Sidho-Kanho-Birsha University

Syllabus for Postgraduate Department of Biotechnology

2021

Tentative Course Plan:

- **Conduction:**

The course of study leading to the Master of Science (M. Sc.) Degree in Biotechnology shall be conducted by the Department of Zoology and Department of Botany during its juvenility.

- **Duration:** Two years

Nature of course: The M. Sc. course in Biotechnology under the Choice Based Credit System shall be divided into four semesters. The duration of each semester shall be of six months, as follows:

Semester- I: July to December
Semester-II: January to June
Semester-III: July to December
Semester-IV: January to June

There will be final Exams at the end of each Semester for 50 marks on each paper (to be appropriated into End-Term exams and Internal Assessments as per norms).

Medium of instruction: English

Mode of Teaching: Hybrid (Offline and online)

Attendance requirement: As per SKBU rules and regulations

Credits: Total 96 credits (one Credit = 15 classes)

Brief Outline of the course structure

1st Semester	**Core Courses**	**Theory**	**Practical**	**Credits24**
MBITCCT101	Biochemistry	50		4
MBITCCT102	Cell Biology and Molecular Biology	50		4
MBITCCT103	Microbiology	50		4
MBITCCS104	Biochemistry		50	4
MBITCCS105	Cell Biology and Molecular Biology		50	4
MBITCCC106	Bio-Instrumentation and Biophysical Chemistry and Microbial techniques	25	25	2+2
2nd Semester	**Core Courses**	**Theory**	**Practical**	**Credits 24**
MBITCCC201	Genetics	25	25	2+2
MBITCCC202	Biostatistics	25	25	2+2
MBITCCT203	Metabolism	25	-	2
MBITCCC204	Recombinant DNA technology	50	25	4+2
MBITCCC205	Diversity of Life form & Environmental application	25	25	2+2
MBITCCC206	Immunology	25	25	2+2
3rd Semester	**Core Courses**	**Theory**	**Practical**	**Credits 24**
MBITCCC301	Genomics Proteomics & Protein Engineering	50	25	4+2
MBITCCC302	Bioinformatics and Computer Application	25	25	4+2

MBITCCC303	Bioprocess Engineering and Microbial Technology, Entrepreneurship	50	25	4+2
	Choice Based Credit Courses			**Credit 8**
MBITOET304	Open elective	50		4
MBITCCS305	Outreach	-	50	4
4thSemester	**Core Courses**	**Theory**	**Practical**	**Credits 24**
MBITCCT401	IPR, Biosafety and Bioethics and Medical Biotechnology	50	-	4
MBITCCS402	Dissertation	-	100	8
MBITCCS403	Seminar & Grand Viva/Industrial training	-	50	2+2
MBITCCC404	Plant and Animal Biotechnology	25	25	2+2
MBITCCT404	Add on	50	-	4

Tentative Syllabus:

SBT CC11, Biochemistry (Core Course) Equivalent to paper 101

Marks: Theory 50, Credit 4

Concept of Chemical bonding: Forces involved in biological molecules, electrostatic, hydrophobic, H-bonding, Vanderwal's Forces.

Structure and Functions of Biomolecules and Macromolecules

Carbohydrates: mono, di- and polysaccharides.

Lipids: classification; structure and function, their role in biological membranes.

Proteins: chemistry of amino acids and peptides, chemical synthesis of peptides, Primary Secondary, Tertiary and Quaternary Structure of proteins; ∝-helix, β-sheet and collagen structure helix-coil transition, Ramachandran plots, amino acid sequences, allosteric interactions, cooperative ligand binding in Oxygen transporters, Hill equation, Protein folding, Naturally occurring peptides (glutathione, bradykinin, kallikrien, tyrocidin)

Nucleic acids: Watson-Crick model of DNA; sugar puckerings, stacking; B-; A-and ZDNA ; denaturation kinetics of DNA , Cot curves; structure of tRNA and ribosomes, Supercoiling of DNA and its influence on structure, Nucleosomal structure.

Separation and purification of biomolecules and macromolecules: ionexchange, gel filtration, affinity chromatography, TLC, HPLC, GC, electrophoresis, electrofocusing.

Introduction: Nomenclature, classification, general properties isoenzyme, active site, substrate, coenzyme, cofactor.

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

Enzyme regulation: allosteric model, substrate induced conformational change in enzyme.

Enzyme inhibitors: competitive, un-competitive and non-competitive inhibitors.

Bioenergetics: Electron-transfer reactions in mitochondria, ATP synthesis: Structure and mechanism of ATP synthase, Chemiosmotic theory, Regulation of oxidative phosphorylation

Carbon cycle, bioenergetics and metabolism. 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.

SBT CC13 Cell and Molecular Biology Equivalent to paper 102

Marks: Theory 50, Credit 4

Membrane Structure and dynamics: 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 membrane, natural and artificial membranes passive movements of solutes; membrane cytoskeleton.

Extracellular matrix: Basal membrane, laminin, collagen, proteoglycan, Focal adhesion, hemidesmosomes, Cadherins, adherens junction, tight junction, Gap junction

Transport: 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.

Cell signalling: Signalling via G-protein-linked cell surface receptors; signaling via Enzyme-linked cell surface.

Cytoskeleton and cell movements: The nature of cytoskeleton; Intermediate Filaments; Microtubules; Cilia and Centrioles.

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, Cell cycle regulation and cell death.

Molecular Biology

DNA replication: Prokaryotic and Eukaryotic DNA replication; mechanics of DNA replication; enzymes & accessory proteins in DNA replication. fidelity of replication, extrachromosomal replicons, Replication of telomere, replication in QX174, M-13, T-odd and even phages; 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 Rec BCD pathways and their experimental supports; meiotic recombination- mechanism, the double-stranded DNA breaks; site-specific recombination and transposition).

Transcription: Prokaryotic and Eukaryotic transcription; RNA polymerases of pro- and eukaryotes; subunits; different sigma factor related to stress, viral infection etc. Transcription of mRNA, rRNA and tRNA; Initiation, elongation and termination (in pro- & eukaryotes); transcription factors; rho dependent and independent termination, Regulatory elements of transcription and mechanisms; Transcription activators and repressors.

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

SBT SC16 Microbiology Equivalent to paper 103
Marks Theory 50 [Credit 4]

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.

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.

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. Bacterial cell structure and fine structure: Structure-function Cell walls of eubacteria (peptidoglycan) and related molecules, Outer-membrane of Gram-ve bacteria, Cell wall and cell membrane synthesis, Flagella and motility, Cell inclusions like endospores capsules, slime layer pili. Quorum sensing and biofilm formation.
Microbial Taxonomy: New approach to bacterial taxonomy and classification including ribotyping and rRNA sequencing.
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.
Chemotherapeutic Antibiotics: Antimicrobial agents Sulfa drugs. Antibiotics Penicillin and cephalosporins. Board-spectrum antibiotics, mode of action of important antibiotics. Resistance to antibiotics.
Virology: Classification and modes of propagation; bacterial, plant and animal viruses: morphology and ultrastructure; assay of viral particles, cell culture; viral enzymes, nucleic acids, DNA viruses: Herpes, Hepatitis B, Adeno virus; RNA viruses: Polio, VSV, Influenza, Retroviruses: Structure, life cycle, transformation; TMV, Baculoviruses,; Response to viral infections: slow and persistent infections, Antiviral agents, Interferons

Fungi: Brief account on fungi and their life cycle pattern; Fungi as a microbial resource in human welfare and environment. Fungi as biopesticides.

SBT CC12 Biochemistry (Practical) Equivalent to Paper 104
Marks: Practical 50, Credit 4

Practical:
Enzyme kinetics, effects of pH and temperature on enzyme activity, use of inhibitors for active site determination, Michaelis-Menten equation: determination KM and Vmax
Isolation and quantification of Protein estimation (Lowry method).
DNA denaturation and renaturation. Estimation of carbohydrates – anthrone method
Estimation of catalase, ACP, ALKP, GGT**,** Titration of amino acids, Quantitation of sugars, Estimation of proteins by different methods, SDS-PAGE, Analysis of oils-iodine number, saponification value,

acid number

Books recommended:

1. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry by T Palmer and P L Bonner.
2. Enzyme Kinetics 2017: Principles and Methods by Hans Bisswanger.
3. Understanding Enzymes Function, Design, Engineering, and AnalysisAllan Svendsen, Jenny Stanford Publishing. CRC press
4. Voet&Voet Fundamentals of Biochemistry, John Wiley & Sons.
5. Harpers Illustrated Biochemistry, McGraw Hill.
6. Textbook of Biochemistry. 1968 by West and Todd (MacMillan).
7. Principles of Biochemistry. 1993 by A. L. Lehninger, Nelson and Cox. (CBS, India).
8. Biochemistry (2nd edition) by Donald Voet and JudithVoet.
9. Biochemistry (4th edition) by L. Stryer (Freeman).
10. Biochemistry by Zubay
11. Nucleic acid Biochemistry and Molecular Biology by Main Waring et al., (Blackwell)
12. Biochemical calculations, Irwin H. Segel, John Wiley and sons Inc.

SBT CC14 Practical Cell Biology and Molecular Biology
Equivalent to Paper 105
Marks: Practical 50 Credit 4

Subcellular fractionations of tissue by centrifugation, Microscopy: Bright field, Phase Contrast & Fluorescence microscope, animal tissue culture, cell counting, cell viability, cell cycle by flow cytometer, Immunofluorescence by fluorescence microscope and confocal microscope, MTT assay
Isolation of DNA from plant and animal tissue, blood, total RNA isolation, quantification of DNA and RNA, Gel electrophoresis, Introduction to PCR. Reverse Transcriptase PCR for gene expression analysis. Estimation of cholesterol from blood, glucose from blood serum, Estimation of liver function test enzyme assay enzyme (AST/ALT/GGT/CAT/SOD)

BOOKS RECOMMENDED

1. *Essential Cell Biology:* **Author(s)**: Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander D.Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter.
2. The Cell: A Molecular Approach by Geoffrey M. Cooper (Author), Robert E. Hausman
3. Cell Biology Third Edition • 2017, Cover for Cell Biology; Thomas D. Pollard, William C. Earnshaw, Graham T. Johnson.
4. Cell and Molecular Biology: Concepts and Experiments, Gerald Karp, Binder Ready Version, 8th Edition, published by Wiley.
5. Molecular Biology of the Gene by James D. Watson, A. Baker Tania, et al. 2017, Pearson
6.Biochemistry and Molecular Biology of Plants by Bob B. Buchanan, Wilhelm Gruissem, et al. September 2015, John Wiley
7. Cell and Molecular Biology, Phillip Sheeler and Donald E. Bianchi, 2009, John Wiley
8. Molecular Biology of the Gene-Watson
9. Molecular Biology-Weaver

SBT SC15 Bioinstrumentation and Biophysical Chemistry and Microbial techniques Equivalent to paper 106

Unit –I
Bioinstrumentation and Biophysical Chemistry
Marks: Theory 25 Credit 2

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

Bio-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

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.

Books Recommended:

1. Bioinstrumentation, John G. Webster (Editor), John Wiley, ISBN: 978-0-471-26327-2.
2. Bioinstrumentation By: L Veerakumari 2015, ISBN: 9788180942549
3. Introduction to Biomedical Equipment Technology, 2002by CARR (Author)

Unit –II
Microbial techniques

Marks: Practical 25 Credit 2

Practical:

Preparation of liquid and solid media for growth of microorganism, isolation and maintenance of organism by plating, streaking and serial dilution methods, slant and stab cultures, storage of microorganism. Isolation of pure cultures, Growth curve, microscopic examination of bacteria, yeast and molds, Gram stain, Assay of Antibiotics, Microbiological analysis of drinking water, Fungi identification.

Books Recommended:

1. Bauman, Microbiology with Diseases by Body System, 4/e Pearson
2. Bauman, Microbiology with Diseases by Taxonomy, 4/e Pearson
3. Cappuccino, Microbiology: A Laboratory Manual, 10e Pearson
4. Tortora, Microbiology: An Introduction, 11e, Pearson
5. Microbiology: An Introduction, 13th Edition.

6. Brock Biology of Microorganisms, 14th Edition.
7. Clinical Microbiology Made Ridiculously Simple, 6th Edition.
8. Prescott's Microbiology, 10th Edition.
9. Jawetz Melnick &Adelbergs Medical Microbiology, 27th Edition.
10. Bailey & Scott's Diagnostic Microbiology, 14th Edition.

2nd SEMESTER

MBITCCC201, Genetics
Theory 25 Practical 25 [Credit 2+2]

Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests Extensions of Mendelian principles, Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. Sex determination and sex linked characteristics, Chromosomal, genetic (genic balance theory), environmental sex determination, structure of chromatin, centromere, telomere; C-value paradox, unique and repetitive DNA; transposable element, mechanism of transposition, transposable element in bacteria, yeast, maize, drosophila, human, retroposon, genetic and evolutionary significance of transposable element.

Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. DNA polymorphism in mapping; structure and function; polygenic inheritance.

Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.
Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders, DNA polymorphism in mapping; structure and function; polygenic inheritance.
Genetics of model organism: Drosophila, Arabidopsis, Mice, *C.elegans*, Zebra Fish
Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.
Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.
Population and Evolutionary genetics: Genotypic and Allelic Frequencies, its calculation, Genotypic Frequencies at Hardy–Weinberg Equilibrium, Nonrandom Mating Affects the Genotypic Frequencies of a Population, Closer Examination of the Assumptions of the Hardy–Weinberg Law its Implications. Extensions of the Hardy–Weinberg Law, Testing for Hardy–Weinberg Proportions, Estimating Allelic Frequencies with the Hardy–Weinberg Law.
Evolutionary Genetics: Organisms Evolve Through Genetic Change, Taking Place Within Populations, Many Natural Populations Contain High Levels of Genetic Variation, Molecular Variation, Protein Variation, DNA Sequence Variation, The Biological Species Concept, Reproductive Isolating Mechanisms, Modes of Speciation, Genetic Differentiation Associated with Speciation

Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Techniques of studying Bacteriophages-virulent phage(T4) and Temperate phage (phage lambda). Important aspects of life cycles; phage genome and gene mapping; host parasite relationship, immunity and repression; site specific recombination (lambda and PI), Transposable phage (Phage Mu), genetic organization and transposition, Mu as a genetic tool.

Practical
1. Bone marrow chromosome preparation from mice/human.
2. Problems & Solution of Human Pedigree
3. Two point and three-point test cross.
4. Problems on Probability.
5. Problems on Hardy Weinberg equilibrium

Books recommended

1. Pierce BA (2012) Genetics a conceptual approach 4th Edition, Freeman.
2. Russel PJ (2010) i-Genetics: A Molecular Approach
3. Lewin B (2006). Essential Genes. Pearson.
4. Klug, Cummins, Spencer Palladino (2012). Concepts of Genetics. Pearson
5. Brooker RJ. (2012). Genetics: Analysis and Principals. McGraw Hill

MBITCCC202, Biostatistics
Theory 25 Practical 25 [Credit 2+2]

Probability and statistics; population, variables, collection, tabulation and graphical representation of data, frequency distribution, central tendency and skewness, binomial, Poisson and Gaussian distributions,

Additive and multiplicative laws of probability, concept and correlation; regression; methods of least squares; chi-square tests, random number generation- testing and use; probability density and cumulative distribution function; systematic and random sampling.

MBITCCT203, Metabolism
Theory 25 [Credit 2]

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, Metabolism of nitrogen compounds protein turnover, metabolic regulation of enzymes, nitrogen fixation - mechanisms and control, nitrogen cycle.

Metabolic regulation: Protein & carbohydrate metabolism-oxidation of some aminoacids, urea sysnthesis, metabolism of creatin and creatinine, oxidation of saturated and unsaturated fatty acids, beta oxidation, ketogenesis.

Hormone action and fluid regulation: Hormones of anterior, intermediate and posterior pituitary, thyroid, parathyroid, adrenal, pancreas, Hormonal regulation in insects, Hormonal control of ionic and water balance

Thermoregulation: Temperature alters rates of chemical reactions and denatures Macromolecules, The thermal adaptation strategies of animals depend on their primary, source of heat, Heat exchange between the body and the environment takes place by radiation, conduction, convection, and evaporation , Heat gain versus heat loss determines core body temperature, Ectothermy, Endothermy and Homeothermy, Challenges and Controversies: What Is the Maximum Temperature for Life, The hypothalamus and/or spine integrates a multitude of thermo-sensory inputs from both the core and the surface of the Heterothermy Regional heterotherms heat only some parts of their bodies.

Plant physiology: Photosynthesis - Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO_2 fixation-C3, C4 and CAM pathways.

Respiration and photorespiration – Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway.

Nitrogen metabolism - Nitrate and ammonium assimilation; amino acid biosynthesis.

Plant hormones – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.

Sensory photobiology - Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks.

Animal Physiology: Nervous system - Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture.

Sense organs - Vision, hearing and tactile response.

Stress and adaptation

Digestive system - Digestion, absorption, energy balance, BMR.

Endocrinology and reproduction - Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, gametogenesis, ovulation, neuroendocrine regulation

Books recommended

1. Norris DO (2006). Williams text book of Endocrinology. Academic Press
2. Greenspan and Gardener (2003). Basic and Clinical Endocrinology, McGraw Hill.
3. David A Bender, Shauna M C Cunningham (2021) Introduction to Nutrition and Metabolism CRC Press.
4. Textbook of Biochemistry for Medical Students Book by Damodaran M. Vasudevan and S. Sreekumari.

5. Carbohydrate Metabolism: Theory and Practical Approach: Shashank Kumar (Editor) Central University of Punjab, Bathinda, Punjab, India.
6. Plant Physiology, 3rd ed by Lincoln Taiz and Eduardo Zeiger Publisher: Sinauer Associates; 3rd edition (Aug 30 2002.
7. Plant Physiology and Development Paperback – 1 March 2018, by Lincoln Taiz (Author), Eduardo Zeiger (Author), Ian M. Møller (Author), Angus Murphy
8. Introduction to Plant Physiology, 4th Edition William G. Hopkins, Norman P. A. Hüner ISBN: 978-0-470-24766-2 December 2008.
9. Biochemistry and Molecular Biology of Plants, 2nd Edition Bob B. Buchanan (Editor), Wilhelm Gruissem (Editor), Russell L. Jones (Editor) ISBN: 978-0-470-71421, 2015 1280 Pages

MBITCCC204, Recombinant DNA technology
Theory 25 Practical 25 [Credit 2+2]

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

Cloning in yeast: transformation in yeast, yeast vector development: Yep, YRp, YCp and YIp, 2m plasmid, yeast artificial chromosome (YAC, BAC), 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.
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.
Gene and Organic manipulation: Knock out/in, gene silencing, Gene editing (CRISPR-CAS) Synthetic biology

Practical
Isolation of plasmid DNA, transformation, restriction enzyme digestion, ligation, Southern blotting, Northern blotting, Overexpression of proteins, GFP- cloning, protein-DNA interactions.

Books Recommended
1. T. A Brown (2001). Gene Cloning and DNA Analysis: An Introduction.
2. SB Primerose and R Twyman (2006). Principles of Gene Manipulation and Genomics, 7th Edition, John Wiley.
3. Murray Moo-Young (2011). Comprehensive Biotechnology, Elsevier
4. From Genes to Genomes: Concepts and Applications of DNA Technology, 3rd Edition, Jeremy W. Dale, Malcolm von Schantz, Nicholas Plant

MBITCCC205, Diversity of Life forms and Environmental Application

Theory 25 Practical 25 Credit 2+2

Evolution of environment and Origin of life: Diversification of life and speciation; Classifying organisms: Concepts of phenetics and cladistics; Principles of ecological organization; Basics of structural & functional ecology; Concept of Population genetics

Basic approach to evolutionary biology and behavioural ecology: Evolutionary principles, Theory of Game and stable strategies; types of selections.

Biodiversity- levels of biodiversity, alpha, beta and gamma diversity, Global patterns of biodiversity, hotspots of biodiversity and megadiversity country; Biogeographic zones in India; factors influencing local andregional biodiversity, Biodiversity documentation

Threat to species diversity, Extinction vortex, Causes of extinction: Population viability analysis; Red Data Book, Biodiversity conservation approaches: Local, National and International, *In situ* and *ex situ* conservation, Concept of protected area network, Selecting protected areas, criteria for measuring conservation value of areas, Sanctuary, National Park and Biosphere reserves; Management of protected areas; Threats to wildlife conservation and wildlife trade; Tools for wildlife research, Wildlife threat, Use of Radiotelemetry and Remote sensing in wildlife research

Environmental biotechnology: Understanding biotechnology, Concept and outlines of various applications- GM crops and GMO: Environmental implications, Biodegradation, Phytoremediation: types and applications Bio-fuel production, Biofertilizer, Bio pesticides; Integrated PestManagement,

Microorganisms and environmental pollutants: Overall process of biodegradation, Environmental biomonitoring and indicator microorganisms, biodegradation of organic pollutants, anaerobic biodegradation, in-situ and ex-situ bioremediation, case studies of microbial remediation, lagoon and Vadose zone bioremediation, surface bioremediation of soils and sludge, Applied bioremediation and industrial applications, developing bioremediation technologies, Concept of Fermentation technology and Bioreactor,

Bioremediation and Microbial degradation of xenobiotics: Microbial transformation of pesticides, plastics, hydrocarbon fuel and halorespiration, microorganisms and metal pollutants, metal – microbial interaction and metal remediation; Surface Bioremediation of soil and sludge

Waste treatment – modern wastewater and solid waste treatment, traditional methods, wetlands and aqua-culture systems.

Practical

Biodiversity assessment: Aquatic and terrestrial communities, Biodiversity study of any ecosystem with indices, quadrate analysis, study of habitat specificity in birds, mammals on campus principally based on observations.

Books Recommended

1. Biodiversity: Concepts and Conservation B.B. Hosetti, S. Ramkrishna
2. Ecology & Biodiversity Dr. Ravi Babu Birudu, Dr. P. Padmavathi
3. Biodiversity: Perception, Peril and Preservation 2017 Prabodh K. Maiti, PaulamiMaiti
4. Concepts and Values in Biodiversity (Routledge Studies in Biodiversity Politics and Management) 1st Edition, Dirk Lanzerath (Editor), MinouFriele
5. Wastewater Treatment for Pollution Control and Reuse 2017 by Soli. J Arceivala, Shyam. R Asolekar.
6. Advances in Chemical Pollution, Environmental Management and Protection by Damia Barcelo, Academic Press.

MBITCCC206, Immunology

Theory 25 Practical 25 Credit 2+2

Blood & Blood cells: Bone Marrow, Reticulo-Endothelial system & ABO Blood groups. Tissue fluid, Lymph, Lymphatics, Lymph nodes and Spleen.
Antigen: Immunogenecity, antigen processing and presentation, structure and function of MHC
Immunoglobins: organization and expressions of Ig genes; B cell maturation, activation and differentiation; MHC/ HLA; antigen processing and presentation; T-cells, T-cell receptors, T-cell maturation, activation and differentiation;
Cytokines: Receptor and antagonist, cell mediated and humoral effector responses, auto immunity, Hypersensitivity and immunodeficiency diseases, transplantation immunology, cancer and immune system. Monoclonal and polyclonal antibodies, monoclonal antibody technique, vaccines
Immunotechniques: Immunoprecipitation, chip, flow cytometry, imaging (Immunofluorescence), ELISA, RIA, RAST and RIST
Practicals
Blood film preparation and identification of cells, determination of blood groups, Separation of PBL using density gradient, Immunodiffusion, Western Blotting (Immuno-blotting), Immunostaining/Immunofluorescence, ELISA, Immunodiagnostics (using commercial kits), Basic flowcytometry.

Books Recommended

1. Fahim Ali Khan (2009): The elements of Immunology. Pearson Press.
2. Abbas and Litchman. (2006) Cellular and Molecular Immunology. Saunders 6th Ed.
3. Roitt and Delves (2001). Essential Immunology. Blackwell Science.
4. Kindt, Goldsby Osborne (2007). Kuby Immunology. 6th Edition Freeman and Co.
5. Zlatko Dembic (2015). The Cytokines of the Immune System: The Role of Cytokines in Disease Related to Immune Response.
6. Janeway's Immunobiology by Kenneth M. Murphy and Casey Weaver9th Ed. 2015.
7. Clinical Immunology and Serology: A Laboratory Perspective Fifth Editionby Linda E. Miller &Christine Dorresteyn Stevens.

3rdSEMESTER

MBITCCC301, Genomics Proteomics and Protein Engineering Theory 50 Practical 25 [Credit 4+2]

Genomics: Introduction to genomics, Population mapping, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, chromosome microdissection.
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, transfection and recovery of clones, application of sequence information for identification of defective genes, receptor sequencing.
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.

Practicals
(i) analyse assembly of sequences (ii) analysis of sequences from already sequenced genomes to annotate promoter, ORF, analyse putative promoters (iii) show them yeast two hybrid screen (iv) arrangement with established facility to learn the process of sequencing and annotation.

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, spinspin interaction, NOE, 2D-NMR, NOESY, COSEY.

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.

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.

Chemical and Medical Industries: Generation of heat stable, pH stable enzymes, application in vaccine development, drug development, sensor development.

Practicals:
Protein electrophoresis-1D+2D, HPLC, FPLC, MALDI-TOF & LC-MS: demonstration.

Books Recommended
Genomics and Proteomics: Principles, Technologies, and Applications by Devarajan Thangadurai and Jeyabalan Sangeetha 2015, CRC Press.
Bioinformatics, Proteomics and Genomics, by Charles Malkoff,2017, Publisher Callisto.
Exploring Genomics, Proteomics and Bioinformaticsby Charles Malkoff, 2016, Syrawood Publishing House.
Genomes: Terence A Brown 2nd edition. Oxford: Wiley-Liss; 2002.
Proteome Analysis: Interpreting the Genomeby David W Speicher | May 18, 2004.

MBITCCC302, Bioinformatics and Computer Application Theory 25 Practical 25 [Credit 2+2]

Biological databases: Basic concepts of databases, importance of databases, integration of databases and its need. Nucleotide sequence databases, protein sequence databases, functional motif databases, Protein structure databases.
Sequence Analysis: Concept of DNA and protein sequence alignments and their importance. Sequence alignment programs. Comparative sequence analysis: Pair-wise sequence alignment and tools of Local and Global alignment, multiple sequence alignment and tools like Clustal W2 and T-Coffee.
Introduction to gene, genome and genomic branches. Define homology, analogy, orthologs and paralogs.
Evolution of genome: lateral or horizontal transfer of genome; phylogenetic analysis
Structural genomics: Genetical and physical mapping of genomes and applications. 4) Microarray technology, transcriptome and applications. Protein profiling (2D gels, protein fingerprinting & identification), protein structure analysis
Protein classification: SCOP and CATH schemes of classification (motifs, domains, folds, class, architecture, family & super family)
Protein structure: structure visualization, Metabolic networks: metabolic pathways and metabolic reconstruction
Practicals
Introduction to Pubmed, NCBI & EMBL
Introduction to FASTA & BLAST Dot-matrix comparison – understanding stringency
Searching DNA databases with FASTA and BLAST
Searching protein sequence databases with FASTA and BLAST; Pairwise alignment, Multiple sequence alignment; Compositional analysis of DNA – GC/AT content - codon usage - codon bias
Protein structure visualization &Understanding the bioinformatics behind human, rice, yeast and E.coli genome project.

Books recommended
1. Basics of Bioinformatics: Lecture Notes of the Graduate Summer School on Bioinformatics of China; Editors: Jiang, Rui, Zhang, Xuegong, Zhang, Michael Q. (Eds.) 2013.

2. Bioinformatics and Functional Genomics 3rd edition, Wiley-Blackwell, 2015.http://www.bioinfbook.org
3. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press.
4. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Cambridge University Press.
5. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition by Andreas D. Baxevanis, B. F. Francis Ouellette, Wiley-Interscience.
6. Practical Bioinformatics By Michael Agostino Copyright Year 2013

MBITCCC303, Bioprocess Engineering and Microbial Technology and Entrepreneurship
Theory 50 Practical 2 [Credit 4+2]

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 medical 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.

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, streptomycin, 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 packing-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.

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 state Fermentations, Fermentation raw materials, Downstream processing, Bio-mass production, fermented milk products (cheese making), bio-polymer (bioplastics), bioinsecticides, food additive (amino acids), health care products (antibiotics), Production of Industrial solvents (butanol); Industrial Enzymes (proteases), Concepts of immobilized enzymes.

Entrepreneurship: Broad ideas, its types, Entrepreneurial behaviors, psychological make up, training make up, financing, it exploitation, decision making, style, business opportunity, innovation, success.

Practical:

Isolation of industrially important microorganisms for microbial processes (citric / lactic/ alpha amylase) and improvement of strain for increase yield by mutation.

Comparison of ethanol production using various Organic wastes /raw Material [Free cells/ immobilized cells].

Cell disruption for endoenzymes by sonication.

Microbial production of glutamic acid.

Production of rifamycin using yeast strain.

Books Recommended

Microbial Technology, 2nd Edition, Microbial Processes, Editor: D Perlman.

Microbes and Microbial Technology, 2011, Agricultural and Environmental Applications, Editors: Ahmad, Iqbal, Ahmad, Farah, Pichtel, John.

Microbial Technology for Health and Environment, 2020, Editors: Arora, Pankaj Kumar

Rajni Gupta, APH Publishing, 2001 - Industrial microbiology

Bioprocess Engineering: An Introductory Engineering and Life Science Approach by Kim Gail Clarke

MBITOET304, Open Elective
Theory 50 Credit 4

MBITCCS305, Outreach
Practical 50 Credit 4

4th SEMESTER
MBITCCT401 , IPR, Biosafety, Bioethics and Medical Biotechnology
Theory 50 Credit 4

Economics, Biosafety. Patent rights and Special Topics Biotechnology R & D and industry: Business aspects of biotechnology, research and market place, Finance and human resources: Intellectual property right: patents, R & D partnership, license agreement and joint venture

Innovation Management: Technology transfer tools, Industry-Academia collaborations, Bio-incubators, Bio-accelerators, Finishing schools.; Bioethics: Role of bioethics in research. Prevention and management of plagiarism, fabrication/manipulation of data, conflict of interest, socio-cultural and behavioral conflicts during the conduct of research. Authorship & patenting/commercial rights and conflicts. Bioethical norms governing research related to animals and humans. Biosafety: Prevention and management of chemical and biological hazards associated with research. Evaluation and interpretation of data sheets, labels etc. for pre-assessment of biological and chemical hazards.

Perception on Bioresource: Legal binding of biological materials- concept of Bio-patents.

Disease diagnosis-probe: Detection of genetic, Neurogenetic disorders involving Metabolic and Movement disorders. Treatment products from recombinant and non-recombinant organisms, Interferons, Antisense therapy, cell penetrating peptides.
Gene therapy: Types of gene therapy, somatic virus germline gene therapy, mechanism of gene therapy, Immunotherapy, Detection of mutations in neoplastic diseases MCC, SSCP, DGGE, PTTC

Books Recommended

1. IPR, Biosafety and Bioethics-2013-Deepa Goel, Shomini Parashar, Pearson.
2. Bioethics and Biosafety Paperback-2013-by M. K. Sateesh.
3. Bases of Bioethics and Biosafety: study guide for stud. of higher medest. Bobyrov V. M.
4. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology 2017 1st Edition Author: Padma Nambisan. Elsevier
5. Biotechnology and Intellectual Property Rights Legal and Social Implications 2015, Authors: Singh, Kshitij Kumar, Springer.
6. Medical Biotechnology: Achievement Prospects and Perceptions 1999, by Albert Sasson.
7. Biotechnology in Medical Sciences 2014, FirdosAlam Khan.

MBITCCS402, Dissertation
Practical 100[Credit 8]

4 weeks training in Biotechnology Industry

MBITCCS403, Seminar & Grand Viva/ Industrial training
Practical 50 [Credit 4]

- **A recent peer reviewed journal paper would be presented in front of external and internal examiners along with power-point slides**
- **What achieved/gathered from Biotechnology Industry**
- **A panel of examiners, comprising of both internal and external examiners, shall conduct the Grand Viva voce examination**

MBITCCC404, Plant and Animal Biotechnology
Theory 25 Practical 25 [Credit 2+2]

Plant cell tissue and organ cultures: Introduction to cell and tissue culture techniques; totipotency; 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.

Animal Biotechnology: Stem cells; potency and differentiation, different signaling for development, Morphogenesis in different model systems, Developmental Regulation in Animal: Gametogenesis, fertilization and early development in animals: the development of germ cells, germ cells differentiation, oogenesis and spermatogenesis in mammals, recognition of egg and sperm, gamete fusion and prevention of polyspermy, the activation of egg metabolism, fusion of genetic material, rearrangement of egg cytoplasm; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals, germinal stem cells. Cloning; Transgenic systems. Animal Cell Culture methods. Application of animal cell culture for in vitro testing of drugs, testing of toxicity of Environmental pollutants in cell culture, Commercial scale production of diagnostic antigens and antisera. Assisted reproductive techniques, Cryopreservation of sperms and ova of livestock, Artificial insemination, Super ovulation, in vitro fertilization, Culture of embryos, Cryopreservation of embroys, Embryo transfer, embryo -splitting, embryo sexing, In utero testing of foetus for genetic defects. vermiculture and application of animal biotechnology in agro-economy. Transgenic animal production and application in expression of therapeutic proteins, biopharming

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 cells. Methods for transfer of DNA to plants, manipulation of gene expression in plants; production of transgenic plants without reporter or marker genes.

Application of plant transformation for productivity and performance: Herbicide resistance; Plantibodies and plantibiotics, Insect resistance; Bt genes; long shelf life of fruits and flowers; molecular farming, benefits and risks; 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.

Practical:

Basic techniques in plant cell, tissue and organ culture: Excised embryo culture; Organogenesis and somatic embryogenesis; Stages of micropropagation; Callus and cell suspension culture; isolation and culture of protoplasts; basic techniques in genetic transformation in plants; transformation with wild type and disarmed strains of Agrobacterium.

MBITCCT404. ADD ON
Theory 50 [Credit 4]