REVISED SYLLABUS

(Approved vide BPGS meeting held on 20-04-2018, Effective from Session 2018- 2019)

Master of Science

in

BIOTECHNOLOGY

BABASAHEB
BHIMRAO
AMBEDKAR
UNIVERSITY

LUCKNOW

प्रज्ञा शील करुणा

ESTABLISHED 1996

Babasaheb Bhimrao Ambedkar University
(A Central University)
Vidya vihar , Raebareli Road
Lucknow -226025

COURSE STRUCTURE FOR M .Sc., BIOTECHNOLOGY

I SEMESTER

Course Code	Course title	Course Type	Max Marks		Total Maximum	
			End Sem	Sessio-nal	Marks	Credit
MBT-101	CELL BIOLOGY	Non-Core	70	30	100	6
MBT-102	BIOMOLECULES	Foundation-Compulsory	70	30	100	6
MBT-103	BIOPHYSICAL TOOLS & TECHNIQUES	Non-Core	70	30	100	4
MBT-104a	INTERMEDIARY METABOLISM	Elective	35	15	50	2
MBT-104b	NANO BIOTECHNOLOGY	Elective	35	15	50	2
MBT-105	LABORATORY COURSE-1	Core	70	30	100	6
MPDC-105	REMEDIAL LANGUAGE COURSE	Foundation-Elective			25	1

II SEMESTER

Course Code	Course title	Course Type	Max Marks		Total Maximum	
			End Sem	Sessio-nal	Marks	Credit
MBT-201	MOLECULAR BIOLOGY	Foundation-Compulsory	70	30	100	6
MBT-202	MICROBIAL TECHNOLOGY	Core	70	30	100	6
MBT-203	ENZYME TECHNOLOGY	Non-Core	70	30	100	4
MBT-204a	IPR AND ETHICAL ISSUES IN BIOTECHNOLOGY	Elective	35	15	50	2
MBT-204b	MOLECULAR DIAGNOSTICS	Elective	35	15	50	2
MBT-205	LABORATORY COURSE-1I	Core	70	30	100	6
MPDC-205	MORAL STUDIES	Foundation-Compulsory			25	1

III SEMESTER

Course Code	Course title	Course Type	Max Marks		Total Maximum	
			End Sem	Sessio-nal	Marks	Credit
MBT-301	GENETIC ENGINEERING	Core	70	30	100	6
MBT-302	IMMUNOTECHNOLOGY	Core	70	30	100	6
MBT-303	PLANT BIOTECHNOLOGY	Core	70	30	100	4
MBT-304a	BIOINFORMATICS & SYSTEM BIOLOGY	Elective	35	15	50	2
MBT-304b	RNAi : BIOLOGY & APPLICATIONS	Elective	35	15	50	2
MBT-304c	STRUCTURAL BIOLOGY	Elective	35	15	50	2
MBT-305	LABORATORY COURSE-III	Core	70	30	100	6
MPDC-305	COMMUNITY SERVICE	Foundation-Compulsory			25	1

IV SEMESTER

Course Code	Course title	Course Type	Max Marks		Total Maximum	
			End Sem	Sessio-nal	Marks	Credit
MBT- 401	ENVIRONMENTAL BIOTECHNOLOGY	Non-Core	70	30	100	6
MBT- 402	BIOPROCESS ENGG. & TECHNOLOGY	Core	70	30	100	6
MBT- 403	ANIMAL CELL SCIENCE & TECHNOLOGY	Core	70	30	100	6
MBT- 404	DISSERTATION	Core	70	30	100	4
MBT- 405	SEMINARS	Core	35	15	50	2
MPDC- 405	AMBEDKAR STUDIES	Foundation-Compulsory			25	1
TOTAL (Minimum necessary for M. Sc Programme)					**2500**	**100**

Note:

1. DBT students can choose any other course of equal or higher credits from any other department of the university in leu of non- core and elective courses under the CBCS programme. However, all of these courses are available to students of other departments under the CBCS programme.
2. Only one elective can be taken by DBT students in a given semester.
3. Dissertation may be based on in house Training/Project Work/Scientific Review/Research Training outside.
4. Marks shown are only indicative for their probable use in the evaluation process.

MBT-101: CELL BIOLOGY

Credit: 06
Maximum Marks:100
Continuous Evaluation:30
End Semester Exam:70
Course Type: Non-Core

1. Structure of prokaryotic and eukaryotic cell – Sub cellular fractionation and criteria of functional integrity. **10hrs**

2. The structure of cellular organelles: Plasma membrane, cell wall, cytoskeleton their structural organization and extra cellular matrix. Mitochondria, chloroplast, ribosome, lysosome, nucleus, and other organelles and their organization.

   15 hrs

3. Biological membranes: Physicochemical properties of cell membranes and their structural constitution. Transport of nutrients across the membranes: simple, passive, facilitated diffusion, Protein targeting and sorting- Post transitional import of proteins to mitochondria lysosomes, nucleus, secretary vesicles, chloroplast and peroxisomes.

   25 hrs

4. Cellular responses to environmental signals in bacteria, plants and animals, Mechanism of signal transduction. Cell cycle molecular events and regulation. Genetic regulation of early embryonic development in Drosophila, homeotic genes

   10 hrs

5. Commercial application of cell Biology: Commercial application of cell culture, tissue culture as screening system; cytotoxicity and diagnostic test; mass production of biologically important compounds (e.g Vaccines); Harvesting of Products, Purification and assay.; Three diamentinal cultures and engineering.

   15 hrs

Total: 75 hrs

Suggested Readings:

1. H Lodish, D Baltimore, A Berk, SL Zipursky, P Matsudaira, J Darnell, *Molecular Cell Biology*, W.H.Freeman, USA.
2. Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, *Essential Cell Biology*, Garland, USA.
3. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, *Molecular Biology of the Cell*, Garland, USA.
4. Lubert Stryer, Jeremy Berg, John Tymoczko, *Biochemistry* , W.H.Freeman, USA.
5. David L. Nelson, Michael M. Cox ,*Lehninger: Principles of Biochemistry*, W.H.Freeman, USA.
   Gerald Karp, *Karp: Cell and Molecular Biology: Concepts and Experiments*, Wiley (Asia Pvt. Ltd).

MBT-102: BIOMOLECULES

Credit: 06
Maximum Marks:100
Continuous Evaluation:30
End Semester Exam:70
Course type: Foundation-Compulsory

1. Classification and physico-chemical properties of amino acids and proteins. Isolation, purification and criteria of purity of proteins. Definition, characteristics and determination of primary, secondary, tertiary and quaternary structures.

15 hrs

2. Classification & properties of mono-, di-, oligo and poly- saccharides. Structural features and compositional analysis of polysaccharides. Biological importance of glucose, fructose, maltose, sucrose, lactose, starch, glycogen, lignin, cellulose, peptidoglycan and glycoproteins.

15 hrs

3. Classification, structure, properties and functions of lipids. Biological importance of choline, lecithine, lipoproteins, chylomicrons , VLDL, LDL, HDL.

15 hrs

4. Structure, properties and functions of nucleic acids. Sequencing of DNA, DNA Polymorphism, Tm and its relation to GC content, Cot value.

15 hrs

5. Classification and properties of porphyrins, metalloproteins. Nature, synthesis and physiological significance of bile pigments.

15 hrs

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Total: 75 hrs

Suggested Readings:

1. Christopher K. Mathews, K.E. van Holde and Kevlin G. Ahern, *Biochemistry*, Pearson Education (Singapore) Pte. Ltd. Indian Branch, 482 F.I.E. Patparganj, Delhi.
2. Lubert Stryer, *Biochemistry*, W.H. Freeman and Company, New York.
3. D.L. Nelson, M.M. Cox, *Lehninger's Principles of Biochemistry*, Macmillan Worth Pub. Inc. New York.
4. Geoffery Zubey, Biochemistry, Macmillon Publishing Company, New York
5. Donald Voet and Judith Voet, *Biochemistry*, John Wiley & Sons, New York.

MBT-103: BIOPHYSICAL TOOLS & TECHNIQUES

Credit: 04
Maximum Marks:100
Continuous Evaluation:30
End Semester Exam:70
Course Type: Non-Core

1. Chemical foundations of biology: Weak and non- covalent interactions among the Biomolecules; Buffers: pH scale, pH and pKa of acids and bases. Hydrodynamic methods - Centrifugation- basic principles of sedimentation, types of analytical and preparative centrifugation their industrial application. Viscosity, Osmosis and surface tension in molecular weight determination. **10 hrs**
2. a) Chromatography- Principles and types chromatography, Planar - Paper (ascending and descending) TLC; column chromatography- Gel permeation; adsorption, ion-exchange, affinity chromatography. HPLC- Reverse and normal phase, FPLC, HPLC and FPLC. Gas Chromatography- types of Columns and detectors.

   b) Electrophoresis principles and types of electrophoresis – Native denatured gel electrophoresis, PAGE, SDS-PAGE, Isoelectric focusing, Pulsed field Gel electrophoresis- Types and its uses, 2D electrophoresis ; Capillary and microchip electrophoresis.

   10 hrs
3. Spectroscopy absorption and difference spectrum; UV-Vis spectrophotometer- basic instrumentation, monochromators and detectors used in UV-Vis spectrometry; Vibrational spectroscopy: IR, FT-IR interferometers used in FT-IR. Mass spectroscopy- types of ionization, Mass analyzers used in Mass spectroscopy, MALDI-TOF, Quadrupoles etc; Tandem Mass spectroscopy.

   10 hrs
4. Microscopy: principles of – light, fluorescent, Phase contrast microscopy. Electron microscopy- SEM and TEM, fixation and staining, specimen prepration ofr SEM and TEM. Flow cytometry - different type of flow cytometers and their principles. Basic instrumentation of flow cytometer- filters, lasers, phototubes and photobodies. Flow cell based, jet flow based technologies used in flow cytometers. NMR: basic principles; chemical shift, spin –spin coupling; Use of NMR in studying protein structure and deformalities. X-ray diffraction- Braggs equation, Reciprocal lattice concept.

   10hrs
5. a) Radioisotope (Tracer) techniques and their applications in biology; isotopic dilution, autoradiography. Radiation dosimetry.
   b) Statistical analysis of biochemical data: Standard deviation, mean, mode and least square analysis. Students T test and Chi square test. ANOVA, variance analysis.

   10 hrs

Total: 50 hrs

Suggested Readings:

1. Keith Wilson and & John Walker : Principles and Techniques of Biochemistry and Molecular Biology , Cambridge, UK
2. David Freifelder : Physical Biochemistry: Applications to Biochemistry and molecular biology , W H Freeman and Company, New York
3. David Sheehan : Physical Biochemistry : Principles and applications , John -Wiley, New York
4. Upadhyay, Upadhyay & Nath : Biophysical Chemistry- Principles and Techniques , Himalaya Publishing House, Mumbai
5. B R Bhatt , Biostatistics , New Age international, New Delhi
6. B Annadurai: A text book of Biostatistics, New Age international, New Delhi
7. David W Mount : Bioinformatics : Sequence and Genome analysis , CSHL Press, New York
8. Lesk, Arthur M: Introduction to Bioinformatics: Oxford University press, Oxford
9. Ralph S Greco , Fritz B. Prinz and R Lane Smith : Nano scale technology in Biological systems , CRC press, United Kingdom
10. Manasi Karkare: Nanotechnology: Fundamentals and applications, IK International publishing House, New Delhi.

MBT-104a:INTERMEDIARY METABOLISM

Credit: 02
Maximum Marks:50
Continuous Evaluation:15
End Semester Exam:35
Course Type: Elective

Unit I: Introduction to Metabolism, Methods to study Intermediary Metabolism, Principles of Bioenergetics, Importance of ATP. Glycolysis: entry of other carbohydrates into the glycolytic sequences, alcoholic fermentation, regulation of glycolysis. Citric acid cycle: establishment of the cyclic nature, individual reactions and enzymes of citric acid cycle, amphibolic nature of the cycle, Control of citric acid cycle. Glyoxylate cycle. Electron Transport chain. Pentose phosphate pathway of glucose oxidation. Importance of the pathway and its regulation. Gluconeogenesis. Introduction Fate of absorbed dietary lipids. Oxidation of fatty acids - Beta oxidation, alpha oxidation and omega oxidation. Oxidation of fatty acids with odd number of carbon atoms. Ketogenesis. Biosynthesis of saturated fatty acids and unsaturated fatty acids.

13 hrs

Unit II: Overview of amino acid degradation, transamination and the role of pyridoxal phosphate, oxidative deamination. Pathways of degradation of different amino acids (fates of carbon atoms of degraded amino acids) via pyruvate, acetoacetyl CoA leading to acetyl CoAKetoglutarate pathway, succinate pathway, fumarate pathway, oxaloacetate pathway. Urea cycle. Biosynthesis of amino acids: Biosynthesis of essential and nonessential amino acids. Nucleotide metabolism- Purine and pyrimidine ribonucleotide metabolism: de novo, and Salvage pathway of purine and pyrimidine ribonucleotide biosyntheses and its regulation.

12 hrs

Total: 25 hrs

Suggested Readings:

1. Lubert stryer 7th Edition. Biochemistry, WH Freeman and Company.
2. Lehninger Principles of Biochemistry, 4th edition by David L Nelson and Michael M Cox, WH Freeman and Company.
3. Thomas M Devlin. Text book of Biochemistry, 7th edition. John Wiley & Sons, Inc.

MBT-104b: NANOBIOTECHNOLOGY

Credit: 02
Maximum Marks:50
Continuous Evaluation:15
End Semester Exam:35
Course Type: Elective

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, Nanophophors, SWNT and MWNT . 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.

13 hrs

Unit II: 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.

12 hrs

Total: 25 hrs

Suggested Readings:

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
5. Guozhong Cao. Nanostructures and Nanomaterials - Synthesis, Properties and Applications, World Scientific publications

MBT-105:LABORATORYCOURSE-1

Credit: 06
Maximum Marks:100
Continuous Evaluation:30
End Semester Exam:70
Course Type: Core

1. Sub cellular fractionation.
2. Titration of amino acids and determination of pKa.
3. Model building using space filling / ball and stick models.
4. Identification of amino acids, sugars and lipids by TLC and/ or color reactions.
5. Isolation and quantification of Nucleic acids.
6. Quantization of proteins, sugars and cholesterol by different methods.
7. Determination of iodine, saponification and acid no. of lipid/ oil samples.
8. Separation of proteins by gel filtration and ion exchange chromatography.
9. Microscopy: Bright field, phase contrast and fluorescence microscopy.
10. Microtomy and Histochemical techniques.
11. Peptide mapping.
12. Separation techniques (HPLC , GLC ,FPLC)

Total: 190 hrs

MPDC-105:REMEDIAL LANGUAGE COURSE

Credit: 01
Maximum Marks:25
Continuous Evaluation:
End Semester Exam:
Course Type: Foundation Elective

MBT-201: MOLECULAR BIOLOGY

Credit: 06
Maximum Marks:100
Continuous Evaluation:30
End Semester Exam:70
Course Type: Foundation
Compulsory

1. Genomic organization of prokaryotes & eukaryotes, Genomes Polytene and Lampbrush chromosomes. Chromatin –histone and non-histone proteins. DNA- supercoiling , structure of gene , introns and exons. Applications of karyotyping, Chromosome painting and its analysis. **15 hrs**
2. DNA replication: prokaryotic and eukaryotic DNA replication, Mechanisms of DNA replication. Enzymes and proteins involved in DNA replication; DNA repair and recombination. PCR based applications in industries related to medical/ forensic and plant sciences. **15 hrs**
3. Transcription: Prokaryotic and eukaryotic transcription factors, regulatory elements and mechanisms of transcription regulation, Modifications in RNA: 5' cap formation, Transcription termination, 3' –end processing and polydenylation, Splicing, Editing and nuclear export of mRNA, mRNA stability. Ribozyme technology: strategies for designing ribozymes. RNAi Technology and its applications in Transgenics. **15 hrs**
4. Translation: Eukaryotic and translation, the translation machinery, mechanisms of initiation elongation and termination, regulation of translation. Synthesis of secretary and membrane proteins, import into nucleus, mitochondria, chloroplast and peroxisomes, receptor mediated endocytosis. Industrial production of commercially important proteins e.g. insulin, plantibodies, lactoferrin in various expression systems. **15 hrs**
5. Molecular mapping of genome : Physical maps, physical mapping and map based cloning , choice of mapping population , Southern and FISH for genome analysis , Chromosome microdissection, Molecular markers in genome analysis :RFLP, RAPD ISSR and AFLP analysis; Germplasm maintenance , genomic /cDNA libraries , Strategies for sequencing genome, Application of above markers in diagnosis of defective genes, paternity test, diseases and forensic science. **15 hrs**

Total: 75 hrs

Suggested Readings:

1. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, *Molecular Biology of Genes,* The Benjamin/ Cummings Publishing Company, New York.
2. T. A. Brown, *Genomes,* Wiley Publishers (Asia Pvt Ltd).
3. Lubert Stryer, Jeremy Berg, John Tymoczko *Biochemistry*, W.H.Freeman, USA.
4. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, *Molecular Biology of the Cell*, Garland, USA.
5. David L. Nelson, Michael M. Cox, *Lehninger: Principles of Biochemistry*, W.H.Freeman, USA.
6. Hartl and Jones, *Genetics*, Jones and Bartlett publishers, USA.
7. H.K.Das, *Textbook of Biotechnology*, Wiley Dreamtech India Pvt. Ltd.
8. Voet and Voet, *Biochemistry*, John Wiley and sons (Asia Pvt Ltd).
9. Benjamin Lewin, *Gene VIII*, Oxford University press, U.K.

MBT-202:MICROBIAL TECHNOLOGY

Credit: 06
Maximum Marks:100
Continuous Evaluation:30
End Semester Exam:70
Course Type: Core

1. History, Development & Scope of Microbiology, Prokaryotic cell: Structure and function, Cell Envelope (outer and inner membrane, surface polysaccharides, peptidoglycan, periplasmic space); Flagella, Pili, Cell inclusions i.e., Endospores, Gas vesicles. Prokaryotic diversity, Systematics and Taxonomy; Modern approaches to bacterial taxonomy, Polyphasic Classification; Ribosomal DNA sequencing, General characteristics of primary domains and of taxonomics groups belonging to Bacteria, Archea and Eukarya. Nomenclature and outline of bacterial classification as per Bergey's Manual. Bacterial genetic system: Transformation, conjugation, Transduction.

   15 hrs

2. Techniques in Microbiology: Theory and practice of sterilization, pure culture techniques; construction of culture media; enrichment of culture techniques, isolation and culture of aerobic and anaerobic bacteria; culture collection, preservation and maintenance of microbial cultures. Microbial growth: mathematical expression of growth, growth curve, measurement of growth and growth yields; synchronous growth; continuous culture; environmental factors affecting growth: temperature, acidity, alkalinity, water availability and oxygen.

   15 hrs

3. Metabolic Diversity among Microorganisms: Principles of microbial Nutrition; Nutrition types and modes of nutrition in bacteria. Bacterial photosynthesis; structural and functional properties of pigments. Oxygenic and anoxygenic photosynthesis and photodynamic death. Chemo lithotrophy; Hydrogen, iron & nitrite oxidizing bacteria; nitrate and sulfate reduction; Methanogenesis and Acetogenesis; Nitrogen metabolism; nitrogen fixation; hydrogen transformation.

   15 hrs

4. Host-parasite relationships: Normal micro-flora of human body, entry of pathogens into the host: Colonization and factors predisposing to infections; Types of toxins (Exo, Endo, Entero) and mode of actions, virulence and pathogenesis. Microbial diseases: Epidemiology of infectious disease with reference to Tuberculosis, Cholera, diseases transmitted by animals (Rabies), insects (Malaria) food (Salmonella) and Pathogenic fungi

   15 hrs

5. Chemotherapy/Antibiotics: Antimicrobial agents; Antibiotics: Penicillins and Cephalosporins; Broad spectrum antibiotics, Sulfa drugs; Antifungal antibiotics; mode of action; Molecular mechanism of drug resistance. Viruses: General properties, Structure and Classification of viruses based on their genomes; Bacterial (Phage λ and its life cycle), Plant (CaMV), Animal (Hepatitis, Retroviruses) Viruses, Virioids and Prions. RNA phages: Retroviruses.

   15 hrs

Total: 75 hrs

Suggested Readings:

1. Pelczar et al , *Microbiology* , Tata Mac Graw Hill , New Delhi

2. Pressscott, Harley, Klein, *Microbiology*-, WCB Mc Graw Hill, New York.

3. Madigan, Martinko, Parker , *Brock's Biology of Microorganisms* , Prentice Hall, New Delhi.

4. J Black , *Microbiology: Principles and Explorations* , John Wiley & Sons, New York.

5. Cappuccino Sherman , *Microbiology- A Laboratory manual*, Benjamin Cummings.

6. R Y Stanier et al , General Microbiology, Mc Millan Press Ltd., New Delhi.

MBT-203: ENZYME TECHNOLOGY

Credit: 04
Maximum Marks:100
Continuous Evaluation:30
End Semester Exam:70
Course Type: Non-Core

1. General characteristics of enzymes, nomenclature and classification of enzymes. Enzyme activity units, specific activity. Co-enzymes, cofactors, prosthetic group and vitamins, Enzymes activators and inhibitors, Multi-enzyme complexes. **10 hrs**

2. Modes and types of enzyme catalysis, Steady state and equilibrium hypotheses of enzyme catalysis, Michaelis-Menten and Brigg's Haldane equations, determination of K_m & V_{max}, meaning and significance of k_{cat}/K_m. **10 hrs**

3. Enzyme inhibition, Types and mechanisms of bi-substrate reactions, Mechanism and features of action of chymotrypsin, carboxypeptidase-A, lysozyme, Modes and types of enzyme regulation, the meaning of energy charge, isozymes and zymogens, and their importance in enzyme regulation, Enzyme induction and repression, covalent modification and feedback inhibition, Allosteric enzymes and their regulation. **10 hrs**

4. Immobilization of enzymes and their uses, Medium engineering-effect of physical factors; enzyme kinetics in biphasic reactions; stabilization of biphasic aqueous-organic systems, equilibria in biphasic aqueous- organic systems; Enzyme reactors; Enzyme Engineering; Biosensors; Designer enzymes/ synzymes; ribozymes, catalytic antibodies. **10 hrs**

5. Industrial Enzymes - proteolytic enzymes in food, meat and leather industry, enzymes in various fermentation processes, cellulose degrading enzymes, thermophilic/ alkalophilic enzymes, amylases, lipases, metal degrading enzymes. Clinical enzymes-Enzymes as thrombolytic agents, anti-inflamatory agents, isoenzymes, Some illustrative examples: CK, LDH, transaminases, cholinesterases, phosphatases, streptokinase, asparaginase. **10 hrs**

Total: 50 hrs

Suggested Readings:

1. Alan Fersht, *Enzyme Structure and Mechanism*, W.H. Freeman and Company, New York.
2. Irwin H. Segal, *Biochemical Calculations*, John Wiley & Sons, New York.
3. Khan, M.Y. and Khan, F. , *Principles of Enzyme Technology*, PHI, New Delhi.
4. Price, N.C. and Stevens, L., *Fundamentals of Enzymology*, Oxford University Press, London
5. Trevar Palmar**,** Enzymes*: Biochemistry, Biotechnology*, *Clinical Chemistry*, Rajkamal Electric Press, Delhi.

MBT-204a: IPR AND ETHICAL ISSUES IN BITECHNOLOGY

Credit: 02
Maximum Marks:50
Continuous Evaluation:15
End Semester Exam:35
Course Type: Elective

1. General Introduction to IPR, Patents, Trade Marks, Copy rights, Geographical indications, Industrial design Integrated circuit designs Plant Breeders' rights, trade secrets and Indian Patent Office. International framework for the protection of IP, IPs of relevance to Biotechnology and few Case Studies. Introduction to History of GATT, WTO, WIPO and TRIPS. **10 hrs**

2. Types of patents; Indian Patent Act 1970; Recent Amendments Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of Indian Patent Office; Procedure for filing a PCT application . Patent infringement- meaning, scope, litigation, case studies and examples, Protection of New GMOs. **10 hrs**

3. Ethical implications of biotechnological products, techniques, social and ethical issues. Biotechnology's Impact on Society; DNA on the Witness Stand - Use of genetic evidence in civil and criminal court cases, Improving public understanding of biotechnology products , Role of faculty , students, law firms and researchers to correct misconceptions among society and policy makers. **05 hrs**

Total: 25 hrs

Suggested Readings:

1. Asia Law House, Hyderabad, 2001, Law of Intellectual property by Myneni.S.R.
2. Butterworth's London 2001. Intellectual property law by Davis. Jennifer
3. Universal Law Publishing, Delhi 2001, Intellectual property: Patents trademarks and allied rights by Cornish W. R.
4. Sign KC : Intellectual Property Rights on Biotechnology , BCIL, New Delhi

MBT-204b:MOLECULAR DIAGNOSTICS

Credit: 02
Maximum Marks:50
Continuous Evaluation:15
End Semester Exam:35
Course Type: Elective

UNIT I: Biochemistry in Diagnostics and Molecular Biology Biochemistry in Diagnostics

What is molecular diagnostics? Why use molecular diagnosis? Proteins and Amino acids, Qualitative and quantitative techniques: Protein stability, denaturation; amino acid sequence analysis; Metabolism of lipids, carbohydrates, amino acids; In-born errors of metabolism; energy requirements, nutritional disorders; vitamins & minerals - biochemical function and deficiency manifestation.

Nucleic acid extraction, principle and methods; Polymerase Chain Reaction – principle, types (including RT-PCR, real-time PCR, QF-PCR) and applications; DNA sequencing methods – principle, types, automated process, DNA sequencers; Hybridization techniques – Southern, Northern, in-situ (including FISH), microarrays – types and applications; Protein extraction and analysis (including PAGE and its variations); Western Blot. **10 hrs**

UNIT II: Immunodiagnostics, drug delivery, GLP and GMP Immunodiagnostics: Introduction, antigen-antibody binding interactions and assays; Immunoassays – types [RIA, ELISA] and specific applications; Immunohistochemistry – principle and techniques. **10 hrs**

UNIT III: Drug delivery: Various drug delivery systems, targeting potentials; systems used for delivery of biotechnological products (Liposomes, microspheres, nanoparticles, immobilization techniques, etc.); GLP and GMP: Awareness, Documentation requirements andData Analysis. **05 hrs**

Total: 25 hrs

Suggested Readings:

1. Genes XII (2012) by B. Lewin, Oxford University Press.
2. An Introduction to Genetic Analysis (2000) by A.J.F. Griffiths, J.H. Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart, W.H. Freeman, New York.
3. Molecular Biology of the Gene (2004) by J.D.Watson, Tania A baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, Pearson Education Pte. Ltd. (Singapore).
4. Essentials of Molecular Biology (1998) by G. M. Malacinski and D. Friefelder, Jones & Bartlett Publishers.
5. rDNA safety guidelines &regulations-Government of India, Ministry of Science and Technology, Dept.of Biotechnology, New Delhi.
6. An Introduction to Forensic DNA Analysis (2002) Rudin, N and Inman, K.CRC Press.
7. Forensic DNA Typing. Biology, Technology and Genetics of STR markers (2005) John M. Butler, Elsevier Academic Press, Amsterdam.
8. Molecular Diagnostics: Fundamentals, Methods & Clinical applications (2007). Lele Buckingham and Maribeth L. Flaws.
9. Fundamentals of Molecular Diagnostics (2007). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Saunders Group.
10. Expert Review of Proteomics and Molecular Diagnostics (Journals).

MBT-205: LABORATORY COURSE -II

Credit: 06
Maximum Marks:100
Continuous Evaluation:30
End Semester Exam:70
Course Type: Core

1. Bacterial transformation
2. Study of mutation by Ames test.
3. Isolation of plasmids .
4. Isolation of genomic DNA and Southern blotting.
5. Isolation of RNA & Northern blotting.
6. Isolation of poly A RNA.
7. Preparation of probes.
8. Demonstration of transcription and translation.
9. Chemical modification of protein.
10. Enzyme: purification and kinetic analysis.
11. Methods for immobilization of enzymes
12. Techniques for analysis of different protein structure
13. Preparation of liquid and solid media.
14. Pure culture isolation and maintenance of organisms from soil and water by plating, streaking and serial dilution methods.
15. Slants and Stab cultures for preservation of microorganism.
16. Growth curve, measurement of bacterial population by turbidometry and serial dilution methods, Effect of temperature, pH and sores on growth.
17. Microscopic examination of bacteria, yeast and moulds and study of organisms by Gram stain, Acid fast stain and staining for spores.
18. Analysis of water for potability and determination of MPN.
19. Biochemical characterization of selected microbes.
20. Transduction.
21. One step growth curve of coliphage.
22. Assay of antibiotic and demonstration of antibiotic resistence.
23. CO_2 fixation by photosynthetic microbes.
24. Isolation of lambda phage DNA.
25. Construction of restriction map of plasmid DNA.
26. Cloning in plasmid /phagemid vectors.
27. Preparation of helper phage and its titration.
28. Preparation of single stranded DNA template.
29. DNA sequencing (demonstration).
30. Gene Expression in *E.coli* and analysis of gene products.
31. DNA amplification by using PCR.

MPDC-205: MORAL STUDIES

Credit: 01
Maximum Marks:25
Continuous Evaluation:
End Semester Exam:
Course Type: Fundamental
Compulsory

MBT-301:GENETIC ENGINEERING

Credit: 06
Maximum Marks:100
Continuous Evaluation:30
End Semester Exam:70
Course Type: Core

1. Molecular tools and their application: Nucelic Acid purifications, amplification, yield analysis and applications .Restriction endonucleases, polymerase nucleases, kinases, topoisomerases, gyrases, methylases and ligases Homologous Recombination: Holliday junction, FLP/FRT and Cre/ Lox recombination RecA and other recombinases. Restriction mapping of DNA fragments and Map construction .Nucleic Acid sequencing. Gene Cloning vectors, plasmids, bacteriophages, cosmids, phagemids , artificial chromosomes.

   15 hrs

2. Construction of cDNA, cloning: mRNA enrichment, reverse transcriptase ,DNA primers, linkers, adaptors and their chemical synthesis; genomic libraries and screening of libraries for selection of desired clones using nucleic acid hybridization techniques.

   15 hrs

3. Techniques for studying gene expression: DNA transfection, Northern and Western blot, DNA footprinting, primer extension, SI mapping, Rnase protection, Reporter assays techniques of in vitro mutagenesis and protein engineering. T-DNA and transposon tagging: role of gene tagging in gene analysis and identification and isolation of genes through T-DNA or transposon tagging.

   15 hrs

4. Polymerase chain reaction: Principles, variations and applications. Microarray: Printing of oligonucleotides and PCR products on glass slides, nitrocellulose paper. Genome analysis for global patterns of gene expression using fluorescent –labelled DNA or end labelled RNA probes. Analysis of single nucleotide polymorphism using DNA chips.
5. Vector engineering and codon optimization, host engineering, in vitro transcription, and translation, expression in bacteria, yeast, insect, mammalian cells and plants. Chromosome.

   15 hrs

6. Engineering Gene therapy: Vector engineering, strategies of gene delivery, gene replacement/ augmentation, gene editing, gene regulation and silencing.

   12 hrs

7. Industrial application expression of heterogonous genes, processing of recombinant proteins, refolding and stabilization, Industrial products of protein engineering, production of monoclonal antibodies by phase display technique using filamentous phase vectors, Gene therapy of human diseases.

   Total 75 hrs

Suggested Readings:

1. J Sambrook & EF Fritsch, *Molecular Cloning: A laboratory manual*, Cold Spring Harbor Laboratory press, U.S.A.
2. S.B Primerose, R M Twyman, *Principles of Gene Manipulation and Genomics*, Blackwell Science (Asia Pvt Ltd).
3. Richard J.Reece, *Analysis of gene and genome*, John Wiley and sons (Asia Pvt Ltd).
4. H.K.Das,*Textbook of Biotechnology*, Wiley Dreamtech India Pvt. Ltd.
5. T.A.Brown, *Principles of Gene Manipulation and Genomics*, Wiley Blackwell Publishers (Asia Pvt Ltd)
6. Bernard R. R. Glick, Jack J. Pasternak, Jack J. Pasternak, Jack J. Pasternak, *Molecular Biotechnology: Principles and Applications of recombinant DNA*, ASM Press, U.S.A.

MBT-302: IMMUNOTECHNOLOGY

Credit: 06
Maximum Marks:100
Continuous Evaluation:30
End Semester Exam:70
Course Type: Core

1. History & phylogeny of Immune system. Types of immunity. Cells & organs of the immune system. Structure and function of immunoglobulin's. Nature of antigens, antigenicity and immunogenecity. Lymphocyte traffic- Role of integrin's and selectin's in lymphocyte homing. **15 hrs**

2. BCR & TCR and generation of immunological diversity. Maturation and activation of B and T cell lymphocytes. Antigen antibody interactions – their principles and applications. Immunological techniques and their clinical applications – Precipitin and agglutination reactions, RIA, ELISA and FACS. **15 hrs**

3. MHC structure and function; MHC –polymorphism; MHC restriction, role of MHC in disease susceptibility/resistance. Antigen processing and presentation: generation of MHC class-I and class-II peptides and their association with antigenic peptides, antigenic cross presentation. Generation of immunological response and its genetic control. Transplantation immunology: Immunological basis of graft rejection; immunosuppressive therapy. Immunological tolerance: Central and peripheral tolerance, Clonal anergy, induction of tolerance, immunological privileged sites. Autoimmunity–systemic and localized autoimmunity and probable mechanisms to develop autoimmunity.
15 hrs

4. Complement system: Different pathways of Complement system activation and its regulation. Hypersensitivity reactions: Types of hypersensitive reactions as per Coombs and Gel classification: immunoprophylactic interventions. Immunodeficiency; primary, secondary immunodeficiency; SCID and AIDS. Tumor immunology - tumor antigens, immunological factors influencing the incidence of cancer, immune surveillance, effecter mechanisms in cancer immunity. **15 hrs**

5. Vaccines: Historical perspective; bacterial, viral vaccines and vaccines against cancer and birth control vaccines. Industrial production of vaccines in prokaryotic and eukaryotic system. Antibody engineering; Chimeric and humanized antibody and their production. Monoclonal and polyclonal sera their role in clinical diagnosis; Production of monoclonal antibodies and their role in clinical diagnosis eg: blood group, pregnancy and doping tests. Immunotoxins. **15 hrs**

Total: 75 hrs

Suggested Readings:

1. Richard A Goldsby, Thomas J Kindt, Barbara S Osborne : Kuby's Immunology. 5th Edition , W.H.Freeman & Coy , New York
2. Abbas , Basic Immunology: Functions& disorders of the immune system , WB Sanders Co. Philadelphia.
3. William Paul : Fundamental Immunology , Lippincot Raven, Philadelphia
4. Roitt : Essential Immunology :9th Edition, Blackwell Science ltd. London.
5. DP Stites, AL Terr, TG Parslow : Medical Immunology, 10th Edition, Appleton and Lange , New York
6. David Male, Jonathan Brostoff, David Roth & Ivan Roitt: Immunology: 7th Edition:Mosbey Title: Philadelphia
7. EP Diamandsis and Theodore K Christopoulos: Immunoassay , Academic press, Sandiego, USA
8. Ronald W Ellis : Vaccines- new approaches to immunological problems , Butterworth Henimann, Boston, USA
9. Hay, Frank C: Practical immunology: Blackwell ScienceLtd. London

MBT-303:PLANT BIOTECHNOLOGY

Credit: 04
Maximum Marks:100
Continuous Evaluation:30
End Semester Exam:70
Course Type: Core

1. Introduction to tissue culture industry: tissue culture as a technique to produce novel plants and hybrids: Tissue culture media (composition and preparation). Initiation and maintenance of callus and suspension culture; single cell clones. Organogenesis: somatic embryogenesis, artificial seeds, transfer and establishment of whole plant in soil. Shoot-tip culture: rapid clonal propagation and production of virus –free plants. Embryo culture and embryo rescue .Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; cybrids. Anther, pollen and ovary culture for production of haploid plants and homozygous lines. Current status of tissue culture industries in India. **10 hrs.**

2. Basic Techniques in r-DNA Technology Plant transformation technology : basis tumor formation , hairy root, features of Ti and Ri plasmids, mechanisms of DNA transfer role of virulence genes, use of Ti and Ri as Vectors, binary vectors , use of 35S and other promoters, genetic markers, Reporter genes, reporter gene with introns, use of scaffold attachment regions, different methods of plant transformation, Agrobacterium mediated, direct DNA transfer, particle bombardment, electroporation, microinjection, transformation of monocots. Transgene stability and transgene silencing, Chloroplast transformation: advantages and success story. **10 hrs.**

3. Industrial application of plant transformation for productivity and performance : with examples of engineering resistance to 1. Herbicides 2. Insect (Bt genes), 3. Virus resistance, (Coat protein/Replicase/RNAi) , 4. Antifungal, 5. Abiotic stress (salinity, drought, temperature) 6. Post harvest losses/ long shelf life of fruits and flowers, (ACC synthase, polygalactouranase, ACC oxidase) 7. Golden Rice 8. Male sterile lines, (bar and barnase systems), and examples of current development in the area. Current update of commercially available transgenic crops produced globally. **10 hrs.**

4. Molecular Marker –aided Breeding vs conventional breeding : RFLP maps, linkage analysis, polymorphism studies using RAPD markers, ISSR, DAMD, SCAR (sequence characterized amplified regions) SSCP (single strand conformational polymorphism) AFLP, QTL molecular marker assisted selection for plant industries, Gene flow in plants . **10 hrs.**
5. Plant Biotechnology and industrial products: Plant secondary metabolites, alkaloids, biodegradable plastics, therapeutic proteins, antibodies, edible vaccines, arid and semiarid plant biotechnology, cryopreservation, DNA banking for germplasm conservation. Industrial uses in therapeutics, cosmetics, food and beverage industries and commodity products.
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10 hrs
Total: 50 hrs

Suggested Readings:

1. Adrian Slater, Mark Fowler, Nigel Scott, *Plant Biotechnology: The genetic Manipulation of Plants* , , Oxford University Press, USA.
2. B.D.singh *Biotechnology: expanding horizons,* Kalyani Publishers, New Delhi.
3. S. B. Primrose, Richard M. Twyman, R. W. Old, *Principles of Gene Manipulation and Genomics*, Blackwell Science (Asia Pvt Ltd).
4. Richard J.Reece, *Analysis of gene and genome*, John Wiley and sons (Asia Pvt Ltd).
5. Rana P. Singh and Pawan K. Jaiwal, *Plant genetic engineering* (Vol 1-7), Studium Press LLC, USA.
6. Bob Buchanan, Wilhelm Gruissem, Russell L. Jones, *Biochemistry and molecular biology of plants*, John Wiley & sons (Asia pvt Ltd.) for American Society of Plant Biotechnology (ASPB) publication, USA.
7. H.S.Chawala, *Biotechnology in Crop Improvemen*, International book Depot, India.
8. Bhojwani and Razdan, *Tissue Culture*, Elsevier, Amsterdam.
9. Bernard R. R. Glick, Jack J. Pasternak, Jack J. Pasternak, Jack J. Pasternak, *Molecular Biotechnology: Principles and Applications of recombinant DNA,* ASM Press, U.S.A.

MBT-304a: BIOINFORMATICS & SYSTEM BIOLOGY

Credit: 02
Maximum Marks:50
Continuous Evaluation:15
End Semester Exam:35
Course Type: Elective

1. Bioinformatics: Introduction to Bioinformatics, Branches of Bioinformatics, Aims and Scope of Bioinformatics. Major Bioinformatics Resources: Biological databases NCBI, Sequence databases, GenBank , EMBL, DDJB, PIR, PDB, NDB, Knowledge driven Databases. **10 hrs.**

2. Sequence Analysis, Basic concepts: Computational analysis of sequences- Sequence-based searches: BLAST and FASTA Sequence submission tools –*Sequin, Webin, Sakura, Bankit*, Sequence similarity, identity and similarity, definitions of homologues, orthologues, paralogues, Multiple sequence Alignment. (MSA), Human and other genome project. **10 hrs.**

3. Gene Prediction Methods, Computational methods of gene prediction, Comparative genomics, Structural and Functional genomics, Gene annotation. **05 hrs.**

Total: 25 hrs.

Suggested Readings:

1.Orpita Basu and Simminder Kaur Thukral. Bioinformatics , *Databases, Tool and Algorithm.* Oxford University Press, USA

2.Zhumur Ghosh and Bibekanand Mallick. Bioinformatics, *Principles and Applications*. , Oxford University Press, USA

3. www.ncbi.nlm.nih.gov

4. Search engines available on Web and user friendly softwares.

5. Andreas D. Baxevanis and B.F. Francis Ouellette. Bioinformatics: *A Practical Guide to the Analysis of Genes and Proteins.* Wiley & sons..

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MBT-304b: RNAi : BIOLOGY AND APPLICATIONS

Credit: 02
Maximum Marks:50
Continuous Evaluation:15
End Semester Exam:35
Course Type: Elective

1. RNAi- Introduction and historical perspective. Post transcriptional gene silencing (PTGS), and related phenomenon. Small noncoding RNAs: dsRNAs, shRNAs, siRNAs, and miRNAs. Mechanism of RNAi in relation to siRNA and miRNA in Plants and Animals.

10 hrs.

2. Computational tools used in the identification of miRNAs. Tools used in designing of siRNA and miRNA, and the computational algorithms used to study the miRNA-mRNA bindings. Molecular basis of siRNA/miRNA mediated gene silencing and RNAi suppressors. Functional genomics.

10 hrs.

3. Applications of RNAi in disease resistance / crop improvement/RNAi therapy. Therapeutic role of RNAi.

05 hrs.

Total: 25 hrs.

Suggested readings:

1. Gregory J. Hannon. RNAi: *A Guide to Gene Silencing*. CSHL Press. USA

2. Ronal P. van Rij . Antiviral RNAi. Concepts, Methods and Applications. Springer Protocols. Human Press. USA

3. Gordon G. Carmichael. RNA Silencing: Methods and Protocols. CSHL Press. USA

4. Lewin B. Genes IX. Jones and Barlett Publishers, USA.

5.Hiroaki Kodama ,and Atsushi Komamine . RNAi and Plant Gene Function Analysis: Methods and Protocols (Methods in Molecular Biology, Vol. 744) Springer. Human Press. USA

MBT-204c:STRUCTURAL BIOLOGY

Credit: 02
Maximum Marks:50
Continuous Evaluation:15
End Semester Exam:35
Course Type: Elective

UNIT -I: **(04 Hours)**

Overview of Structural Biology:Basic structural principles, conformational principles, Ramachandran diagram, forces involved in macromolecular interaction, building blocks of proteins, Proteins-Primary Structure, Chemistry And Covalent Modifications, motifs of protein structures:Protein Secondary and Supersecondary Structure , alpha domain structures, alpha/beta structures, Macromolecular crystallography-concepts.

UNIT -II: **(04 Hours)**

Structural Classification of Proteins, Profiles and Protein Families, DNA structures, DNA recognition in prokaryotes and eukaryotes, specific transcription factors, enzyme catalysis and structure. Membrane proteins, signal transduction, proteins of the immune system. Structure of Spherical viruses, DNA – Protein Interactions,RNA – Protein Interactions.

UNIT -III: **(04 Hours)**

Protein Folding and flexibility, Protein Misfolding, Disease, in vivo Folding and Degradation, Prediction, Engineering and design of protein structures. Methods toidentify secondary structural elements, Macromolecular Machines in Protein Folding and Unfolding.

UNIT-IV **(04 Hours)**

Determination of protein structures by X-ray and NMR methods. Prediction of secondary structure- PHD and PSI-PRED methods. Tertiary Structure : homology and comparative modelling, fold recognition and ab-initio approaches. Structures of oligomeric proteins and study of interaction interfaces.

UNIT- V **(04 Hours)**

Introduction to Molecular Graphics, *In silico* study of biological structures. Structural genomics-concepts and significance, Structural databases**,** Protein Quaternary Structure and Cooperativity, Metalloenzymes – Structure & Mechanism, Carbohydrate Binding Proteins: Structure and Function.

Prescribed Text Books:

1. Introduction to Protein Structure by Carl-Ivar Branden, John Tooze
2. Proteins: Structures and molecular properties. Freeman, New York. Second edition by Creighton, T. E.
3. Introduction to Protein Architecture Arthur M. Lesk (2001) Oxford University Press

Additional Reading:

1. Voet & Voet. (2011). Biochemistry, (4^{th} edition), Wiley
2. Nelson & Cox, Lehninger. (2008). Principles of Biochemistry 4th edition, W. H. Freeman Publications.
3. Foundations of Structural Biology by Leonard J. Banaszak

MBT-305: LABORATORY COURSE -III

Credit: 06
Maximum Marks:100
Continuous Evaluation:30
End Semester Exam:70
Course Type: Core

1. Blood film preparation and identification of cells.
2. Lymphoid organs and their microscopic organization.
3. Immunization and collection of serum.
4. Radial immunodiffusion and double diffusion.
5. Immunoelectrophoresis.
6. Purification of IgG from serum.
7. Purification of mononuclear cells by Ficoll-Hypaque.
8. conA induced proliferation of thymocytes (By MTT method)
9. ELISA and Western blotting
10. Hapten conjugation and quantitation**.**
11. Preparation of tissue culture medium and role of serum in it.
12. Preparation of single cell suspension from spleen and thymus.
13. Cell counting and cell viability.
14. Macrophage from monolayer from PEG and measurement of phagocytic activity.
15. Trypsinzation of monolayer and subculturing.
16. Cryopreservation and thawing.
17. Preparation of metaphase chromosomes from cultured cells.
18. Isolation of DNA and demonstration of apoptosis of DNA laddering.
19. MTT assay for cell viability and growth.
20. Cell fusion with PEG.
21. Callus propagation, organogenesis, transfer of plants to soil.
22. Protoplast isolation and culture.
23. Anther culture, production of Haploids.
24. Cytological examination of regenerated plants.
25. Agrobacterium culture , selection of transformants, reporter gene (GUS) assays.
26. Developing RFLP and RAPD maps.

Total: 190 hrs

MPDC-305: COMMUNITY SERVICE

Credit: 01
Maximum Marks:25
Continuous Evaluation:
End Semester Exam:
Course Type: Foundation Compulsory

MBT-401:ENVIROMENTAL BIOTECHNOLOGY

Credit: 06
Maximum Marks:100
Continuous Evaluation:30
End Semester Exam:70
Course Type: Non-Core

1. Environment: basic concept and issues. Environment pollution: types of pollution, methods for the measurement of pollution; methodology of environmental management the problem solving approach, its limitations.

   25 hrs

2. Air pollution and its control through biotechnology. Water pollution and its control: water as a scarce natural resources, need for water management, measurement of water pollution, sources of water pollution, waste water treatment –physical, chemical and biological treatment processes.

   15 hrs

3. Microbiology of waste water treatments, aerobic process: activated sludge, oxidation ditches, trickling filters, towers, rotating discs, rotating drums, oxidation ponds. Anaerobic processes: anaerobic digestion, anaerobic digestion, anaerobic filters, upflow anaerobic sludge blanket reactors.
   Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic Industries. Solid wastes: sources and management (Composting, vermiculture and methane production).

   20 hrs

4. Microbiology of degradation of xenobiotics in environment –ecological considerations, decay behaviour & degradative plasmids; hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides. Biopesticides in integrated pest management. Bioremediation of contaminated soils and wasteland.

   15 hrs

5. Global environmental problems: ozone depletion, UV-B, green house effect and acid rain, their impact and biotechnological approaches for management. **10 hrs**

Total: 75 hrs

Suggested Readings:

1. M. Yoong, *Comprehensive Biotechnology*, Pergamon Press, Oxford.
2. Metcall and Eddy, *Waste Water Engineering-Treatment, Disposal and Reuse*, McGraw Hill, New York.
3. I S Thakur, Environmental Biotechnology, I.K. International Pvt. Ltd, New Delhi.
4. B.D.Singh, Biotechnology- Expanding Horizons, Kalyani Publishers, New Delhi.
5. Ronald,L. Grawford et al, **Manual of Environmental Microbiology**, ASM Press, New York.

MBT-402: BIOPROCESS ENGG. & TECHNOLOGY

Credit: 06
Maximum Marks:100
Continuous Evaluation:30
End Semester Exam:70
Course Type: Core

1. Air and media sterilization Media for industrial fermentation Isolation, preservation and maintenance of microorganisms, Kinetics of microbial growth and death.

15 hrs

2. Types of fermentation process: Analysis of batch, fed –batch and continuous bioreactors, stability of microbial reactors, stability of microbial reactors, analysis of mixed microbial populations, Bioreactors (pulse, fluidized, photo bioreactors etc.)

15 hrs

3. Measurement and control of bioprocess parameters; downstream processing: Introduction, removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, cell disruption, liquid –liquid extraction, chromatography, membrane process, drying and crystallization.

15hrs

4. Whole cell immbolization and its industrial application. Industrial production of chemicals: alcohol (ethanol), acids (citric, acetic and gluconic), solvents (glycerol, acetone, butoanol), antibiotics (penicillin, streptomycin, tetracycline), amino acids (lysine glutamic acid), single cell protein.

15 hrs

5. 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. **15 hrs**

Total: 75hrs

Suggested Readings:

1. Stanbury, P.F & Whittacker , *Principles of Fermentation technology* , Pergamon. Press Oxford
2. Michael L Shuler & Fikret Kargi , *Bioprocess Engg.: Basic concepts* , Prentice Hall, New Delhi.
3. M.Yoong (Ed-in-Chief) , *Comprehensive Biotechnology Vol 3* , Pergamon, Oxford
4. B.D.Singh , *Biotechnology- Expanding Horizons* , Kalyani Publishers ,NewDelhi
5. H.K.Das , *Text book of Biotechnology* , Wiley Publications , New Delhi

MBT-403: ANIMAL CELL SCIENCE AND TECHNOLOGY

Credit: 06
Maximum Marks:100
Continuous Evaluation:30
End Semester Exam:70
Course Type: Core

1. Basic techniques of mammalian cell culture: Disaggregation of tissue; Primary and established cell line cultures. Measurement of cell viability and cell cytotoxicity. Measurement of growth. Culture medium- Different types of culture media; Biological significance of serum in media and serum free media.
    a. Biology and characterization of the cultured cells; Maintenance of cell culture- Contamination. Different methods used in Cell separation.
    b. Cell Cloning and Cell synchronization, Scaling –up of animal cell culture. Industrial production of different vaccines using various cell lines. **15 hrs**

2. Cell Transformation and Differentiation. Stem cell cultures- source of stem cells, embryonic stem cells and their medical applications. Organ culture and organotypic culture. 3-D functional organ printing, artificial organ. Somatic cell Nuclear transfer experiments- Roslin and Honolulu techniques. Molecular events during fertilization. Role of maternal contribution in early embryonic development.
15 hrs
3. Biology of Cancer: Chemical carcinogenesis. Oncogenes and viral oncogenes- mechanism of conversion of protooncogenes to oncogenes, mechanism of action of oncogenes. Tumor suppressor genes- structure, function and mechanism of action of pRB and p53 tumor suppressor proteins. Cancer chemotherapy and radiotherapy. Role of mAbs as therapeutics in cancer. Apoptosis- morphologic and biochemical features of apoptosis, role of apoptosis in regulating lymphocyte development. Autophagy. **15 hrs**

4. Gene therapy: Somatic and Germ line gene therapy; strategies of gene delivery in animal cells, targeted gene replacement /augmentation, gene editing and gene silencing .Transgenic animals: Use of transgenic animals for various applications in Biomedical research and industrial products. Molecular pharming. Production of gene knockouts and conditional gene knockouts mice. Vector engineering- for high level (protein) expression in animal cells. Ethical and biosafety considerations in producing the transgenic animals. **15 hrs**
5. Molecular markers linked in clinical diagnostic of human disease / disorders. Disease resistant genes in Malaria and AIDS. Application of RFLP in disease diagnosis and prognosis. Pedigree analysis for different human disorders and its use in genetic counseling. **15 hrs**

Total: 75 hrs

Suggested Readings:

1. Freshney, R.I : Culture of Animal cells , Wiley Publications , New York
2. Edi. Jhon R.W. Masters : Animal cell culture- practical approach , Oxford University press, Oxford
3. Ed. R.Basega : Cell growth and division : A practical approach , IRL press,Oxford University press, Oxford
4. Ed. Martin Clynes : Animal cell culture techniques , Springer- Verlag, New York,
5. F.Grasveld, George V. Kallias: Transgenic Animals, Academic press, Sandiego, USA
6. Asok Mukhopadhyay: Animal cell technology, IK International publishing House, New Delhi.

MBT-404: DISSERTATION

Credit: 04
Maximum Marks:100
Continuous Evaluation:30
End Semester Exam:70
Course Type: Core

(In house Training/ Project Work/Scientific Review/Research Training outside)

To be under taken by the students under the guidance of advisor allotted

MBT-405: SEMINARS

Credit: 02
Maximum Marks:50
Continuous Evaluation:15
End Semester Exam:35
Course Type: Core

MPDC-405: AMBEDKAR STUDIES

Credit: 01
Maximum Marks:25
Continuous Evaluation:
End Semester Exam:
Course Type: Foundation Compulsory