
- Batch, fed-batch and continuous culture operations
- Starter culture, its importance and preparation
- Mass transfer bioprocess
- Scale up bioprocess

Unit 3: Product Recovery & Purification (Downstream Processing)

- Extraction and separation techniques; Cell disruption – disintegration, Flocculation & Floatation, Filtration, Centrifugation, Distillation
- Enrichment of product by: Thermal process, Membrane filtration and dialysis, Freeze concentration, Chromatographic methods, Purification: Crystallization and drying
- Bioassay and fermentation economics

Unit 4: Industrial production of chemicals

- Alcohol Fermentation
- Organic acids (Gluconic acid & Citric acid)
- Vitamins (Vit. B12)
- Amino acids (Lysine & Glutamic acid)
- Single cell protein
- Antibiotics (Penicillin & streptomycin)
- Enzyme (Amylase, Protease & lipase)

Unit 5: Food Technology

- Food Spoilage & Preservation
- Methods of Food Processing
- Designer Foods, Nutraceuticals & Genetically Modified Foods

BT 312: MOLECULAR BIOTECHNOLOGY-II [CORE-II]

UNIT – 1: Proteomics techniques

- Techniques used in gene detection and expression studies: Southern hybridization, Northern hybridization, western hybridization, PCR and RT-PCR
- Peptide sequencing and synthesis: principles and strategies for protein sequencing. Design of primers from ammo acids sequences.

UNIT – 2: DNA- protein interaction techniques

- Gel mobility shift assay, DNA-protein cross-linking assay, Dnase I foot printing and Sl nuclease mapping.
- Protein- protein interactions: chemical cross-linking. Yeast-2-hybid, Yeast-3-hybid and their various versions. Principles and applications.

UNIT – 3: Reporter genes

- Chloramphenicol acetyl transferase (cat), neomycin phosphoryl transferase II (nptII), Luciferase, β- galactosidese etc. and their applications in expression kinetics and promoter probing studies.

UNIT – 4: Protein folding

- Protein folding and the roles of Molecular chaperones
- Mechanism and relevance to biotechnology
- Assisted protein folding , In-vitro protein folding

UNIT – 5: Protein engineering and drugs design

- Rational of protein engineering,
- Methods and approaches: directed Evolution and gene shuffling, random mutagenesis and selection of engineered proteins, gene modification at specific sites, synthesis of complete gene. Engineering by gene fusion.

- Drug design and various approaches: by blocking enzyme activity, Inhibitor for Dihydroxyfolate reducase (DHFR), Renin. HIV reverse transcriptase etc Drug design by blocking hormone receptors, propanolol for norepinephrine and epinephrine etc, and drug design by inhibiting nucleic acid synthesis using antisense RNA technology.

BT 313: BIOINFORMATICS [CORE-III]

Unit 1: Computational approach

- Introduction to operating system and Basics of computer.
- Use of computer networking - LAN, WAN, MODEM, Fibre Optics Network. Introduction to Internet. WWW, NICNET, ERNET VSNL. ISDN ETC.
- Introduction to artificial intelligence and neural networks.
- Current perspective & Emergence of Bioinformatics
- Commercial use of Bioinformatics

Unit 2: Biological databases

- Primary & secondary database
- Database searching
- Database Management:- Sequence Retrieval system (SRS)

Unit 3: Data mining and Sequence Alignment (Primer Designing)

- Data mining & Data warehouse, Machine Learning methods, Data mining tools & techniques,
- Pair wise sequence Alignments, Global & Local Alignments, Multiple Sequence Alignments, Gaps & scoring matrices, Homology, orthology, Analogy & Paralogy
- Primer designing

Unit 4: Gene Prediction & Genome analysis

- Reliability of ORF Prediction
- Methods for Gene prediction in microbial genomics & in eukaryotes
- Evaluation of gene prediction
- Comparative genomics
- Functional Genomics
- Microarray methods & its applications in genome analysis

Unit 5: Protein structure prediction

- Terms used for classifying protein structure & sequences
- Alignment of protein structures
- Structural prediction and its evaluation
- Structural modeling

BT 314: ENVIRONMENTAL BIOTECHNOLOGY [ELECTIVE I]

Unit 1: Environmental impact and Biosensors

- Reducing environmental impact of industrial effluents Toxic site reclamation, removal of spilled oil and grease deposits. Microbial degradation of textile dyes, timber petroleum products, leather plastics and food product
- Biosensors, recent approaches and applications

Unit 2: Bio fertilizers

- Use of mycorrhizae in reforestation and aforestation
- Biofertilizers and biopesticides
- Role of *Dienococcus sp.* in bioremediation of radioactive waste. Molecular mechanisms of radiation resistant

Unit 3: Environment and energy

- Renewable source of energy: Biomass production and Biogas production. Generation of energy and fuel using microorganisms (Hydrogen production and Methane production)
- Brief account of alternative energy source: Biofuel etc.
- Conservation of energy: Global Warming and carbon credit
- Heavy metals and its effect on microbes and higher organisms

Unit 4: Biodiversity

- Biodiversity & species concept
- Benefits from Biodiversity
- Factors threatening Biodiversity
- Endangered species management & Biodiversity protection

BT 315: CELL CULTURE [ELECTIVE II]

Unit 1: Plant Biotechnology

- Culture media: - constituents and concepts of sterilization, Preparation, isolation and selection of explant, Concepts of totipotency.
- Suspension cell culture, Callus culture, Protoplast Isolation, culture & fusion.
- Anther & pollen culture for production, Somatic embryogenesis, Synthetic seeds.
- Germplasm Conservation: Improvement, exploitation and conservation of plant genetic resources.

Unit 2: Animal Biotechnology

- Equipments & media used for Animal cell culture technology, Primary & established cell line culture and culture media
- Applications of animal cell cultures
- Serum protein media viability and cytotoxicity, Basic techniques of mammalian cell culture
- Cryopreservation and transshipment of animal tissue and cell line

Unit 3: Stem cells

- Erythrogenesis, Chondrogenesis,. Cell cycle analysis, cells synchronization, cells separation, cells transformation in vitro, cells locomotion and cell cloning
- Different types of stem cell Characteristics of stem cells. The methods for stem cells differentiations. Potential of stem cell research in treatment of different genetic, infectious diseases and drug targeting
- Gene therapy and its application

Unit 4: Transgenics

- Objectives of transgenics
- Methods of gene transfer in plants and animals
- Expression of transgene in higher plants and animals for producing value based products
- Application of transgenic plants and animals: Recombinant product produced through transgene viz. Edible Vaccine, Recombinant proteins, Hormone production etc.

BT 316: FOOD BIOTECHNOLOGY [Elective-III]

Unit 1

- Starter cultures and their biochemical activities; production of alcoholic beverages; production of Single cell protein and Baker's yeast; Mushroom cultivation
- Food and dairy products: Cheese, bread and yogurt.
- Fermented vegetables – Saurkraut; Fermented Meat – Sausages

Unit 2

- Novel microorganisms eg. LAB (Probiotics), Cyanobacteria, methylotrophs enzyme biotransformations
- Role of Plant tissue culture for improvement of food additives; color and flavor
- Genetic modifications of microorganisms; detection and rapid diagnosis
- Genetically modified foods and crop

Unit 3

- Food borne infections and intoxications; with examples of infective and toxic types – Clostridium, Salmonella, Staphylococcus
- Mycotoxins in food with reference to Aspergillus species
- Food preservation: canning, dehydration, ultrafiltration, sterilization, irradiation
- Chemical and naturally occurring antimicrobials; Biosensors in food industry

Unit 4

- Quality assurance: Microbiological quality standards of food
- Intellectual property rights and animal welfare
- Government regulatory practices and policies. FDA, EPA, HACCP, ISI
- Risk analysis; consumer and industry perceptions

M.Sc. Biotechnology Semester IV

BT 418: MOLECULAR PHYLOGENY AND EXTREMOPHILES [CORE]

Unit 1: Microbial evolution and phylogeny

- Molecular basis of microbial classification,
- Chronometers and chronological distances,
- Paradox in establishing Evolutionary distances.

Unit 2: Non-cultivable microbes

- Cultivable vs. non-cultivable microbes, Genetic heterogeneity among non-cultivable, Metabolic potential of non-cultivable microbes, Evolutionary and biotechnological significance of non-cultivable microbes
- Molecular methods for studying non-cultivable microbes: Isolation of nucleic acids and analyses of microbial diversity, In-situ hybridization, Methods of 16S rRNA analysis

Unit 3: Archaebacteria:

- Archaebacteria - distinguishing features, Phylogenetic groups of Archaebacteria, Ecology and habitats of Archaebacteria, Physiology of Archaebacteria

Unit 4: Life at Extremities:

- Life at hyper-extremities: hyperthermophilic Archaebacteria and bacteria, Life at hyper salinity, other forms of extremophiles
- Gene expression in hyperthermophilic bacteria and archaea, Genome analysis from extremophiles
- Protein stability in hyper-extremophiles

Unit 5: Biotechnology and Extremophiles:

- Hyper-extremophiles and their novel metabolic machinery and biomolecules-future unique applications

BT – 419: SOCIO-ECONOMIC ASPECTS & IPR [ELECTIVE-1]

UNIT – 1:

- Steps to preserve biodiversity. In situ and Ex Situ conservation - Gene banks, In-situ and Ex situ conservation. Ex situ conservation efforts at international level, Ex-situ conservation by G-15 countries, Europe, India.
- Conservation efforts by private sectors, management of germplasm collection. Species conservations.

UNIT – 2:

- Biosafety and Societal Concern: Public debate and concern on Genetically modified microorganisms, plants and animals, scientific analyses of the concern, Biosafety regulation and guidelines on developing and using the Genetically modified organisms, radiation safety.

UNIT – 3:

- Intellectual property, Intellectual property rights (IPR) (Patents, trade secret, copy right, trade marks), Choice of intellectual property protection (IPP). IPR and plant genetic resources (PGR).

UNIT – 4:

- Patenting of Biological Materials: International conventions. International cooperation obligations with patent applications, implications of patenting, current issues: Can live form be patented-? with special reference to Factor VIII, Erythropoitin, tissue plasminogen, activator, hybridoma technology etc.
- Patenting of higher plants and animals: Transgenic organisms and isolated genes. Patenting of genes and DNA sequences, plant breeder's rights and farmer's right.

BT 420: PHARMACEUTICAL BIOTECHNOLOGY [Elective II]

Unit 1: Structural and functional genomics

- Structural and functional organization of the human genome.
- Physical mapping and linkage analysis, Identification of the disease linked genes and markers, positional cloning, isolation of the disease responsible genes and their characterization.
- Global genome functional variations: assessment by microarrays (cDNA and Oligo microarrays), 2D protein gel electrophorosis, MALDI.
- Functional analysis of human genome for studying the diseases and drug functionality and drug side effects (by microarray and 2D gel electrophoresis).

Unit 2: AIDS

- History of HIV, types, Life cycle to the HIV
- Genome variations among the HIV strains
- Key aspects for the drug designing targets.

Unit 3: Pharmacogenomics and molecular diagnostics

- Importance and types of drug metabolizing enzymes
- Variations in the drug metabolizing genes their effects, Individualized medicine and their application in the drug dosage and treatment in cancer.

- Principles and application of the molecular diagnosis via protein, DNA and other bio-molecular detections.

Unit 4: Antibiotics and Pharmacokinetics

- Antimicrobial agents
- Vaccines
- Modern approaches in Vaccination

BT – 421: AGRICULTURE BIOTECHNOLOGY [Elective – III]

UNIT – 1: Taxonomy and physiology

- Classification of plant kingdom (Bentham and Hooker)
- Absorption of water, mineral nutrition, transpiration, phytohormones

UNIT – 2: Molecular Biology of Stress Tolerance in Plants

- Basic plant physiology and regulation
- Water Stress, salt stress, High Temperature Stress, Freezing Stress, Systems Biology to Study Cold Tolerance, Nutrient Stress, Heavy Metal Stress

UNIT – 3: Genetic Transformation of Plants

- Agrobacterium mediated and biolistics-basic principles and applications, Ti plasmids, binary vectors, transformation hosts, Selection markers, Reporter genes, promoters
- Mechanism of transformation
- Screening of the transgenic plants and heterologous gene expression

UNIT – 4: Molecular farming: (Reported examples)

- Transgenic crop with Heat shock proteins, Ion/proton transporters, Reactive oxygen scavenger, Transcription and factors
- Transgenetic plants with pathogenetic resistance protein
- Plant-derived recombinant therapeutic protein, plant-derived recombinant antibody, vaccine candidate –hepatitis B virus surface antigen in tobacco, plant-derived industrial enzyme, amylase in tobacco, Secretory IgA produced in tobacco.

M.Sc. Biotechnology (PRACTICALS)

Semester I

MODULE I: Microbiology

1. Isolation & maintenance of organism by plating, streaking & serial isolation methods slants & stab culture, storage of microorganism
2. Microscopic observation - Gram staining, Capsule & Spore Staining
3. Growth cure – Diauxic
4. Effect of Physicochemical Factors on Growth of Bacteria: Salt, Temp, pH
5. Viable count of bacteria from soil sample (Dilution Plating Method)
6. Biochemical characterization of selected Microbes
7. Isolation of bacteriophages from sewage sample
8. Enrichment and Isolation of:
   a) Halophiles b) Acidophiles c) Phenol Degraders
   d) Nitrogen Fixers e) Antibiotic Producers f) Kojic Acid Producers
9. Effect of Antibiotics on various Gram Positive and Gram Negative bacteria (Antibiotic sensitivity of bacteria)
10. Determination of Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC) of various Antibiotics on different Organisms
11. Isolation of auxotrophic mutant by 5 BrU mutagenesis
12. Bacterial Conjunction
13. Physical mapping with interrupted conjugation techniques (By Problem solving approach)
14. Bacterial Transformation

MODULE II: Enzymology

1. Enzyme assay: Amylase/Protease/Xylanase/Cellulase
2. Enzyme Kinetics: Determination of Km &Vmax,
3. Effect of Physical parameters on enzyme: pH, Temperature on Amylase/Alkaline phosphatase /protease/cellulose
4. Effect of chemicals on enzyme: Inhibitors, Chelators, Solvents on Amylase/Alkaline phosphatase/protease/cellulose.
5. Alkaline Phosphatase i.e, a) Competitive Inhibition (NaH, PNP) b) Uncompetitive Inhibition (L – Phenylalanine)

MODULE III: Molecular Biology

1. Isolation of Genomic DNA from bacterial cell / plant cell
2. Isolation of RNA from Yeast cells
3. Isolation of Plasmid DNA
4. Determination of Tm values of DNA
5. Blotting techniques: Western and Southern
6. Plasmid Curing by Acridine Orange (Shift to sem I)

MODULE IV: Biochemistry

1. Method of Protein Estimation
    i) Estimation of Protein by Biuret methods
    ii) Estimation of Protein by Folin Lowry methods
    iii) Estimation of Protein by Bradford method
    iv) Estimation of Protein by UV Absorption.

2. Method of Carbohydrate Estimation
    i) Estimation of reducing sugar by DNSA method.
    ii) Estimation of Carbohydrate by Nelson-somogys method
    iii) Estimation of Carbohydrate by GOD/POD method.
    iv) Estimation of Carbohydrate by Phenol Sulphuric acid method.
    v) Estimation of Carbohydrate by Anthrone's method

3. Nucleic acid Estimation
    i) Estimation of DNA by DPA method
    ii) Estimation of RNA by orcinol method /modified orcinol
    iii) Estimation of Nucleic acid by UV Absorption method
    iv)Estimation of total lipids in seeds
4. Analysis of oils, iodine numbers, saponification value, acid number
5. Separation of plant pigments by paper chromatography (Shift in Sem II parcticals)
6. Separation of Amino acids by thin layer chromatography (Shift in Sem II parcticals)

SEMESTER-II

MODULE V: Molecular Cell Biology

1. NESTROF (Naked Eye Single Tube Red Cell Osmotic Fragility Test) - Screening Test For β-Thalassemia Trait
2. Study of various stages of mitosis from onion root tip cells.
3. Effect of colchicines on the DNA content of cell.
4. Study of different stages of meiosis in flower bud of *Tradenscantia sp.*
5. Localization of protein by mercuric bromophenol blue.
6. Localization of lipid by Sudan black B.
7. Study of Karyotyping.
8. Study of permanent slides of the chick embryo.
9. Staining of Golgi appartus using Neutral Red stain.
10. Staining of mitochondria in human cheek epithelial cells.

MODULE VI: Immunology

1. Total count of RBC & WBC differential count & Blood grouping
2. Western Blotting
3. Single Radial Immunology Diffusion
4. Octerlony Double diffusion
5. WIDAL test
6. VDRL test

7. ELISA
8. Generation of primary antibody by using mice as model organism.

MODULE VII: Metagenomics and Molecular Phylogeny

1. Isolation of soil metagenome
2. Restriction Digestion of λ DNA using three Restriction Endonuclease enzymes:
   a) EcoR V b) Hind III c) BamH I
3. Accessing population diversity by 16S rDNA analysis
4. Isolation of Lambda phage DNA
5. PCR:
   - Basic PCR
   - Nested PCR
   - Multiplex PCR
   - RAPD
   - RFLP

SEMESTER III

MODULE VIII: Fermentation technology

1. Primary screening of amylase, protease, lipase and cellulase producing microorganisms.
2. To study the submerged fermentation for enzyme production (lab scale).
3. To study alcohol tolerance of given culture of yeast.
4. To study sugar tolerance of given culture of yeast.
5. To demonstrate the production of alcohol by yeast and the quantification of alcohol produced in the fermentation broth
6. Comparative studies of ethanol production using different substrates
7. To estimate alcohol present in the given sample by potassium dichromate (K2Cr2O7) method.
8. To estimate the potency of antibiotic streptomycin in the given sample by bioassay technique
9. To carry out fermentation of Ca-gluconate using *Aspergillusniger*.
10. To prepare a standard curve of Ca-gluconate

MODULE IX: Food Biotechnology

1. Milk analysis: Methylene blue reduction test (MBRT), Resazurin reduction test (RRT), Acid fast staining
2. Food analysis: Standard Plate Count (SPC)
3. Water analysis: IMViC test
4. Isolation of probiotics organisms from various samples

MODULE X: Protein Purification

1. Protein Purification of different proteins/enzymes:
   - Gel Filtration Chromatography,
   - Ion Exchange Chromatography
2. SDS PAGE
3. Native PAGE
4. Silver staining technique

5. Induction of Protein synthesis in *E.coli* cells.
6. Protein Folding Studies.

MODULE XI: Bioinformatics

1. Use of NCBI Bioinformatics tools

(a) Pubmed (b) OMIM (c) Taxonomy (d) Protein analysis (e) Genes and Diseases

2. Use of Expasy tools
3. FASTA and sequence formats
4. BLAST
5. Alingments- pair wise and global
6. Construction of dendogram
7. Prediction of ORF/Gene prediction
8. Protein visualization (RASMOL, SPDB VIEWER, PROTEIN EXPLORER)
9. Protein modeling- Homology modeling and Acvitve site prediction
10. Primer Designing

SEMESTER - IV

BT-422: DISSERTATION

BT-423: SEMINAR

BT-424: EDUCATIONAL TOUR / FIELD WORK