Course Structure for Master of Science in Biotechnology

Two-year program (Four Semester)

(Choice Based Credit System)

Department of Biotechnology,
Faculty of Science,
Siddharth University, Kapilvastu,
Siddharth Nagar, UP- 272202

To be implemented from Academic Session 2022-23

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Subject: Biotechnology First year, Semester-I

Course Code	Credit/Max. marks	Paper number	Course name	Remark
MBTC-401	04/100	Paper -1	Microbiology	Core
MBTC-402	04/100	Paper -2	Molecular Biology	Core
MBTC-403	04/100	Paper -3	Biomolecules	Core
MBTC-404	04/100	Paper -4	Biophysical chemistry and technique	Core
MBTM-405	04/100	Paper -5	Introductory Biotechnology (Open for Other Departments)	Minor Elective
MBTL-406	04/100	Paper -6	Practical	
MBTP-407	04/--	Paper -7	Research Project	
Total	28/600			

Subject: Biotechnology First year, Semester-II

Course Code	Credit/Max marks	Paper number	Course name	Remark
MBTC-411	04/100	Paper -1	Immunology	Core
MBTC-412	04/100	Paper -2	Cell Biology	Core
MBTC-413	04/100	Paper -3	Bioinformatics and Biostatistics	Core
MBTC-414	04/100	Paper -4	Genetic Engineering	Core
MBTL-415	04/100	Paper -5	Practical	
MBTP-416	04/100	Paper -6	Research Project	
Total	24/600			

Subject: Biotechnology Second year, Semester-III

Course Code	Credit/Max. marks	Paper number	Course name	Remark
MBTC-501	04/100	Paper -1	Plant Biotechnology	Core
MBTC-502	04/100	Paper -2	Animal Biotechnology	Core
MBTE-503a	04/100	Paper -3	Enzyme Technology	Elective
MBTE-503b			Nanobiotechnology	
MBTE-504a	04/100	Paper -4	Genomics and Proteomics	Elective
MBTE-504b			Cancer Biology	
MBTL-505	04/100	Paper -5	Practical	
MBTP-506	04/--	Paper -6	Research Project	
Total	24/500			

Subject: Biotechnology First year, Semester-IV

Course Code	Credit/Max. marks	Paper number	Course name	Remark
MBTC-511	04/100	Paper -1	Industrial Biotechnology	Core
MBTC-512	04/100	Paper -2	Environmental Biotechnology	Core
MBTE-513a	04/100	Paper -3	Biosafety, IPR and Research Ethics	Elective
MBTE-513b			Computer Aided Drug Designing	
MBTE-514a	04/100	Paper -4	Bioenterpreneurship	Elective
MBTE-514b			Genomics for Crop Improvement	
MBTL-515	04/100	Paper -5	Practical	
MBTP-516	04/100	Paper -6	Research Project	
Total	24/600			
Grand Total	100/2300			

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Semester I

MBTC-401: Microbiology

Course Objectives and Outcomes:

- The objectives of this course are to introduce the students to the field of microbiology with special emphasis on microbial diversity, morphology, physiology and nutrition; methods for control of microbes, their role in environment, and metabolic processes. Students will learn to identify and demonstrate the structural, physiological, and genetic similarities and differences of the major categories of microorganisms, to identify and demonstrate how to control microbial growth.

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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MBTC- 402: Molecular Biology

Course Objectives and Outcomes:

- To teach topological properties of DNA, genetic code and students will benefited with a deep insight and mechanism of the various cellular processes such as DNA Replication, Transcription and Translation.

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

MBTC- 403: Biomolecules

Course Objectives and Outcomes:

- To extend comprehensive knowledge about structure and properties of biomolecules of the cell. Student will be able to understand assembly of biomolecules with each other to form supramolecular assemblies having structural and functional role in cell.

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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 GeofferyZubey, 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.

MBC-404: Biophysical Chemistry and Techniques

Course Objectives and Outcomes

- The goal is to impart basic conceptual understanding of principles of these techniques and emphasize biochemical utility of the same. Student is expected to have a clear understanding of all analytical techniques and to implement the knowledge in experiments.

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.

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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

MBTM-405: Introductory Biotechnology
(Elective for other Departments)

Course Objectives and Outcomes
- The goal is to introduce students the basic information and conceptual understanding of various biotechnology techniques for understanding their use and applications.

Unit I:
Biotechnology: An overview-definition, scope and importance of Biotechnology, Concept of Recombinant DNA technology and Gene Cloning. Microbial Biotechnology: A brief account of microbes in industry and agriculture, Metabolic engineering for over production of metabolites.

Unit II:
Plant Biotechnology: Introduction to plant tissue culture and its applications, Gene transfer methods in plants, Transgenic plants (A brief introduction), Chloroplast and mitochondria engineering. Animal Biotechnology: Introduction to animal cell and tissue culture and its applications, production of transgenic animals, cell transformation and cell lines, animal cloning.

Unit III:
Medical Biotechnology: (A brief account) Biotechnology in medicine, Vaccines, Diagnostic, Forensic, Gene therapy, Nano Medicine & Drug Delivery Cell & Tissue Engineering, Stem Cell therapy. Environmental Biotechnology: (A brief account) Role of biotechnology in pollution control, Sewage treatment, Energy management, Bioremediation, Restoration of degraded lands and Conservation of biodiversity.

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Unit IV:
Bioinformatics: (A brief account) Importance, Scope of Bioinformatics, world wide web as a tool, Bioinformatics institutes and databases, Bioinformatics training & limitations. Bio-business and Bio-safety, Biotechnology for developing countries and IPR.

Books recommended:

- Das H.K. (2004), Textbook of Biotechnology, Willey Dreamtech. Pvt. Ltd, New Delhi.
- Kumar H.D. (2004), A Text Book of Biotechnology, Eastern Willey Press, New Delhi.
- Gupta P.K. (2010), Biotechnology & Genomics, 5th Reprint, Rastogi Publications Meerut. 8.
- Biotechnology – Expanding Horizons by *B.D. Singh*. 2nd Edition Kalyani Publishers .
- Black J.G (2008) Microbiology- Principles and Explorations, 7th edition, John Wiley & Sons

MBTL-406: Practical

Based on papers MBTC- 401, MBTC-402, MBTC-403 and MBTC-404

MBTP- 407: Research Project

Related to the course

Semester II

MBTC-411: Immunology

Course Objectives and Outcomes:

- To provide a basic knowledge of the components of immune system and responsess that work together to protect the host. The students will gain the concept of immunity and immunity related diseases like hypersensitivity, immune disorders, and immunodeficiencies and various Immunotechniques.

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: Haematopoesis and differentiation, lymphocyte trafficking, B lymphocytes, T- lymphocytes, Macrophages, dendritic cells, natural killer and lymphokine activated killer cells, Eosinophils, Neutrophils and mast cells. Antigens 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 medicated 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, Immunoprophylatic intervention: Basic concepts of vaccination and different types of vaccines, Vaccines against Covid-19.

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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, 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.

MBTC-412: Cell Biology

Course Objectives and Outcomes:
- The course aims to an extensive coverage of molecular cell biology and shall enable the student to comprehend problems and latest research in the area of advanced 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, Morphogenetic determinants in egg cytoplasm, genetic regulation of early embryonic development in Drosophila, homeotic ge*nes.

Books Recommended:
1. Essential Cell Biology by Bruce Albertset.al., Garland Publisher.
2. Cell and Molecular Biology by F. D P deRobertes, LW & W Publisher.

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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.

MBTC-413: Bioinformatics and Biostatistics

Course Objectives and Outcomes:

- This course aims to teach o learn about this relatively newer branch bioinformatics and its applications. The student will learn about various tools, databases mining with the help of computers and perform Interpretation of data analysis.

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.

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.

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MBTC-414: Genetic Engineering

Course objectives and Outcomes:

- This course provides concepts of genetic engineering to the students of biotechnology and specially Recombinant DNA technology has been used commercially for the production of useful compound related to areas such as agriculture, medicine, environment and forensics.

Unit I:
Molecular tools and their applications: Restriction endonucleases, polymerases, nucleases, kinases, topoisomerases, gyrases, methylases and ligases. Cloning vectors: Plasmids, Bacteriophages, Cosmids, Phagemids, Artifical 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.

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.

MBTL-415: Practical

Based on papers MBTC- 411, MBTC-412, MBTC-413 and MBTC-414

MBTP- 416: Research Project

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

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Semester III

MBTC-501: Plant Biotechnology

Course objectives and Outcomes:

- The objectives of this course is to introduce students to the principles, practices and applications of plant biotechnology, plant tissue culture, genetic transformation and transgenics techniques to produce superior varieties. Students will learn the various applications of plant tissue culture and methods of gene transfer, and the production of hybrid varieties of plants in crop improvement.

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.

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

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MBTC-502: Animal Biotechnology

Course Objectives and Outcomes:

- This course will provide students the principles, basic concepts and applications of animal cell culture. Students will understand animal cell culture techniques and different approaches to generate transgenic animals and animal cloning along with gene therapy for the treatment of various diseases will be imparted to the students.

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 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.

MBTE-503a: Enzyme Technology

Course Objectives and Outcome:

- This course, students will provide students the information on enzymes, advanced kinetics of enzymes especially those catalyzing bisubstrate reactions. They will learn classification, annotation and kinetics of bisubstrate reactions, its kinetics and properties of allosteric enzymes, various mechanisms of enzyme action.

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

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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.

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

MBTE-503b: Nanobiotechnology

Course Objectives and Outcome:

- This course covers the concept & phenomena of nanotechnology in biological and biomedical research. The student will be able to understand the fundamentals of nanoscience, nanotechnology and their applications in biology by using nanomaterials in different medical/environmental applications.

Unit I:
Nanobiotechnology- introduction and its historical perspective. From Biotechnology to Nanobiotechnology. Introduction to nanomaterials, Properties of nanomaterials. Carbon Nano Structures and their properties Fullerenes, Bucky balls, quantum dots, Nanophosphors, SWNT and MWNT.

Unit II:
Synthesis of nanomaterials- Topdown and bottom-up approach for building nanobiomaterials, Chemical Transformation Biomaterials. Biomolecular Structure and Stability, challenges for the design of, nanobiomachines . Biomaterial supplementing important human body part.

Unit III:
Nanosensors-Miniaturization of Biosensors, Nanomaterial Based Biosensors. Effect of Biosensor in biological and physicochemical techniques. Applications of nanobiotechnology in early medical diagnostics, drug targeting. Nanobiomachines. Nanotoxicology and ethical considerations.

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Unit IV:
Preparation and characterization of nanoparticles: nanoparticular carrier system, micro and nano fluidics, drug and gene delivery system, microfabrication, chip technologies, biosensors, nano-imaging.

Books recommended:

1. Christof C Niemeyer and Chad A Mirkin , ed. Nanobiotechnology: concepts, applications & perspectives, Wiley-VCH Verlag GmbH & Co. KGaA
2. Jain, KK. Nanobiotechnology in molecular diagnostics: current techniques and applications, Horizon BioScience
3. Ralph S Greco, Fritz B Prinz and R Lane Smith : Nanoscale technology in Biological systems, CRC Press, United Kingdom.
4. Manasi Karkare : Nanotechnology: Fundamentals and applications, IK International publishing House, New Delhi

MBTE-504a Genomics and Proteomics

Objectives and Outcomes:
- This course will provide information related to prokaryotic and eukaryotic genomes as well as forward and reverse genetics and about the advances in structural and functional genomics and proteomics techniques. Students will gains the knowledge of functional genomics and proteomic approaches on newly sequenced genome for functional characterization of genes.

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.

MBTE-504b: Cancer Biology

Course Objectives and Outcomes:

- This course on cancer biology intends to provide basic information about the cancer, its types, causes and a cross talk of molecular cascades in cancer pathogenesis. It will help students to learn the concept of tumor heterogeneity, concept of cancer stem cells and advancements in cancer therapies.

Unit-I
Introduction to cancer, Types and Molecular reasons for cancer. Causes of cancer: Age distribution; Environment; Initiators and Promoters,

Unit-II
Tumor classification. Tumor behavior: Preneoplastic conditions; Preinvasive states; Benign tumors; Malignant tumors; tumor heterogeneity

Unit III
Oncogenes and tumor suppressor genes: their role in cancer. Molecular mechanisms of cancer pathogenesis, Tumor angiogenesis, extracellular matrix, overview of invasion and metastasis.

Unit-IV
Cancer treatment: Chemotherapy; Radiotherapy; new approaches to treatment. Biology of cancer stem cells and resistance to therapies

Books Recommended:
1. Alberts B, Bray D, Lewis J, Raff M, Roberts K, and Watson JD. Molecular Biology of the Cell Garland Science.
2. Introduction to Cancer Biology, Robin Hesketh, University of Cambridge, 2013
3. Understanding Cancer: From Basic Science to Clinical Practice, Alison MR and Sarraf CE, Cambridge University Press. 1997
4. iGenetics by Peter J Russell, Benjamin/ Cummings, New York

MBTL-505: Practicals

Based on papers MBTC- 501, MBTC-502, MBTE-503 and MBTE-504

MBTP- 506: Research Project

Related to the course

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Semester IV

MBTC-511: Industrial Biotechnology

Course Objectives and Outcomes:

- The objectives of this course are to introduce the students to the field of microbial technology with special emphasis on isolation and improvement of strains, bioreactor design, functional aspects of upstream and downstream processes in fermentation industry. Aims to educate students about the fundamental concepts of bioprocess technology and its related applications.

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:
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), Butterworh Heineman.
4. A Textbook of Industrial Microbiology by W Cruger & A Cruger, W. H Freeman (Panima) Publisher.

MBTC-512: Environmental Biotechnology

Course Objectives and Outcomes:

• The objectives of this course is to introduce the students to the field of environment related issue such as ever-increasing pollution and its effect on animal, plant and human health. Furthermore, detailed knowledge of water pollution, its sources waste water management, control and their remedial measures.

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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, 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, Green-house 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.

MBTE-513a: Biosafety, IPR and Research Ethics

Course objectives and Outcomes:

- This course aims to demonstrate detailed knowledge of various forms of intellectual property right such as patent, copyrights, geographical indications, industrial design, trade mark etc, filing of patent application, infringement of patent rights is very important for MSc. Students of life sciences as intellectual property rights and technological innovation have played an important role in improving the economy of Nations.

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.

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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.

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.

MBTE-513b: Computer-aided Drug Designing

Course objectives and Outcomes:

- This course aims to demonstrate the key skills of molecular modeling techniques currently practiced in any pharmaceutical research and development unit. Students will gain knowledge about the techniques for molecular modelling and drug designing

Unit I:
Drug discovery issues, computational approaches, their advantages, disease, and target selection, structure-based and ligand-based drug designing, drug target identification, PDB database, structure retrieval and analysis, complex structure, visualization, analysis and interpretation, database resources for drug discovery

Unit II:
Structure modeling, homology modeling, threading, fold recognition methods, tools, and servers for modeling, Ramachandran plot, accuracy, cavity, and binding site prediction, lead compound, lead optimization strategies

Unit III:
Ligand databases, PubChem, ZINC, ChEMBL, SMILES, searching, drawing, structure comparison and interpretation, pharmacophore modeling, molecular docking, virtual screening, protein-ligand interaction, molecular dynamics simulation

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Unit IV:
Absorption, distribution, metabolism, excretion, and toxicity (ADMET) parameters, significance, predictions tools, interpretation, Quantitative structure-activity relation (QSAR) analysis, pharmacokinetics, and pharmacodynamics, pharmacogenomics concept and applications, machine learning methods, and their roles in drug discovery.

Books Recommended:

1. Computer-Aided Drug Design (2020) by Singh DB, Springer Singapore
2. Computer-Aided Drug Design and Delivery Systems (2011) by Nag A and Dey B, The McGraw-Hill Companies, Inc
3. Bioinformatics: Methods and Applications (2021), by Singh DB and Pathak RK, Academic Press (Elsevier)

MBTE-514a: Bioentrepreneurship

Course objectives and Outcomes:

- This course aims to cover the awareness about the biotechnology enterprise. Exposure of management principles and the global scenario of biotechnology industries. The students will be able to address the market challenges for a new enterprise. Assess the global market scenario of their product and setup enterprise for new biotechnology product.

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 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.

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6. Entrepreneurship reflection & investigation; M.S. Bisht & R.C. Mishra, Chugh Publication.
7. Science Business: The Promise, the Reality, and the Future of Biotech by Gary P. Pisano Harvard Business School Press: 2006.

MBTE-514b: Genomics for Crop Improvement

Course objectives and Outcomes:

- This course will provide information related to structural and functional genomics related to crop plants. Students will gain the knowledge of functional genomics approaches for crop varieties and various techniques used for their improvements.

Unit I:
Introduction to science of omics for crop improvement, Introduction to the plant genome-nuclear, chloroplast and mitochondrial genomes, genome size and complexity, mapping of genome: genetic and physical maps, map-based cloning, molecular markers in plant genome analysis; RFLP, RAPD, STS, Microsatellite, SCAR (Sequence characterized amplified regions), SSCP (single strand conformational Polymorphism), and AFLP analysis, FISH and GISH for genome analysis.

Unit II:
Plant gene expression and regulation, functional genomics-expression analysis using microarrays, transposon tagging and Insertional mutagenesis - methods and significance, TILLING and EcoTILLING, Diversity Array Technology, transcriptomics.

Unit II:
Whole genome analysis: Genome size, strategies for sequencing genome, ordered genomic libraries (Cosmid, YAC, BAC libraries), Genome sequencing in plants–Principles and Techniques; Next generation sequencing technologies, Applications of sequence information in plant genome analyses; Comparative genomics, Detection of Single Nucleotide Polymorphism; Role of transcriptomics, proteomics and metabolomics in linking genome and phenome.

Unit IV:
Marker assisted selection (MAS), Genomic assisted breeding approaches, Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding, tagging of agronomically important traits, RNA interference in crop improvement.

Books recommended;

1. Genomes by T.A. Brown, John Wiley & Sons Ltd, New York
2. Genome analysis (Volume I, II, III and IV) a Laboratory Manual by Bruce Birren, Eric D. Green, Sue Klapholz, Richard M. Myers and Jane Roskams, Cold Spring Harbor Laboratory Press.
3. Discovery Genomics, Proteomics and Bioinformatics, Campbell AM &Heyer L, 2004, Pearson Education.

MBTL-515: Practical

Based on papers MBTC-511, MBTC-512, MBTE-513 and MBTE-514

MBT-516 Project Dissertation and Presentation

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

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