

**Course Structure and syllabus for Master of Science in
Biotechnology**

Two-year program (Four Semester)



(Choice Based Credit System)

**Department of Biotechnology,
Siddharth University, Kapilvastu,
Siddharth Nagar, UP- 272202**

To be implemented from Academic Session 2021-22

Semester wise distribution of course and credits for M. Sc. Biotechnology

Course No.	Course Title	Nature	Credit
Semester I			
MBT-101	Microbiology	Core	4
MBT-102	Molecular Biology	Core	4
MBT-103	Biomolecules	Core	4
MBT-104	Biophysical chemistry and technique	Core	4
MBT-105	Laboratory Course-I (Based on MBT-101, 102, 103 and 104)	Core	8
		Total	24
Semester II			
MBT-201	Immunology	Core	4
MBT-202	Cell Biology	Core	4
MBT-203	Bioinformatics and Biostatistics	Core	4
MBT-204	Genetic Engineering	Core	4
MBT-205	Laboratory Course-II (Based on MBT-201, 202, 203 and 204)	Core	8
		Total	24
Semester III			
MBT-301	Enzyme Technology	Core	4
MBT-302	Animal Biotechnology	Core	4
MBT-303	Plant Biotechnology	Core	4
MBT-304	Genomics and Proteomics	Core	4
MBT-305	Laboratory Course-III (Based on MBT-301, 302, 303 and 304)	Core	8
		Total	24
Semester IV			
MBT-401	Industrial Biotechnology	Elective	4
MBT-402	Environmental Biotechnology		
MBT-403	Biosafety, IPR and Research Ethics	Elective	3
MBT-404	Bioentrepreneurship		
MBT-405	Seminar	Core	3
MBT-406	Project Dissertation and Presentation	Core	14
		Total	24
Total credits of 4 semesters			96





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Semester I

MBT-101: Microbiology

Unit I:

Microbial diversity and systematics, Modern approaches to bacterial taxonomy, polyphasic classification, General characteristics of primary domains and of taxonomic groups belonging to Bacteria, Archaea and Eukarya, Nomenclature and outline of bacterial classification as per Bergey's Manual, Accessing microbial diversity using molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rRNA restriction analysis, terminal Restriction Fragment Length Polymorphism (T-RFLP), 16S rDNA sequencing, metagenomics. Viruses and their impact on daily life.

Unit II:

Methods in Microbiology: Theory and practice of sterilization, Pure culture techniques, Principles of microbial nutrition, Construction of culture media, Enrichment culture techniques, Isolation and culture of aerobic and anaerobic bacteria, Culture collection, preservation and maintenance of microbial cultures.

Unit III:

Metabolic Diversity among Microorganism: Microbial Nutrition: nutritional types and modes of nutrition in bacteria, Extremophiles. Microbial growth: The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth and Continuous culture.

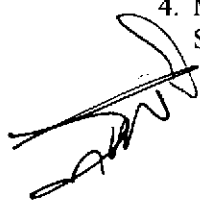
Unit IV:

Chemotherapy/Antibiotics Antimicrobial agents; Antibiotics: Penicillins and Cephalosporins and Broad- spectrum antibiotics, sulfa drugs, Antifungal antibiotics, Mode of action, Molecular mechanism of drug resistance. Bacterial Genetic System: Transformation, Conjugation, Transduction, Recombination, bacterial genetic map with reference to *E coli*.

Books Recommended:

1. Brock Biology of Microorganisms, 9th Edition. By Michael T. Madigan, John M. Martinko, Jack Parker. Prentice Hall, Inc.
2. Microbiology, 4th Edition. By Lansing M. Prescott, John P. Harley, Donald A. Klein. WCB McGraw Hill.
3. General Microbiology, 5th Edition by Roger Y. Stanier, John L. Ingraham, Mark L. Wheelis, Page R. Painter, Macmillan Press Limited.
4. Microbiology: Principles and Explorations, 5th Edition. By Jacquelyn G. Black, John Wiley & Son, Inc.

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MBT- 102: Molecular Biology

Unit I:

Prokaryotic and eukaryotic genome organization, structural elements of chromosome and construction of artificial chromosome. DNA replication: Enzymes, accessory proteins and mechanisms of prokaryotic and eukaryotic DNA replication.

Unit II:

Fine structure of gene, molecular basis of spontaneous and induced mutations and their role in evolution; DNA damage and repair, DNA amplification and rearrangement. Anti-sense and Ribozyme Technology: Inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme, hammerhead, hairpin and other ribozymes, applications of anti-sense and ribozyme technologies.

Unit III:

Transcription: Organization of transcriptional units, mechanisms of transcription and its regulation in prokaryotes and eukaryotes, Operon concept, attenuation and antitermination controls, RNA processing (capping, polyadenylation, splicing), DNA methylation, heterochromatization, General and specific transcription factors, regulatory elements and mechanism of transcription regulation, transcriptional and post-transcriptional gene silencing, environmental regulation of gene expression.

Unit IV:

Translation: Genetic code, Prokaryotic and Eukaryotic translation, mechanisms for initiation, elongation and termination, regulation of translation, co-and post- translational modifications of proteins. Homologous Recombination and Site-specific recombination.

Books Recommended:

1. iGenetics by Peter J Russell, Benjamin/ Cummings, New York
2. Molecular Biology of the Gene (4th Edition) J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M Weiner, The Benjamin/ Cummings Publ. Co. Inc, California
3. Molecular Biology of the cell (3rd Edition) by Bruce Alberts, Dennis Bray, Julian Lewis, martin Raff, Keith Roberts and James D. Watson, Garland Publishing, Inc, New York & London
4. Gene Cloning and DNA Analysis (4th Edition) by T.A Brown, Blackwell Science

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MBT- 103: Biomolecules

Unit I:

Amino acids and proteins: Classification, structure and properties of amino acids; primary, secondary, tertiary, quaternary and domain structure of proteins, forces stabilizing protein structure, Ramachandran plot, DNA-protein and protein-protein interactions, protein folding, protein misfolding and related diseases; protein sequencing.

Unit II:

Carbohydrates: Classification and structure of carbohydrates, polysaccharides, glycoproteins and peptidoglycans, glycolysis, TCA cycle, oxidative phosphorylation, glycogen synthesis and breakdown, gluconeogenesis, interconversion of pentoses and hexoses.

Unit III:

Nucleic acids: Primary and secondary structure of nucleic acids, Watson-Crick model of DNA, structural polymorphism of DNA and RNA, Conformation, Super coiling, Melting of DNA, Denaturation and Renaturation kinetics. Three-dimensional structure of RNA, classification, structure and functions of different types of RNAs, biosynthesis of purines and pyrimidines.

Unit-IV

Lipids: Classification, structure and functions, biosynthesis of fatty acids, oxidation of lipids, triglycerides, phospholipids, sterols. Glycoproteins and Glycolipids. Self-assembly of lipids, micelle, biomembrane organizations.

Books Recommended:

1. Biochemistry by Stryer, Freeman publisher
2. Biochemistry, Vol I, II, III by Geoffery Zubey, WCB press
3. Fundamentals of Biochemistry by Voet, Voet & Pratt, John Wiley publisher
4. Principles of Biochemistry by Albert Lehninger, David L Nelson & Michael M Cox, Mac Milan worth publisher.

MBT-104: Biophysical Chemistry and Techniques

Unit I:

Properties of biomolecules-mass, density, charge, isoelectric point, absorption/emission of light, detergent and membrane proteins, dialysis, ultra-filtration, protein crystallization, theory and methods, API-electrospray, MALDI-TOF, and ESI-mass spectroscopy.

Unit II:

Buffers and buffering capacity, Determination of pH: theory and instrumentation. Partition coefficient, general techniques of absorption and partition chromatography, TLC and paper chromatography, Gel-permeation, ion exchange, hydrophobic, reverse phase and affinity chromatography, HPLC, EPLC, GLC.

Unit III:

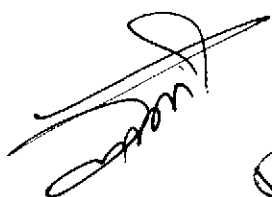
Electrophoretic techniques, polyacrylamide and agarose gel electrophoresis, Gradient electrophoresis, capillary electrophoresis, 2D electrophoresis, pulse field gel electrophoresis, centrifugation techniques (RCF, RPM, sedimentation coefficient), microcentrifuge and ultracentrifuge, differential and density gradient centrifugation, isolation of cell components, determination of molecular mass by sedimentation velocity and sedimentation equilibrium methods.

Unit IV:

Theory and principal of UV-visible, Raman spectroscopy, fluorimetry, circular dichroism, NMR, ESR, X-ray crystallography, radioactivity and stable isotopes, rate of radioactivity decay, measurement-Geiger-muller counter, solid and liquid scintillation counters, radiation dosimetry, Cerenkov radiation, applications of isotopes in biochemistry, radiotracer techniques, isotope dilution technique and metabolic studies.

Books Recommended:

1. Freifelder D. Physical biochemistry, Applications to biochemistry and molecular biology, 2nd edition, W.H. Freeman and company, San Francisco, 1982.
2. Keith Wilson and John Walker, Principles and techniques of practical biochemistry, 5th edition, Cambridge University Press, 2000.
3. D. Holme and H. Peck, Analytical Biochemistry, 3rd edition, Longman, 1998.
4. R. Scopes, Protein purification-principles & practices, 3rd edition, Springer, 1994



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MBT-105: Practicals

Based on papers MBT- 101, MBT-102, MBT-103 and MBT-104

Semester II

MBT-201: Immunology

Unit I:

Introduction: Phylogeny of Immune System, Innate and acquired immunity, Clonal nature of immune response, Primary and secondary immune response, Organization and structure of lymphoid organs, Cells of the immune system: Haematopoiesis and differentiation, lymphocyte trafficking, B lymphocytes, T- lymphocytes, Macrophages, dendritic cells, natural killer and lymphokine activated killer cells, Eosinophils, Neutrophils and mast cells. Antigen and superantigens Structure and function of immunoglobulins.

Unit II:

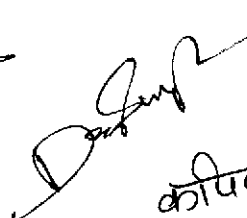
Major histocompatibility complex; Antigen processing and presentation, BCR and TCR, generation of immunological diversity, Complement system. Cell- mediated cytotoxicity: Mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity, effector mechanism.

Unit III:

Regulation of immune response: Generation of humoral and cell mediated immune responses, Activation of B-and T-lymphocytes, cytokines and their role in immune regulation, Immunological tolerance, Genetic control of immune responses. Immune Response against Covid-19 virus, cytokine storm syndrome, Immunoprophylactic intervention: Basic concepts of vaccination and different types of vaccines, Vaccines against Covid-19.

Unit IV:

Types of Hypersensitivity reactions, Autoimmunity and autoimmune disorders, Hypersensitivity, Autoimmunity, Tumor immunology, Primary and acquired immune-deficiencies with special reference to AIDS. Antigen and antibody interactions,



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Immunodiffusion, Immunoelectrophoresis, RIA, ELISA, Hybridoma technology and monoclonal antibodies.

Books Recommended:

1. Cellular and Molecular Immunology by Abbas et al., Saunder Publication.
2. Essential Immunology by Roitt, Blackwell Publisher.
3. Immunology by Kuby, Freeman Publisher.
4. Immunology-a short course by Benjamini, Wiley-Liss Publisher.

MBT-202: Cell Biology

Unit I:

Structure of prokaryotic and eukaryotic cells, Cellular organelles: Plasma membrane, cell wall, cytoskeleton- their structural organization; Mitochondria; Chloroplast; Nucleus and other organelles and their organization and function, genetic constitution of mitochondria and chloroplast, artificial membrane Liposomes.

Unit II:

Microscopic techniques: Principles and application of light, phase contrast, fluorescence, confocal, scanning and transmission electron microscopy, cytophotometry and flow cytometry, fixation and staining, Fluorescence in-situ hybridization (FISH), GISH (Genomic in-situ hybridization).

Unit III:

Transport of nutrients, ions and macromolecules across membranes, Cell cycle: Mitosis, meiosis, role of cyclins and cyclin dependent kinases, regulation of Cdk-cyclin activity, Cdk inhibitors, induction of cancer with respect to cell cycle, molecular events and regulation in model systems, cell surface receptors, second messenger system, MAP kinase pathways, mechanism of signal transduction pathway.

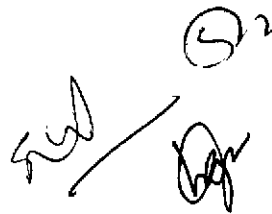
Unit IV:

Molecular biology and biochemistry of cancer, oncogenes, tumor suppressor genes, chemical carcinogenesis, Cellular basis of differentiation and development- cell division, gametogenesis and fertilization, differential gene activity and cell differentiation,

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Morphogenetic determinants in egg cytoplasm, genetic regulation of early embryonic development in *Drosophila*, homeotic genes.

Books Recommended:

1. Essential Cell Biology by Bruce Alberts et al., Garland Publisher.
2. Cell and Molecular Biology by F. D P deRobertes, LW & W Publisher.
3. Molecular Biology of the Cell by Alberts, Bray, Lewis, Raff, Roberts and Watson, Garland Publishers.
4. Molecular Cell Biology by H. Lodish, D. Baltimore, A. Bark, S. L. Zipursky, P. Matsudaira and J. Darnell, Scientific American Books.

MBT-203: Bioinformatics and Biostatistics

Unit I:

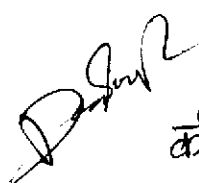
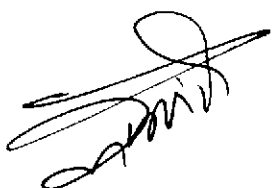
Fundamentals of computer, binary number, computer languages, client and server, internet and search engines. Introduction to Bioinformatics, database management system, biological databases such as GenBank, EMBL, DDBJ, Swiss-Prot, PIR, TIGR, TAIR, browsing and data retrieval, structure databases, sequence alignments, sequence comparisons, FASTA and BLAST analysis,

Unit II:

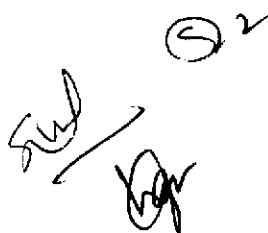
Gene predictions, comparative genomics, genome annotation, molecular evolution and phylogenetic tree, computational structural biology, Artificial Intelligence, data mining and cloud computing including its applications, In-silico methods for structural analysis, ligand drawing, homology modeling, threading, ab-initio modelling, model validation, computer aided drug design and application tools.

Unit III:

Biostatistics and applications, sources of data, selection of sample, sampling methods, qualitative and quantitative data, collection of data, their classification, tabulation, graphic representation and diagrammatic representation, measures of central tendency and dispersion.



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Unit IV:

Normal distribution and its applications, sampling variability, confidence limit, level of significance, testing of hypothesis, types of errors, Z-test, t-test, variance ratio test, chi-square test, correlation, regression analysis.

Books Recommended:

1. Introduction to Bioinformatics by Stephen A Krawetz and David D. Womble, Humana Press.
2. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor
3. Laboratory Press Fundamental of Biostatistics (5th edition) by Bernard Rosner, Duxbury Thomson Learning
4. Basic Statistics (2nd edition) by B. L. Agrawal, Wiley Eastern India.
5. Introductory Statistics for Biology Students by T. A Hall, Chapman & Hall publisher.
6. Statistical Methods in Biology by N. T. J Bailey, Cambridge Press.

MBT-204: Genetic Engineering

Unit I:

Molecular tools and their applications: Restriction endonucleases, polymerases, nucleases, kinases, topoisomerases, gyrases, methylases and ligases. Cloning vectors: Plasmids, Bacteriophages, Cosmids, Phagemids, Artificial chromosomes (BAC, PAC, MAC).

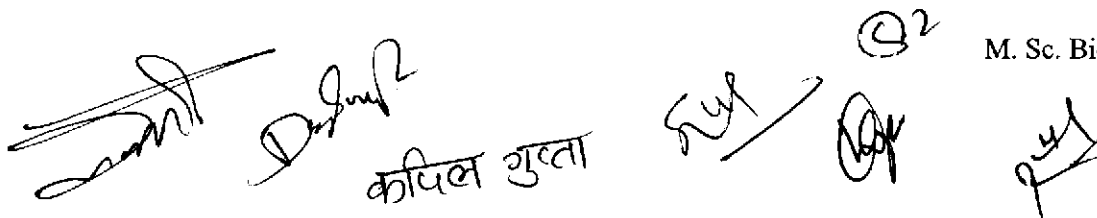
Unit II:

Construction and screening of genomic and cDNA libraries, EMSA (Electrophoretic mobility shift assay), DNA footprinting, Primer extension, SI mapping, RNase protection assay, Reporter assays, Principles and techniques of nucleic acid hybridization, Southern, Northern and Western hybridization/blotting, DNA microarray-fabrications, variations and applications, Serial Analysis of Gene Expression (SAGE).

Unit III:

Polymerase chain reaction: principle, different ingredients of PCR, primer-designing, variations-standard PCR, Touch down PCR, Hot- start PCR, Asymmetric PCR, Inverse PCR, Long PCR, High Fidelity PCR, Multiplex PCR, Nested PCR, Reverse transcriptase PCR, Real Time quantitative PCR, Applications of PCR in different fields.

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Unit IV:

Expression strategies for heterologous genes: vector engineering, codon optimization, host engineering, expression in bacteria, yeast, insects, mammalian cells and plants, in-vitro transcription and translation, T-DNA and transposon tagging.

Books Recommended:

1. iGenetics by Peter J Russell, Benjamin/ Cummings, New York
2. From Genes to Clones: Introduction to gene technology, by Ernst-L Winnacker, VCH Publication, Germany
3. Principles of Gene Manipulation: An Introduction to genetic Engineering (6th Edition) by R.W. Old and S.B. Primrose, Blackwell Publication
4. Genes IX by Benjamin Lewin, Oxford University Press, U.K.

MBT-205: Practicals

Based on papers MBT- 201, MBT-202, MBT-203 and MBT-204

Semester III

MBT-301: Enzyme Technology

Unit I:

Nomenclature and classification of enzymes, general properties of enzymes, active sites, cofactors and specificity. Isolation, purification and large scale production of enzymes with principles and applications of the involved techniques, viz gel filtration, ion exchange and affinity chromatography, centrifugation and electrophoretic techniques.

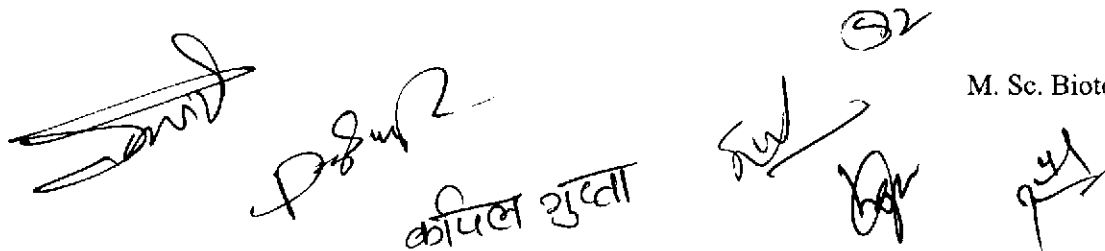
Unit II:

Enzyme kinetics: Enzymatic reaction mechanisms, Michaelis-Menten equation, Effect of substrate, pH, temperature and inhibitors on enzyme activity.

Mechanism of enzyme action and regulation: Active and regulatory sites, chemical modification, feedback inhibition, positive and negative cooperativity, allosteric enzymes.

Unit III:

Isozymes, multienzyme complexes, artificial enzymes, catalytic antibodies. Enzyme engineering-strategies, directed evolution, degradation of unnatural substrates.

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Unit IV:

Industrial enzymes: In detergent, food, leather, dairy, medicines and chemical industries.

Enzyme immobilization: Introduction, methods, applications and limitations.

Books recommended:

1. Enzymes: Biochemistry, Clinical Chemistry by T. Palmor, Harwood press
2. Fundamentals of Enzymology: The cell and molecular biology of catalytic proteins, by NC Price and Steven, Oxford press.
3. Biochemistry, Vol I, II, III by Geoffery Zubey, WCB press
4. Fundamentals of Biochemistry by Voet, Voet & Pratt, John Wiley publisher

MBT-302: Animal Biotechnology

Unit I:

Introduction to animal cell and tissue culture, its advantages and limitations, Applications of animal cell and tissue culture. Basic techniques in animal cell culture: Disaggregation of tissue and setting up of primary culture, established cell line cultures, maintenance of cell culture, culture media and role of serum in cell culture, organ culture.

Unit II:

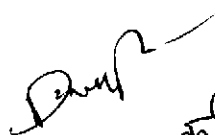
Biology and characterization of the cultured cells, measurement of growth, measurement of viability and cytotoxicity. Scale up of animal cell culture, cell cloning, cell synchronization and transformation.

Unit III:

Stem cell cultures: Embryonic and adult stem cells, their isolation, culture and applications, animal cloning. Transgenic animals, advantages: Construction of transgenic animals, gene knockouts, ethical and biosafety considerations.

Unit IV:

Gene therapy: Genetic disorders, vector engineering, types of gene therapy, strategies of gene delivery, targeted gene replacement/augmentation, gene editing, gene correction, gene silencing. Molecular markers linked to disease resistance genes, Application of



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RFLP in forensic, disease prognosis, genetic counseling and pedigree analysis, therapeutic proteins: methods of production and application.

Books recommended:

1. Animal Cell Culture: A practical approach by R.I. Freshney, IRL press.
2. Culture of animal cells: A manual of basic techniques by R.I. Freshney, Willy-Liss and Sons publication.
3. Animal cell culture technique by Martin Clynes, Springer publication.

MBT-303: Plant Biotechnology

Unit I:

History of plant cell and tissue culture; Culture media; various types of culture; callus, suspension, nurse, root, meristem, etc.; In vitro differentiation; organogenesis and somatic embryogenesis. History of plant cell and tissue culture; Culture media; various types of culture; callus, susp. Micropropagation; Anther and microspore culture; Somaclonal variation; In vitro fertilization; In vitro germplasm conservation; Production of secondary metabolites; Synthetic seeds.

Unit II:

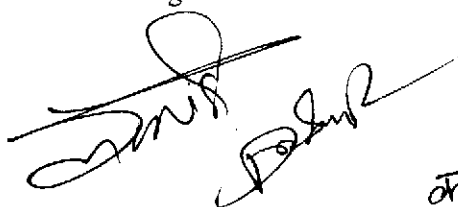
Embryo culture and embryo rescue; Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids. Conventional versus non-conventional methods for crop improvement; Present status and recent developments on available molecular markers, transformation and genomic tools for crop improvements. Molecular marker-aided breeding, QTL, molecular marker assisted selection.

Unit III:

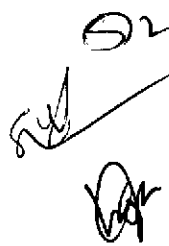
Plant transformation technology: Agrobacterium mediated gene transfer, Particle bombardment, Electroporation; transgene stability and gene silencing. Chloroplast Transformation, Genetic engineering for resistance against abiotic (drought, salinity, flooding, temperature, etc.) and biotic (insect pest, fungal, viral and bacterial diseases, weeds, etc.) stresses; Genetic engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; Genetic engineering for quality improvement (protein, essential amino acids, vitamins, minerals nutrients, etc.) etc.

Unit IV:

Metabolic Engineering and Industrial Products: Plant secondary metabolites, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway; alkaloids, biodegradable plastics, therapeutic proteins, edible vaccines, purification strategies.



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Books Recommended:

1. Plant Tissue Culture: Application and Limitation by S. S. Bhojwani and M. K. Razdan, Elsevier Publication
2. Plants, Genes and Agriculture by Maarten J Chrispeels and David E. Sadava, Jones & Bartlett Publishers
3. An Introduction to Plant Tissue Culture by M. K. Razdan, Oxford & IBH Publishing Co. Pvt. Ltd.
4. Plant Biotechnology: The genetic manipulation of plants by Adrian Slater, Nigel Scott, and Mark Fowler, Oxford University Press

MBT-304 Genomics and Proteomics

Unit I:

Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping, Next generation sequencing and its application.

Unit II:

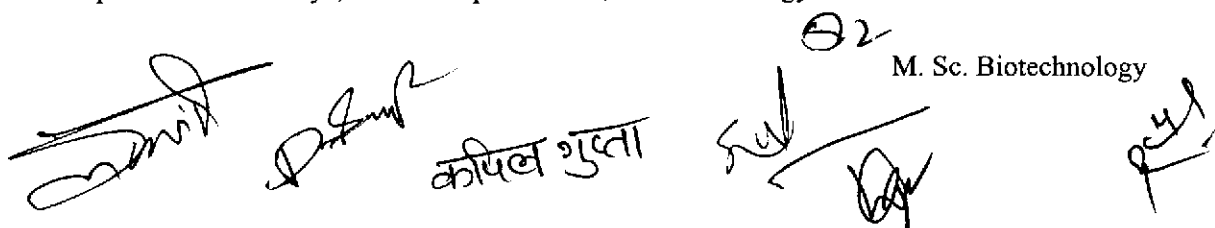
Genome sequencing projects, Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.

Unit III:

Proteomics: Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectric focusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.

Unit IV:

High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development, Functional genomics and proteomics, Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays; Structural proteomics, Nanotechnology and nano vehicles.

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Books recommended:

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and
4. Bioinformatics, 2nd Edition. Benjamin Cummings 2007
5. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
6. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.

MBT-305: Practicals

Based on papers MBT- 301, MBT-302, MBT-303 and MBT-304

Semester IV

MBT-401: Industrial Biotechnology

Unit I:

Introduction to bioprocess technology, bioreactors, Isolation, preservation and maintenance of industrial microorganisms, kinetics of microbial growth and death, media for industrial fermentation, air and media sterilization.

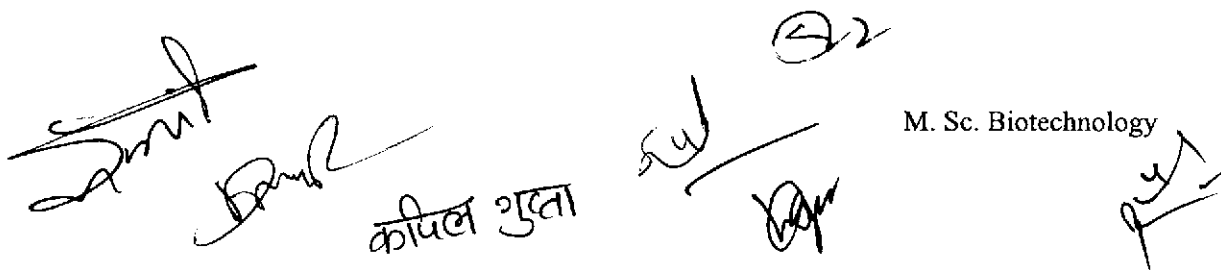
Unit II:

Types of fermentation processes: Analysis of batch, fed-batch, and continuous bioreactors, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, photobioreactors etc.), measurement and control of bioprocess parameters.

Unit III:

Downstream processing: Introduction, removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, Membrane process, Drying and crystallization, Whole cell immobilization and its industrial application.

Unit IV:

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Industrial production of chemicals: Alcohol (ethanol), acids (citric, acetic and gluconic), Solvents (glycerol, acetone, butanol), Antibiotics (penicillin, streptomycin, tetracycline). Amino acids (lysine, glutamic acid), Single cell protein, Use of microbes in mineral beneficiation and oil recovery, Introduction to food technology:Elementary idea of canning and packing, Sterilization and pasteurization of food products.,Technology of typical food/ food products (bread, cheese, idli), Food preservation.

Books recommended:

1. Principles of fermentation technology by PF Stanbury, A Whitekar and SJ Hall, Aditya Books.
2. Bioprocess Engineering; Basic Concept by ML Suler& F Kargi, PHI Press.
3. Operational modes of bioreactors (BIOTAL Series), Butterworth Heineman.
4. A Textbook of Industrial Microbiology by W Cruger&ACruger, W. H Freeman (Panima) Publisher.

MBT-402: Environmental Biotechnology

Unit I:

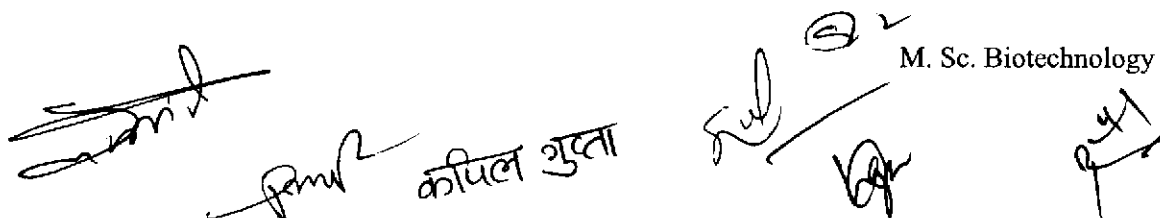
Introduction to Environmental Science: Environmental Pollution: Classification of pollutants, Ecosystem structure and functions, abiotic and biotic component, Energy flow, food chain, food web, Ecological Pyramids-types, biogeochemical cycles. Air, Water, Soil, Noise and Thermal pollution: Their source, Effect and biotechnology-based control measures. Solid waste pollution and its management. Harmful effects of air and water Pollution on humans, Air quality index.

Unit II:

Waste water Treatment: Biological treatment system (Oxidative ponds, aerobic and anaerobic ponds, facultative ponds, aerated ponds), Biological waste treatment, activated sludge treatment, microbial pollution in activated sludge, percolating filters, waste water treatment by biofilms. Treatment scheme of Dairy, Distillery, Tannery, Sugar, Fertilizers, Refinery, Chemical and Antibiotic waste.

Unit III:

Bioremediation & Phytoremediation: Biofeasibility, applications of bioremediation, Bioreduction, Phytoremediation. Microbial Leaching and biomining, Recovery of metals from solutions, Microbes in petroleum extraction, Microbial desulfurization of coal,

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microbial transportation of toxic metals, Biodegradation of chlorinated hydrocarbons and xenobiotic compounds, pesticides, oil spills, and toxic dyes industrial effluents.

Unit IV:

Biofertilizers, biopesticides with special reference to Bt Cotton and Integrated pest management (IPM). Energy & Biofuels: Non-conventional or renewable sources of energy, Energy from Biomass, Biosensors and biochips. Ozone depletion, UV-B, Greenhouse effect and acid rain, their impact and biotechnological approaches for management.

Books recommended;

1. Biotechnology -Expanding Horizons by B.D. Singh. 2nd Edition Kalyani Publishers.
2. Microbial Ecology: Fundamentals & Applications by Atlas, R.M. Wc Brown.
3. Environmental Microbiology by A.H. Varman, ASM Press.
4. Biodegradation and Bioremediation by Alexandar, M. Wiley International.

MBT-403 Biosafety, IPR and Research Ethics

Unit I:

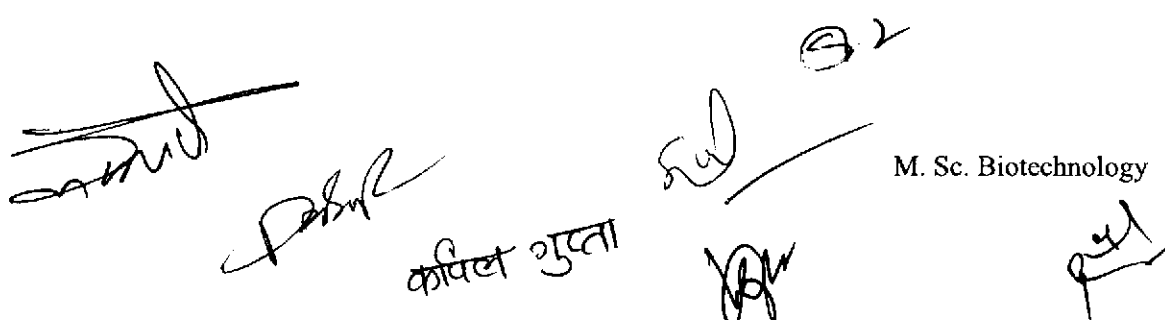
Intellectual property (IP), types, patent, copyright, trademark, trade secret, Industrial design, geographical indication, International framework for protection of IP, protection of new GMOs, IP in Biotechnology R & D, infringement, introduction of WIPO, TRIPS, WTO, GATT.

Unit II:

Patent database, searching international database, country wise patent searches (USPTO, EPO, India), analysis and report preparation, Indian patent act, recent amendments, patent filing, patenting-disclosure/non-disclosure, patent offices, PCT application.

Unit II:

International patenting, requirement, fees and guidelines, provisional/complete specifications, financial assistance for patent, publication of patent gazette of India, University/research rules in India and abroad, credit sharing, power of attorney, patent infringement and case studies.

A collection of handwritten signatures and marks at the bottom of the page. On the left, there is a large, stylized signature. Below it, another signature is visible. In the center, the name 'कपिल गुप्ता' (Kapil Gupta) is written in Hindi. To the right, there is a signature with a circled '2' above it. Below this, another signature is present. On the far right, the text 'M. Sc. Biotechnology' is printed, with a signature written over it.

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Unit IV:

Introductions to biological safety, cabinets, primary contaminants for biohazards, Biosafety levels, biosafety levels for specific microorganism, recommended biosafety levels for infectious agents and infected animals, Biosafety guidelines, GMOs and LMOs, Institutional biosafety committee, environmental release of GMOs, risk analysis, risk assessment and management, bioterrorism, National regulations and some international agreements, Cartagena protocol, Scientific communication and paper writing.

Books recommended

1. Gassmann, Oliver, Bader, Martin A., Thompson, Mark James Patent Management Protecting Intellectual Property and Innovation, Springer, 2021.
2. Padma Nambisan, An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology, Academic Press, 2017.
3. Kshitij Kumar Singh, Biotechnology and Intellectual Property Rights, Springer, 2015.
4. Karen B. Byers and Dawn P. Wooley, Biological Safety: Principles and Practices, ASM Press; 5th edition, 2017.

MBT-404: Bioentrepreneurship

Unit I:

Need and importance of entrepreneurship, Factors affecting entrepreneurship, Promotion of entrepreneurship, Features of a successful entrepreneurship.

Unit II:

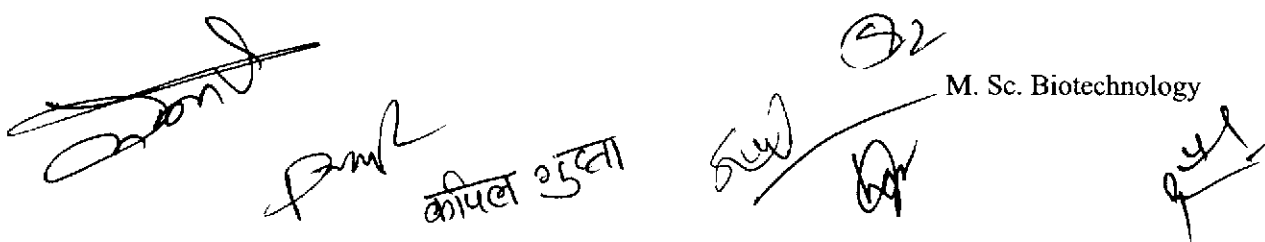
Types of business organization, Project Identification, Product selection and its formulation, Assessment of product feasibility.

Unit III:

Importance of Finance/loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital and its sources, ways to move for loans, Inventory direct and indirect raw materials and its management.

Unit IV:

Meaning and importance of marketing-mix, product management-Product line, Product mix, stages of product life cycle, Marketing research and importance of survey, Physical

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distribution and stock management. International business, Export financing, Institutional support for exports.

Books Recommended:

1. Holt DH. Enterprenuership; New venture Creation.
2. Kaplan JM. Patterns of Enterprenueership.
3. Gupta CB, Khanka SS. Enterprenuership and small Business Management, Sultan Chand & Sons.
4. Vasant Desai. Dynamics of Entrepreneurial Development & Management, Himalaya Publishing House
5. Poornima M. Charantimath. Entrepreneurship Development, Small Business Enterprises, Pearson Education.

MBT-405 Seminar

Seminar will be conducted by students on allotted topics based on the papers of course.

MBT-406 Project Dissertation and Presentation

Each Student will have to submit Dissertation report based on research works on assigned topic, followed by work presentation and Viva-Voce.





