

Course Structure at a Glance

M.Sc. Biotechnology

(4 Semester PG Degree Course)

(Choice Based Credit System)

Department of Biotechnology

Jamia Millia Islamia, New Delhi

Semester I			
Paper Code	Paper Title	Maximum Marks	Credits
MBT 101	Molecular Biology	100	4
MBT 102	Cell Biology	100	4
MBT 103	Biochemistry and Biophysics	100	4
MBT 104	Genetics (CBCE)	100	4
MBT 105	Immunology	100	4
MBT 106	Lab Course-I	100	4

Semester II			
Paper Code	Paper Title	Maximum Marks	Credits
MBT 201	Microbiology	100	4
MBT 202	Metabolism and Enzymology	100	4
MBT 203	Animal Biotechnology	100	4
MBT 204	Genetic Engineering	100	4
MBT 205	Cellular and Molecular Physiology (CBCE)	100	4
MBT 206	Modern (-Omics) Technologies (SEC)	100	4
MBT 207	Lab Course-II	100	4
MBT 208	Seminar-II	25	

Semester III			
Paper Code	Paper Title	Maximum Marks	Credits
MBT 301	Bioprocess Engineering and Fermentation Technology	100	4
MBT 302	Plant Biotechnology	100	4
MBT 303	Environmental Biotechnology	100	4
MBT 304	Biostatistics and Bioinformatics	100	4
MBT 305	Medical Biotechnology and Mol. Medicine (CBCE)	100	4
MBT 306	IPR, Bioethics and Entrepreneurship (AECC)	100	4
MBT 307	Lab Course- III	100	4
MBT 308	Seminar III	25	

Semester IV			
Paper Code	Paper Title	Maximum Marks	Credits
MBT 401	Research Project	400	16
MBT 402	Seminar IV	100	4

Semesters	Marks	Credits
Semester-I	600	24
Semester-II	725	28
Semester-III	725	28
Semester-IV	500	20
Total	2550	100

SEMESTER- I

Molecular Biology (Code: MBT-101)

**4 Credits
MM:100**

Unit 1: Structure and organisation of genome

Packaging and organisation of genomes in virus, bacteria and eukaryotes, structure of chromatin, nucleosome, chromatin organisation and remodelling, chromosome, centromere, telomeres, histone proteins, heterochromatin and euchromatin, torsional stress, DNA topology- linking number, twist, writhe, supercoiling, topoisomers.

Unit 2: DNA replication, repair and recombination

DNA replication models, Meselson and Stahl experiment, DNA polymerases, DNA replication in viruses, bacteria and eukaryotes, replication fork, trombone model, proofreading and fidelity of replication, extrachromosomal replicons, end replication problem and telomerase, replication inhibiting drugs, DNA damaging agents, DNA repair mechanisms (nucleotide excision repair, base excision repair, mismatch repair, recombination repair, double strand break repair, transcriptional coupled repair, recombination- homologous, non-homologous and site-specific recombination), gene conversion, recombination proteins- RecA, RuvA, B, C.

Unit 3: Gene expression and regulation

Structure of prokaryotic and eukaryotic genes, regulatory regions, transcription factors, transcription machinery, RNA polymerases, RNA processing, RNA transport, structure and functions of different RNA types, initiation complex formation, elongation, termination, operon concept- lac operon, trp operon, ara operon, λ -repressor, lexA repressor, transduction, lysogenic and lytic cycles of bacteriophages, quorum sensing, riboswitches, chromatin remodelling in transcription, Swi/Snf complex, inhibitors of transcription.

Unit 4: Protein synthesis, processing and transport

mRNA translation, translational machinery, translation mechanics, structure of ribosomes, genetic code, wobble hypothesis, codon degeneracy, economy of tRNA, aminoacylation of tRNA, proofreading in translation, post-translational modifications in proteins, regulation of protein synthesis, role of mTOR pathway in protein synthesis, transport of synthesized proteins, protein turnover and degradation, translational inhibitors.

Unit 5: Methods and techniques in molecular biology

Methods of isolating DNA (genomic and plasmid) and RNA, DNA and RNA analysis by electrophoresis, agarose and polyacrylamide gels, PFGE, DNA and RNA purity analysis, DNase I footprinting, EMSA, yeast-two hybrid system, PCR.

Suggested readings:

1. *Molecular Cell Biology: 7th Edition, (2012)- Lodish H., Berk A, Kaiser C., KReiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA.*

2. *Genes XI: 11th edition (2012)*- Benjamin Lewin, Publisher - Jones and Barlett Inc. USA.
3. *Molecular Biology of the Gene, 6th Edition (2008)*- James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA.
4. *Molecular Biology, 5th Edition (2011)*- Weaver R., McGraw Hill Science. USA.
5. *Fundamentals of Molecular Biology, (2009)*- Pal J.K. and Saroj Ghaskadbi, Oxford University Press. India.
6. *Molecular Biology: genes to proteins, 4th edition (2011)*- Burton E Tropp, Jones & Bartlett Learning, USA.

Cell Biology (Code: MBT-102)

4 Credits
MM:100

Unit 1: Cellular structure and composition

Prokaryotic and eukaryotic cell structure, compartmentalisation of cells, structure and functional features of cellular organelles; nucleus and its components, endoplasmic reticulum, golgi apparatus, lysosome, mitochondria, chloroplast, peroxisome, vacuoles, microtubules, flagella, microfilaments, cell junctions, animal and plant cell walls, plasmodesmata, interrelationships between cell organelles.

Unit 2: Membrane structure and function

Plasma membranes, lipid bilayers, membrane models, cytoplasmic membrane system, structural and functional properties of plasma membrane, transport across plasma membrane, sorting and regulation of intracellular transport, membrane electric potentials, vesicular traffic, exocytosis, endocytosis, pinocytosis, protein trafficking.

Unit 3: Cell signalling

Extracellular and intracellular signaling, signal transduction receptors, ligands, structure and function of G-protein coupled receptors, receptor and non-receptor kinases, intracellular signalling transducers, kinases, phosphorylations, PI3K, MAPK and JAK-STAT pathways, signalling molecules, IP3/DAG, cAMP, secondary messengers, hormones and non-receptors signalling pathways, control of gene activity by signaling pathways- activation of transcription factors by signaling.

Unit 4: Cell differentiation, cell death, cell cycle and cancer

Cell differentiation, programmed cell death, necrosis, cell cycle and its regulation, role of hormones and growth factors in- regulation of differentiation, cell death and cell cycle, pluripotency and proliferation, cell transformation and cancer, hallmarks of cancer, initiation, progression and evolution of cancer, oncogenes and tumour suppressor genes and their mutations, cancer causing viruses, metastasis, role of mutations in cancer.

Unit 5: Methods and techniques in cell biology

Microscopy to study cellular localisation of proteins, GF and RF proteins, immunofluorescence microscopy, freeze-etching, freeze-fracture, sample staining and fixation for microscopy, radio-labelling and radioisotopes, fractionation of sub cellular

components- cell disruption, centrifugation (differential and density gradient), purification of organelles using antibodies, cell sorting (flow cytometry).

Suggested readings:

1. *The Cell: A Molecular Approach, 6th edition (2013)- Geoffrey M. Cooper, Robert E.Hausman, Sinauer Associates, Inc. USA*
2. *Molecular Biology of the Cell: 5th edition (2007)- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, USA.*
3. *Cell Biology: 6th edition, (2010)- Gerald Karp. John Wiley & Sons., USA*
4. *Molecular Cell Biology: 7th Edition, (2012)- Lodish H., Berk A, Kaiser C., KReiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA*

Biochemistry and Biophysics (Code: MBT-103)

4 Credits

MM:100

Unit 1: Biomolecules

Atomic and molecular structure, chemical bonds, structure of macromolecules (DNA, RNA, proteins, lipids, carbohydrates), non-covalent interactions (Vander Waals, electrostatic, hydrogen bonding, hydrophobic interactions), conformation of nucleic acids (A, B, Z DNA helix, tRNA, mRNA, rRNA) and proteins (Ramachandran plot, primary, secondary, tertiary and quaternary structures, domain, motif and folds), stability of nucleic acids and proteins, structure of carbohydrates and lipids, mono-, di- and polysaccharides, storage carbohydrates, glycogen, cellulose, peptidoglycan, chitin, lipids- glycoproteins and glycolipids, lipoproteins, structure of nucleotides, ATP, amino acids, vitamins, prosthetic groups, co-enzymes.

Unit 2: Biophysical chemistry

Concepts of pH, buffer, reaction kinetics, Henderson-Hasselbalch equation, thermodynamics, enthalpy, free energy, entropy, Gibbs-helmholtz equation, spontaneous and non-spontaneous reaction, endergonic and exergonic reactions, reversible and irreversible reactions, colligative properties, concepts of- molarity, normality, moles, Avogadro number, dielectric constant and molarity of water.

Unit 3: Protein biochemistry

Protein folding, folding funnel hypothesis, free energy changes during folding, Levinthal's paradox, chaperones, molten globule, protein misfolding and aggregation, protein misfolding diseases, effect of denaturants and reducing agents on protein folding and structure, protein degradation- ubiquitination, proteosomal degradation, lysosomal degradation, protein half-life, N-terminal rule, degran.

Unit 4: Methods and techniques

Electrophoresis- SDS and native polyacrylamide gel electrophoresis, 1- and 2 dimensional electrophoresis, isotachopheresis, isoelectric focusing, protein purification, dialysis, salting-in and salting-out, affinity, size-exclusion, and ion-exchange chromatography, molecular

structure determination- X-ray diffraction, NMR and cryo-electron microscopy, UV-Visible spectroscopy, circular dichroism, ESR, differential scanning calorimetry, FTIR, protein quantitation, and detection- Bradford method, Lowry method, ELISA.

Suggested readings:

1. *Lehninger, Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.*
2. *Fundamentals of Biochemistry. 3rd Edition (2008), Donald Voet & Judith Voet, John Wiley and Sons, Inc. USA*
3. *Proteins: Structure and Molecular Properties by T.E. Creighton*
4. *Physical Biochemistry by David Freifelder*
5. *Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England*
6. *Biochemistry: 7th Edition, (2012), Jeremy Berg, Lubert Stryer, W.H. Freeman and company, NY*
7. *Introduction to Practical Biochemistry, (2000), S. K. Sawhney, Randhir Singh Narosa, 2000. Practical Enzymology, 2nd edition (2011), Hans Biss Wanger, Wiley-Blackwell, USA*

Genetics (Code: MBT-104) : CBCE

4 Credits

MM:100

Unit 1: Inheritance biology

Mendelian genetics- dominance, segregation, independent assortment, co-dominance, incomplete dominance, gene interactions, pleiotropy, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters, gene mapping- linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, extra-chromosomal inheritance- inheritance of mitochondrial and chloroplast genes, maternal inheritance, pedigree analysis, LOD score for linkage testing, karyotypes, genetic disorders, polygenic inheritance, heritability and its measurements, QTL mapping.

Unit 2: Mutations and chromosomal abnormalities

Mutations- types, causes and detection, mutant types- lethal, conditional, biochemical, loss of function, gain of function, germinal versus somatic mutants, insertional mutagenesis, structural and numerical alterations of chromosomes- deletion, duplication, inversion, translocation, ploidy and their genetic implications.

Unit 3: Molecular genetics

C-value paradox and genome size, Cot curves, repetitive and non-repetitive DNA sequences, transposons in prokaryotes and eukaryotes, replicative and non-replicative transposons, IS elements, SINES, LINES and retrotransposons, DNA hyperchromicity, annealing, hybridisation, denaturation, $Cot^{1/2}$ and $Rot^{1/2}$ values, satellite DNA, DNA melting and buoyant density, gene families, clusters, pseudogenes, super-families, organelle genomes.

Important model system in genetics and methodologies- *Drosophila*, *C. elegans*, Zebrafish, *Arabidopsis*

Unit 4: Mechanisms of gene regulation

Epigenetic control of gene expression, DNA methylation, CpG islands, histone code, histone acetylation and de-acetylation, RNA editing, splicing, transcriptional regulation in prokaryotes and eukaryotes, operons, non-coding RNAs, microRNAs, ceRNAs, siRNAs, ribonucleoproteins, ribonome and transcriptome, gene silencing, siRNAs, shRNAs.

Unit 5: Methods and techniques

DNA microarray, qPCR, RFLP, RAPD and AFLP techniques, FISH, chromosome painting, karyotyping, luciferase assay, mutagenesis and deletion techniques for identification of regulatory regions, Ames test.

Suggested readings:

1. *Concepts of Genetics*, Klug W. S. and Cummings M. R, Prentice-Hall
2. *Principles of Genetics*, Snustad D. P. and Simmons M. J. John Wiley & Sons
3. *Genetics-a Conceptual Approach*, Pierce B. A. Freeman
4. *Molecular Cell Biology: 7th Edition*, (2012)- Lodish H., Berk A, Kaiser C., KReiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA.
5. *Genes XI: 11th edition* (2012)- Benjamin Lewin, Publisher - Jones and Barlett Inc. USA.
6. *Molecular Biology of the Gene*, 6th Edition (2008)- James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA.
7. *Molecular Biology*, 5th Edition (2011)- Weaver R., McGraw Hill Science. USA.
8. *Fundamentals of Molecular Biology*, (2009)- Pal J.K. and Saroj Ghaskadbi, Oxford University Press. India.
9. *Molecular Biology: genes to proteins*, 4th edition (2011)- Burton E Tropp, Jones & Bartlett Learning, USA.

Immunology (Code: MBT-105)

4 Credits

MM:100

Unit 1: Introduction to immune system

Cells, organs and tissues of immune system, types of Immunity - innate immunity, acquired immunity, humeral and cellular immune response, primary and secondary immune modulation, cells and molecules involved in innate and adaptive immunity, B and T cells, toll-like receptors, cell mediated effector functions.

Unit 2: Antigens and antibody

Concept of self and non-self discrimination, antigens, antigenicity, immunogenicity, epitope, adjuvants, haptens, the immunoglobulin molecule: structure and function antibody, light and heavy chains, hyper variable regions, antibody generation and diversity, V-J and V-D-J rearrangements, antigenic determinants, antibody types, isotypes, idiotypes, allotypes, monoclonal and polyclonal antibodies, hybridoma technology, cross-reactivity, antigen-antibody reactions and their applications in diagnostics, antibody engineering, chimeric antibodies, phage display, humanised antibody.

Unit 3: Complement system, MHC, hypersensitivity and transplantation immunology

Components of complement system, pathways of complement activation, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, inflammation, hypersensitivity, auto immunity, molecular mimicry, therapy, transplant immunology, graft rejection, immunosuppressants.

Unit 4: Parasitic, tumor immunology and immune diseases

Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, immunology of tumors, congenital and acquired immunodeficiencies.

Unit 5: Experimental and applied immunology

Vaccine development, recombinant vaccines, animal models in immunological studies, routes of inoculation, relevance of transgenic animals in immunology, immunodiagnostics.

Suggested readings:

1. *Kuby immunology*, Judy Owen , Jenni Punt , Sharon Stranford, 7th edition (2012), Freeman and Co., NY
2. *Textbook of basic and clinical immunology*, 1st edition (2013), Sudha Gangal and Shubhangi Sontakke, University Press, India
3. *Immunology*, 7th edition (2006), David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Mosby, USA.

SEMESTER- II

Microbiology (Code: MBT-201)

4 credits

MM:100

Unit 1: Fundamentals of bacteriology

History of bacteriology, landmarks in bacteriology, scope of bacteriology, bacterial cell, size, shapes, flagella, fimbriae and pilli, capsule, sheath, prosthecae and stalk, structure and chemical composition of cell wall (Gram +ve and Gram -ve), cytoplasmic membrane, protoplast, spheroplast, cytoplasmic inclusions, genetic material, spores, and cysts, growth yield and characteristics, strategies of cell division, stress response, methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

Unit 2: Basic virology

General properties of viruses, morphology and ultrastructure of viruses, structure of HIV, classification of viruses- ICTV system, Baltimore system, DNA and RNA virus, bacteriophages, retroviruses, genome organization in virus, DNA replication in viruses, rolling circle model, viral replication- DNA and RNA virus, bacteriophages- transduction, lysogenic and lytic cycles of bacteriophages, replication of HIV, HIV proteins and their function, viral diagnosis: cultivation, serological and molecular methods, infectivity assays, immunodiagnosis, plaque assay.

Unit 3: Microbes in diseases and antibiotics

Human diseases and causing microbes (bacteria, fungi and viruses), pathogenicity and virulence of bacteria, antibiotics, classes and generations, mechanisms of action, sulfonamides, penicillin, cephalosporin, aminoglycosides, chloramphenicol and other antibiotics, antifungal drugs, drug resistance, superbugs, mechanisms of drug resistance, origin and transmission, antibiotic susceptibility.

Unit 4: Laboratory and industrial microbiology

Control of bacterial growth (sterilization and disinfection methods), handling pathogens, safety in microbiology laboratory, nutrition (nutritional classes) and growth media types, microbial fermentation, industrial microbiology, microbes in meat and dairy industry.

Unit 5: Tools of microbiology

Cultivation of aerobes, anaerobes and microaerophiles. pure culture techniques (streak and spread plate, serial dilution, pour plate, enrichment and single cell isolation), cell visualisation by microscopy- light, bright field, phase contrast microscopy, fluorescence and confocal (deconvolution) microscopy, concept of resolving power and magnification, microscopy for dead and living cells, stained and unstained cells, Gram staining, SEM and TEM, sample preparation in microscopy and electron microscopy.

Suggested readings:

1. Brock's Biology of Microorganisms. 11th Edition, (2006). Madigan MT, Martinko JM. Pearson Education Inc., USA

2. *Prescott's Microbiology: Ninth Edition*, Joanne Willey, Linda Sherwood, Chris Woolverton McGraw-Hill Higher Education, 2013
3. *Microbiology* / Michael J. Pelczar, Jr., Roger D. Reid, E. C. S. Chan, Fifth Edition, Tata McGraw-Hill Education Pvt. Ltd
4. *Introduction to Microbiology. 3rd Edition*, (2004), Ingraham JL and Ingraham CA. Thomson Brooks / Cole.
5. *Principles of Virology, Third edition*, (1999), Flint Jane. S., ASM (American Society of Microbiology) Press Publisher, 2 volumes., USA
6. *Field's Virology - 2 volumes, 5th edition*, (2006), Bernard.N. Fields, Lippincott and Williams Wilkins, USA

Metabolism & Enzymology (Code: MBT-202)

4 Credits

MM:100

Unit 1: Digestive physiology and metabolism

Introduction to digestion, digestive enzymes, absorption, mechanisms of transport of absorbed nutrients to cells of body, BMR. Introduction to metabolism, functions of metabolism, characteristics of metabolic pathways, metabolic reactions, laws of thermodynamics, ATP structure and function, history of glycolysis, experimental approaches to the study of metabolism, one gene-one enzyme hypothesis.

Unit 2: Concepts of enzymology

General characteristics of enzymes, classification of enzymes, activation energy, catalysis and catalytic power of enzymes, enzyme activity, effect of pH, temperature, substrate and product concentrations on enzyme activity, feedback and feed-forward regulation of enzymes, concepts of enzyme kinetics, Michaelis-Menten equation, double reciprocal plots, allosteric enzymes and their regulation, T and R state, haemoglobin and myoglobin kinetics, enzyme inhibition and activation, immobilisation of enzymes and its applications, specific activity of enzyme, isozymes, abzymes.

Unit 3: Glucose metabolism

Glycolysis, reaction and enzymes, regulatory reaction, metabolic fates of pyruvate, glycolysis as central metabolic pathways, entry of important hexoses in glycolysis, HMP pathway, gluconeogenesis, glycogen synthesis and degradation, TCA cycle: reactions, enzymes and regulation, anaplerosis, oxidative phosphorylation, mechanics of ATP synthesis, reactive oxygen species, concept of uncoupling, glyoxylate pathway, metabolism of fasting and starvation, hormonal control of glucose metabolism.

Unit 4: Lipid and amino acid metabolism

Lipids, transport of lipids, fatty acid activation and transport into mitochondria, beta-oxidation, oxidation of odd chain & unsaturated fatty acids, formation and oxidation of ketone bodies, fatty acid biosynthesis, elongation and desaturation of fatty acids, arachidonate metabolism, cholesterol biosynthesis, biosynthesis of triacylglycerol and

glycerophospholipids. Amino acid metabolism: transamination reactions, transport of amino groups, urea cycle, metabolic breakdown of individual amino acids, biosynthesis of non-essential and essential amino acids, heme biosynthesis and degradation, genetic defects in amino acid metabolism.

Unit 5: Nucleotide metabolism

Structures of nucleotides, synthesis of purines and pyrimidines- de novo and salvage pathways, catabolism of purine & pyrimidines, fates of uric acid, genetic defects in nucleotide metabolism, enzymes of nucleotide metabolism as targets of anticancer agents.

Suggested readings:

1. *Lehninger Principles of Biochemistry, 3rd edition, May 2000, David L. Nelson, David L. Nelson, Albert L. Lehninger, Michael M. Cox, Worth Publishing, ISBN: 1572599316*
1. *Biochemistry, 5th Ed, February 2002, Lubert Stryer, John L. Tymoczko, Jeremy Mark Berg, Pub. W. H. Freeman Company, ISBN: 0716730510*
2. *Harper's Illustrated Biochemistry; 26th Ed March, 2003 by Robert K. Murray, Darryl K. Granner, Peter A. Mayes, Victor W. Rodwell Pub: McGraw-Hill Medical ISBN-10: 0071389016*

Animal Biotechnology (Code: MBT-203)

4 Credits

MM:100

Unit 1: Introduction to animal tissue culture

Tissue culture- definition, concept and significance, maintenance of sterility and use of antibiotics, detection of various biological contamination, cross contamination, formulation of tissue culture media- serum and synthetic media, sterilization of culture media and reagents, introduction to the balance salt solutions, simple growth media, culture conditions, role of temperature, pH, carbon dioxide and oxygen in animal cell culture, role of different media components in cell culture.

Unit 2: Tissue culture characteristics

Primary culture, establishment of cell lines, immortalisation of cell lines, maintenance and passaging, cryo-preservation and revival of cells in culture, freezing and storage of culture cells, cell growth curve, adherent and suspension culture, biology of cultured cells, adhesion molecules, cell surface molecules, anchorage dependent and independent growth, soft-agar assays, role of growth factors in cell culture, various methods of cell separation, flow cytometry.

Unit 3: Organ culture

3D culture and spheroid formation, applications of 3D culture, organ explant and utility of organ culture, histotypic and organotypic cultures, organ transplants, tissue engineering.

Unit 4: Tissue culture applications

Experimental applications- cell proliferation assays, study of cell cycle, cell synchronization, mitosis in growing cells, measurement of viability and cytotoxicity. cell cloning, transformation, transfection, micro-manipulation, nuclear transplantation, cell hybridization, combining embryo cells, intracellular manipulations and conservation of manipulated embryos, in vitro drug testing in cell culture, production of vaccines and proteins of pharmaceutical relevance, recombinant protein production, harvesting and purification.

Unit 5: Applied animal biotechnology

Artificial breeding – in vitro fertilization and embryo transfer technology, artificial insemination, germ cell storage, transgenic animals- fish, mice and sheep, gene targeting and transfer, mouse models for human genetic disorder and diseases, knock-out and knock-in mice.

Suggested readings:

1. R. Ian Freshney. *Culture of Animal cells, 5th Edition, 2010. A John Wiley & Sons, Inc., Publications, USA*
2. *Gene Transfer to Animal Cells, 1st edition (2005), R. M. Twyman, Taylor & Francis USA.*
3. *Molecular Biotechnology: 4 edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA*

Genetic engineering (Code: MBT-204)

4 Credits

MM:100

Unit 1: Tools of genetic engineering

DNA modifying enzymes, restriction enzymes, vectors in gene cloning- plasmid, cosmid, phages, phasmids, advanced cloning vectors-BAC, YAC, PAC, transformation, transduction and transfection, cDNA and genomic DNA library.

Unit 2: Recombinant gene expression

Gene cloning, various expression vectors in bacteria and eukaryotes- yeast, baculoviruses, mammalian and shuttle vectors, induced expression strategies and protocols. Expression of industrially important gene products, recombinant protein expression.

Unit 3: Tools and techniques of rDNA technology

DNA sequencing- Maxam-Gilbert method, Sanger's Dideoxy chain termination method, automated DNA sequencing, PCR and its types-inverse, nested, reverse transcription-PCR, hot start PCR, qPCR, use in diagnosis of diseases, genetic and physical mapping techniques.

Unit 4: Applications of genetic engineering

Gene therapy and gene delivery systems, detection and diagnosis of genetic diseases, DNA fingerprinting, genetically engineered bio-therapeutics and vaccines and their manufacturing, transgenic animals and bio-pharming, immuno-PCR, site-directed mutagenesis, generation of knock-out and knock-in mice, DNA chip technology, CRISPR/Cas9, Cre/lox and FLP/FRT systems and their applications.

Suggested readings:

1. *From Genes to Genomes, 2nd edition, (2008), J.Dale and M.Schantz, John Wiley & Son Ltd. USA*
2. *Gene Cloning and DNA Analysis: an introduction, 6th edition, (2010) T. A. Brown, Wiley-Blackwell Publisher, UK*
3. *From Gene to Clones ; Introduction to gene technology, 4th edition, (2003), E. Winnacker, Panima Publisher, India*
4. *Molecular Biology Problem solver: A laboratory guide (2004), A. Gerstein, A John Wiley & Sons, Inc., Publication, USA.*
5. *Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA*
6. *Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA.*
7. *Principles of Gene Manipulation & Genomics, 7th Edition (2006), Primrose and Twyman, Blackwell Publishing, USA.*
8. *Molecular cloning – a laboratory manual – (Vol. 1-3), 4th edition, (2012), Green and Sambrook, Cold Spring Harbor Laboratory Press, USA*

Cellular & Molecular Physiology (CBCE) (Code: MBT-205)

4 Credits

MM:100

Unit 1: Vascular and respiratory physiology

Blood and circulation- blood corpuscles, haemotopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, carbon dioxide and oxygen transport, Bohr effect, homeostasis. Heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation. Respiratory system- comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.

Unit 2: Endocrinology and reproduction

Endocrine glands, basic mechanism of hormone action, hormones and diseases, different types of hormones, classes of hormones, hormone receptors, function of different hormones, regulation of hormone secretion and feedback mechanism, reproductive processes and its hormonal regulation, gametogenesis, ovulation, neuroendocrine regulation.

Unit 3: Nervous system and sense organs

Neurons, synapse, action potential, nerve impulses and excitation, neurotransmitters, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture, motor plates and neuromuscular junctions. Vision, hearing and tactile response.

Unit 4: Excretory and thermoregulatory system

Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance. Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.

Suggested readings:

1. *Textbook of Medical Physiology 10th Ed Aug 2000 by Arthur C. Guyton, John E. Hall, A.C. and Hall, J.E., W.B. Saunders Company, ISBN-10: 072168677X*
2. *Review of Medical Physiology, 21st Ed 2003 by William F. Ganong, H; McGrawHill.*
3. *Human Anatomy & Physiology, 6th Ed May, 2003 by Elaine N. Marieb; Benjamin Cummings, ISBN-10: 080535462X*

Modern (OMICS) Technology (SEC) (Code: MBT-206)

4 Credits

MM:100

Unit 1: Genomics

Introduction to genomics, large scale DNA sequencing methods- whole genome analysis, next generation sequencing, genome mapping, structural and functional genomics, comparative genomics, metagenomics, toxicogenomics, pharmacogenomics, different methods for characterization of animal genomes, SNP, STR, QTL, RFLP, RAPD, genome bioinformatics, genome annotation.

Unit 2: Transcriptomics and microarray technology

Transcriptome and expression profiling, DNA and RNA microarray, RNA seq, microarray databases and bioinformatics tools.

Unit 3: Proteomics

Introduction to proteomics, concept and applications, structural proteomics, functional proteomics, tools and techniques in proteomics- IEF, 2D PAGE and mass spectrometry, analytical chromatography (HPLC, UPLC, nano-HPLC) and working principle of mass-spectrometry, types and variants of mass-spectrometry (ESI, MALDI-TOF, FT-MS, Triple-Quad, MS/MS, Quadrupole), MS1 and MS2, use of mass-spectrometry in proteomic analysis, interactome and PTM analysis by mass-spectrometry, protein identification, expressional, functional and structural proteomics in health and disease, diagnostics and biomarker discovery.

Unit 4: Metabolomics

Introduction, concept and applications, metabolomics instrumentation, use of NMR and mass-spectrometers in metabolomics, metabolomics in health and disease, metabolomics in diagnostics and biomarker discovery.

Suggested Readings:

1. *Genes IX* by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. *Modern Biotechnology, 2nd Edition*, S.B. Primrose, Blackwell Publishing, 1987.
3. *Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition*, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
4. *Molecular Cloning: A Laboratory Manual (3rd Edition)* Sambrook and Russell Vol. I to III, 1989.
5. *Principles of Gene Manipulation 6th Edition*, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
6. Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics. V Edition*. John Wiley and Sons Inc.
7. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). *Concepts of Genetics. IX Edition*. Benjamin Cummings.
8. Russell, P. J. (2009). *iGenetics- A Molecular Approach. III Edition*. Benjamin Cummings.
9. Glick, B.R., Pasternak, J.J. (2003). *Molecular Biotechnology- Principles and Applications of recombinant DNA*. ASM Press, Washington.
10. Pevsner, J. (2009). *Bioinformatics and Functional Genomics. II Edition*. John Wiley & Sons.

SEMESTER- III

Bioprocess Engineering and Fermentation Technology (Code: MBT-301) 4 Credits

MM:100

Unit 1: Bioreactors and their design

Design of fermenters/ bioreactors, design of stirred tank reactor and non-mechanically agitated bioreactors (Air lift and Bubble column), operation of bioreactors: batch, fed-batch and continuous processes. Mass transfer: concept of mass transfer, molecular diffusion and role in bioprocess, two– film theory, convective and volumetric mass transfer (KLa introduction), aeration and agitation, oxygen transfer rate, heat control, scale-up bioprocess.

Unit 2: Fermentation technology

Fermentation and its types, biofuels, fermentation media, sterilization and monitoring of process variables, media components and their optimization. Sterilization of media: kinetics of destruction of microorganisms, indicator organism Del factor, designs of Batch and continuous sterilization (Del factor calculation). Monitoring of process variables: types of sensors, measurement and control of various parameters (pH, temperature, dissolved oxygen, microbial biomass, inlet and exit gases, fluid flow, Pressure, Foam). scale-up and scale down.

Unit 3: Cellular and molecular engineering

Strains and pathways important in biotech industry, their genetic manipulation, protoplast fusion, parasexual cycle and genetic engineering for strain improvements, product formation and inhibition of pathways and their regulation; applications in medicine, agriculture and industry.

Unit 4: Downstream processing

Concept of primary (growth associated) and secondary metabolites (Growth non -associated) metabolites, kinetics of growth and product formation. Yield coefficient and efficiency. Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration: Physical, chemical and enzymatic methods. Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods. Concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization. Treatment of effluent and its disposal strategies.

Suggested readings:

1. Stanbury, P. F. and Whittaker, A. (1984) *Principles of Fermentation technology*, Pergamon press
2. Pepler, H. L 1979, *Microbial Technology, Vol I and II*, Academic Press.
3. Casida, L. E., 1984, *Industrial Microbiology*, Wiley Easterns, New Delhi
4. Prescott. S.C and Dunn, C. G., 1983 *Industrial Microbiology*, Reed G. AVitech books.
5. *Operational Modes of Bioreactors*, BIOTOL series - Butter worth, Heinemann 1992

6. *Bioreactor Design & Product Yield, BIOTOL series - Butter worth Heinemann 1992*
7. *A. H. Patel. (1985), Industrial Microbiology, Macmillan India Ltd. Crueger, W. and Crueger, A. (2005) A Text Book Of Industrial Biotechnology, Panima, New Delhi.*
8. *Satyanarayan U, Biotechnology, Arunabha Sen Books allied Publishers.*
9. *Schuler, M. and Kargi, F. Bioprocess Engineering - Basic Concept, Prentice Hall of India, New Delhi.*
10. *Bioprocess Engineering Principles - Pauline Doran, Academic Press 1995*
11. *Lydersen, Bioprocess Engineering : Systems, Equipment & Facilities*

Plant Biotechnology (Code: MBT- 302)

4 Credits

MM:100

Unit 1: Plant tissue culture, protoplast fusion and somatic hybridisation

Protoplast isolation, culture, immobilization, preservation and regeneration. Protoplast fusion and somatic hybridization, markers for identifying somatic hybrids, gross phenotypic differences, cybrids. Totipotency, organogenesis; somatic embryogenesis- regulation and applications, artificial seed production; micropropagation; somaclonal variation; androgenesis and its applications in genetics and plant breeding; germplasm conservation and cryopreservation. Selectable genetic markers and biochemical markers. Role in crop improvement.

Unit 2: Genetic engineering, molecular mapping and marker assisted selection

Agrobacterium-plant interaction, virulence genes, Ti and Ri plasmids, hairy root features, T-DNA transfer, disarming the Ti plasmid. Agrobacterium-mediated gene delivery; Co integrate and binary vectors and their utility; Direct gene transfer-PEG-mediated, electroporation, particle bombardment. Screenable and selectable markers; Characterization of transgenics; Chloroplast transformation; Marker-free methodologies; Gene targeting. Quantitative and qualitative traits; MAS for genes of agronomic importance, e.g. insert resistance, grain quality and grain yield; Molecular polymorphism, RFLP, RAPD, STSAFLP, SNP markers; Construction of genetic and physical map; Gene mapping and cloning; QTL mapping and cloning.

Unit 3: Transgenic plants

Gene transfer- vertical and horizontal, issues with horizontal gene transfer, methods of gene transfer. Transgenic plants-for- biotic and abiotic stress tolerance, production of secondary metabolites, manipulation of photosynthesis and nitrogen fixation for increased productivity by, molecular farming (improvement in protein, lipids, carbohydrates, plantibodies, vaccines, therapeutic proteins and active principles).

Unit 4: Applied plant biotechnology

Plant as biofactories- production of industrial enzymes, vitamins and antibiotics and other biomolecules, plant cell cultures for secondary metabolite production, production of pharmaceutically important compounds, bioenergy generation, examples of engineered plants

in human health and disease. Algal and Fungal biotechnology- qualitative (product improvement, strainimprovement) and quantitative (yield) improvement in economicallyimportant algae and fungus.

Suggested readings:

1. Altman A, Hasegawa PM (Ed) (2012) – *Plant Biotechnology and agriculture. Prospectsfor the 21st century* (Academic press)
2. Bhojwani SS. & Razdan MK (1996). - *Plant Tissue Culture : Theory & Practice*(Elsevier)
3. Chawla HC (2004) – *Introduction to plant biotechnology* (Science Publ.)
4. Slater A, Scott NW, Fowler MR (2008) – *Plant Biotechnology: the genetic manipulationof plants*(Oxford Press)
5. Rai M (2009) – *Fungal Biotechnology* (IK International)
6. Vasil IK, Thorpe TA (1994) – *Plant cell and tissue culture* (Springer)
7. H K Das *Textbook of Biotechnology 4th Edition*
8. *Plants Cell Culture 1994, Chrisped, M.J. and Sadana, D.E., Bios Sceintific Publishers, Oxford,UK.*
9. *Plant Cell and Tissue Culture, 1994, Vasis, I.K. and Thorpe, T.A., Klmeer Academic Press, The Netherlands.*
10. *An Introduction to Plant Tissue Culture, 1993, Razdan, M.K., Published by Oxford and I.B.H.Publishing Co. Pvt. Ltd. New Delhi.*
11. *Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture, 3rd Ed 1992, Rienert,J. and Bajaj Y.P.S.; Narosa Publishing House, New Delhi.*
12. *Biotechnology and Plant Genetic Resources, 1997, Callom, J.A., Ford – Lloyd, B.V. andNewbury, H.J., Conservation and use, CAB International, Oxon, UK.*

Environmental Biotechnology (Code: MBT-303)

4 Credits

MM:100

Unit 1: Environmental monitoring

Environmental and ecosystem process (components of ecosystems, major ecosystems, biological magnification), industrial sites, level and type of contaminants,atmospheric pollutants(air, water and soil pollution), air, water and soil quality index, physical, chemical and biological analysis of samples, use of recombinant DNA technology for the study of bacterial community,determination of dissolved oxygen, biological oxygen demand(BOD), chemical oxygen demand (COD),pollution monitoring (bio indicators and biomarkers), toxicity testing using biological material.

Unit 2: Solid waste management and sewage treatment

Basic aspects of solid waste management,aerobic and anaerobic management of solid wastes,function of the waste treatment system,sewage- treatment methods (Lagoons, trickling filters, Activated sludge process (ASP), operating parameters, operating factors, sludge residence time, plant and sludge loading, sludge settling and recirculation mode of operation), modification to existing processes,removal of nitrogen and phosphorus (nitrification and denitrification),sludge treatment and disposal.

Unit 3: Bioremediation, biotransformation and biodegradation

Bioremediation strategies, *in-situ* and *ex-situ* bioremediation; phytoremediation, applications of genetic engineering to phytoremediation, metals and gaseous bioremediation; biocatalyst; Recovery of metals; Factors affecting process of biodegradation, Biochemical pathway of biodegradation, Xenobiotics; Persistence and bio magnification of xenobiotic molecules.

Unit 4: Biotechnology for management of resources and sustainable technology

Need for management of resources, biogas and biofuel production, bio-fertilizers and biopesticides, bioleaching, composting, integrated waste management, provision of bulk and fine chemicals, microbial polymers and plastics, industrial processes and clean technology.

Suggested readings:

1. *Ecology and environmental biology* (2011) Saha T K Books & Allied (p) Ltd, Delhi
2. *Environment Problems & Solutions* (2001) Asthana & Asthana S. Chand Limited, New Delhi
3. *Wastewater Engineering Treatment and Reuse, 4th Ed 2005* by Metcalf & Eddy, Inc. from C.H.I.P.S.
4. *Introduction to Environmental Biotechnology 2002*, Chatterji, A.K; Prentice Hall of India Pvt. Ltd., New Delhi.
5. *Bioremediation* (1994) Baker, K.H and Herson, D.S. Mc Graw Hill, Inc. New York
6. *Biotreatment of Industrial & Hazardous Waste* (1993) M.V. Levin and Gealt, M.A
7. McGraw Hill. Inc, New York
8. *Renewable Energy Sources and their Environmental Impact, 2002*, Abbasi, S.A. and Abbasi, N; Prentice-Hall of India Pvt. Ltd., New Delhi.
9. *Environmental Chemistry*, De, A.K., 1993, Wiley Eastern Ltd.
10. *Biotechnology for Waste Water Treatment 2001*, Nicholas P. Cheremisinof; Printice Hall of India Private Ltd. New Delhi
11. *Biochemistry of Microbial Degradation 1994*, C. Ratledge; Kulwer Academic Publisher.
12. *Concept of Ecology, 1989*, Kormondy, E.J.; Prentice-Hall of India Pvt. Ltd. New Delhi
13. *Environmental Biology and Toxicology, 1993*. Sharma, P.D.
14. *Environmental Biology Principles of Ecology, 1998*, Verma, P.S., V.K. Agarwal; S. Chand & Co. Ltd., New Delhi

Biostatistics & Bioinformatics (Code: MBT-304)

4 Credits

MM:100

Unit 1: Measure of Central tendency, correlation and regression

Measures of central tendency (mean, median and mode) and dispersal, measure of variation (mean deviation and standard deviation), frequency distribution and its graphical representation, probability distribution (Binomial, Poisson and normal). Correlation, Karl

Pearson's coefficient of correlation, interpretation of correlation coefficient, method of least square, regression and calculation of regression coefficient.

Unit 2: Sampling distribution and hypothesis testing

Sampling distribution, difference between parametric and non-parametric statistics, errors, confidence intervals, levels of significance, null hypothesis, Chi-square test, ANOVA, univariate and multivariate analysis.

Unit 3: Bioinformatics in data analysis

Sequence Alignments- algorithms, scoring matrices, multiple sequence alignment (MSA), detecting open reading frames, outline of sequence assembly, mutation/substitution matrices, pairwise alignments, primer designing, FASTA, BLAST, in-silico PCR. Biological database searching and data retrieval, disease databases, genome annotation, gene ontology and GO terms, identification of pathway represented by set of genes using online tools- DAVID, PANTHER. Web based servers and softwares for genome analysis- ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome.

Unit 4. Molecular modelling and structural bioinformatics

Acquisition and visualization of molecular structures and energy optimization methods., sequence and structure based predictions- simulation of molecular interactions, phylogenetic analysis and tree construction methods, protein information sources, PDB, SWISSPROT, TREMBL, structural bioinformatics- SCOP and CATH, introduction to protein motifs and domain prediction. Use of bioinformatics in drug design and target, introduction to immunoinformatics and cheminformatics, applications of immuno- and chemi-informatics.

Suggested readings:

1. *A text book of bioinformatics (2008) Sharma, Munjal and Shankar. Rastogi Publications, Meerut.*
2. *An introduction to Bioinformatics Algorithms (2004) Neil Jones, Pavel Pevzner A Bradford Book, The MIT Press, USA*
3. *Daniel W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.*
4. *Bioinformatics-Sequence and Genome Analysis (2004) David W Mount Cold Spring Harbor Laboratory Press; 2nd edition, USA*
5. *Discovering genomics, Proteomics and Bioinformatics (2006) A. Malcolm Campbell, Laurie J. Heyer Pearson-Benjamin Cummings; 2nd edition, USA*
6. *Immunoinformatics (2008) Schönbach, Ranganathan, Brusica Springer, New York*
7. *Protein Structure Prediction, methods and protocol (2000) David M. Webster Springer, New York*
8. *Bioinformatics, Concept, Skills & Applications, 2003, Rastogi, S C, Mendiratta, Namita, Rastogi, Parag; CBS Publications. ISBN-8123908857*
9. *Glaser AN (2001) High Yield™ Biostatistics. Lippincott Williams and Wilkins, USA*

Medical Biotechnology & Molecular Medicine (CBCE) (Code: MBT-305) 4 Credits

MM:100

Unit 1: Molecular diagnostics and therapeutics

Diagnosis of biochemical disorders and inherited disorders, antibody based diagnosis: diagnosis of bacterial, viral and parasitic diseases using ELISA and Western blot. PCR and array based diagnosis of diseases, present methods for diagnosis of specific diseases like tuberculosis, malaria, AIDS, CML bcr/abl. Prenatal diagnosis- indications for prenatal diagnosis; pre-implantation genetic diagnosis; invasive techniques- amniocentesis, fetoscopy, chorionic villi sampling (CVS); non-invasive techniques- ultrasonography, X-ray, TIFA, maternal serum screening and fetal cells in maternal blood, Diagnosis using protein and enzyme markers (PKU- Guthrie test, Dystrophy- Creatine kinase).

Unit 2: Stem cell technology and regenerative medicine

Stem cells: definition, properties and potency of stem cells, embryonic and adult stem cells, concept of tissue engineering, hematopoietic stem cell therapy, cancer stem cells, potential uses of stem cells in cell based therapies. Bioartificial organs- liver, heart auricles, blood vessels & skin.

Unit 3: Nanobiotechnology

Introduction, biomolecules as nanostructures and their applications in nanotechnology- biosensors, separation of cells and cell organelles, cancer therapy, gene therapy etc. Nanomedicine: nanomaterials in medicine- quantum dots, dendrimers, peptidnanotubes, smartdrugs, nanopore sensors, nanopore immune isolation devices, nanorobots (microbivores, respirocyte), DNA based nano devices; nanomedicine in cancer, drug delivery systems- criteria for drug delivery systems, drug delivery carriers, controlled release mechanisms, administration routes.

Unit 4. Clinical biotechnology

Clinical applications of recombinant technology: erythropoietin, insulin analogs and its role in diabetes, recombinant human growth hormone, streptokinase and urokinase in thrombosis, recombinant coagulation factors, pharmacogenomics and its relevance in personalised medicine, gene therapy, strategies and vectors used in gene therapy, enzyme therapy, DNA based vaccines.

Suggested readings:

- 1. Introduction to Human Molecular Genetics- J.J Pasternak, John Wiley Publishers*
- 2. Human Molecular Genetics- Tom Strachen and A P Read, Bios Scientific Publishers*
- 3. Human Genetics Molecular Evolution- Mc Conkey*
- 4. Recombinant DNA Technology- AEH Emery*
- 5. Principles and Practice of Medical Genetics, I, II, III Volumes by AEH Edts. Emery*
- 6. Medical Biotechnology- Pratibha Nallari, V. Venugopal Rao- Oxford Press*

7. *Medical Biotechnology 1st Edition- Judit pongracz, Mary Keen*
8. *Medical Biotechnology by Bernard R. Glick, Terry L. Delovitch, Cheryl L. Pattern. ASM press, 2014*
9. *Molecular Biotechnology-Principles and Applications of Recombinant DNA- 4th Edition by Bernard R. Glick, Jacj J. Pasternack, Cheryl L. Pattern*
10. *Nanotechnology; Principals and Practices by Sulabha K. Kulkarni, (2009 Revised edition), Capital Publishing company , New Delhi.*
11. *Biological Nanostructures and Application of Nanostructures in Biology by Michael A. Stroschio and Mitra Dutta (2004),Kulwer Academic Publishers,*
12. *BioNanotechnology,Elisabeth S. Papazoglou, Aravind Parthasarathy, First Edition (2007), Morgan & Claypool Publishers ' series.*
13. *Bionanotechnology, by David S. Goodsell (2004), John Wiley & Sons, Inc,Publication*

IPR, Bioethics and Entrepreneurship (AECC) (Code: MBT-306)

4 Credits

MM:100

Unit 1: Intellectual property rights (IPR)

Introduction to Intellectual Property: types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; international framework for the protection of IP, IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; Introduction to history of GATT, WTO, WIPO and TRIPS.

Unit 2: Patents and related issues

Invention in context of “prior art”; patent databases; searching international databases; country-wise patent searches (USPTO, EPO, India etc.); analysis and report formation, 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 a country patent office; procedure for filing a PCT application. Patenting by research students, lecturers and scientists-University/organizational rules in India and abroad, credit sharing by workers, financial incentives. Patent infringement-meaning, scope, litigation, case studies and examples

Unit 3: Bioethics

Introduction to bioethics, philosophical considerations; epistemology of Science; ethical terms; principles & theories; Relevance to Biotechnology. Ethics and the law issues in genetic engineering, stem cells, cloning, medical techniques, transhumanism, bioweapons. Ethical issues in research- animal Rights, ethics of human cloning, use of genetic evidence in civil and criminal court cases, challenges to Public Policy - to Regulate or notto regulate.

Unit 4: Bio-Entrepreneurship

Definition of entrepreneur, role and functions of entrepreneur, role of entrepreneurs in economic development, entrepreneurship in India, biotechnology and entrepreneurship, business models and opportunities in biotechnology, development of products in the biotech industry, biotech business, market and market potential, marketing research, role of government and schemes, financial institutions in promoting bio-entrepreneurship.

Suggested readings:

1. <http://www.w3.org/IPR/>
2. <http://www.wipo.int/portal/index.html.en>
http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
3. www.patentoffice.nic.in
4. www.iprlawindia.org/ - 31k - Cached - Similar page
5. <http://www.cbd.int/biosafety/background.shtml>
6. www.oecd.org/dataoecd/16/9/40181372.pdf
7. www.patentoffice.nic.in/
8. http://www.biotechnology.gov.au/assets/documents/bainternetBA_IPManual20050401114445.pdf
9. http://www.bicpu.edu.in/ipr_ppt/15/kulkarni.pdf
10. *Commercializing Successful Biomedical Technologies*, 2008, Shreefal S. Mehta, Cambridge University Press
11. *Handbook Of Bioentrepreneurship*, 2008 , Patzelt, Holger; Brenner, Thomas, Springer
12. *Entrepreneurship And Business Of Biotechnology*, Prof S N Jogdand, Himalaya Publisher
13. *Entrepreneurship Development*, 2003, S Anil Kumar, New Age International (P) Ltd. Publishers
14. *Entrepreneurship For Everyone: A Student Textbook*, 2009, Robert Mellor, Sage Publication Ltd

SEMESTER- IV

Research Project and Thesis: MBT401

16 Credit

Seminar Presentation: MBT 402

4 Credit

Lab Courses M.Sc. Biotechnology

(4 Semester PG Degree Course)

(Choice Based Credit System)

Department of Biotechnology

Jamia Millia Islamia, New Delhi

SEMESTER- I

Lab Course-I (Code: MBT-106)

4 Credits

Max M.

100

1. Concepts of Buffers and their preparation
2. Isolation & Purification of genomic DNA from bacteria
3. Isolation & Purification of plasmid DNA
4. Agarose gel electrophoresis of chromosomal & plasmid DNA
5. Restriction Digestion of chromosomal & plasmid DNA
6. Isolation of DNA fragment from agarose gel
7. Primer designing and Polymerase chain reaction of selected gene
8. Protein extraction, estimation and purification from mammalian/bacterial/plant cells
9. Identification of specific protein in the unknown cell extract using western blotting
10. Analysis of induced protein expression in bacterial system by SDS-PAGE.
11. Demonstration of Protein purification techniques using crude protein extract of mammalian/bacterial/plant cells
 - i) Gel filtration chromatography
 - ii) Ion- exchange chromatography
 - iii) Affinity chromatography
12. Determination of Allelic and Genotypic frequencies.
13. Transformation of given Plasmid in E coli DH5 alpha and BL-21 cells.
14. Isolation of RNA from animal tissue/mammalian cells
15. The estimation of DNA by diphenylamine
16. Estimation of RNA by orcinol method

17. Isolation of PBMCs through Ficoll density gradient centrifugation
18. Differentiation of monocytes into macrophages
19. To check the purity of macrophages through FACS. (CD14/CD3/CD4)
20. Quantification of antigen through ELISA
21. Detection of antigen/antibody through Double immunodiffusion (Ouchterlony double diffusion)

SEMESTER- II

100

1. To prepare LB Broth and LB Agar
2. Isolation of pure culture by streak plate and spread plate technique
3. Quantification of viable counts through serial dilution from soil/water
4. To study the microbial interaction through models
5. To perform antibiotic sensitivity assay
6. To perform indole test for identification of bacteria
7. To perform MR-VP, citrate, catalase, urease and methyl-reductase tests for identification of bacteria
8. To grow fungi in Sabouraud agar and study their morphology
9. Study of Biphasic and normal growth curve
10. Induced expression of a heterologous protein (GST/GFP) in bacterial cells, followed by comassie staining or fluorescent microscopy.
11. Restriction Digestion and demonstration of the effect of DNA methylation on restriction digestion of Lambda DNA.
12. DNA ligation of lambda DNA HindIII digest with T4 DNA ligase
13. TA cloning of a purified PCR product.
14. Demonstration of site directed mutagenesis using XL Blue plasmid and blue white colony formation, selection and screening of recombinant clones.
15. To perform Thawing of provided cell culture.
16. To perform passaging of provided cell culture.
17. To determine viability of cells by Trypan Blue Method
18. To perform transient transfection in cell lines.
19. To analyze the expression of given gene in transient transfection system by immunoblotting
20. Tissue fixation and processing for histology
21. Section cutting and preparation of slides
22. Hematoxylin-Xylene Staining for histopathology
23. Tissue Immunostaining (IHC) for the detection of location of signaling protein in the tissues
24. Protein isoelectric focusing
25. Extraction, precipitation, solubilization and estimation of proteins
26. Measuring time course of an enzyme
27. Effect of varying enzyme concentration
28. Estimation of K_m and V_{max} for an enzyme
29. Effect of temperature on enzyme activity
30. Effect of pH on enzyme activity
31. Enzyme inhibition
32. Temperature stability of enzymes
33. pH stability of enzymes

SEMESTER- III

Lab Course-III (Code: MBT-307)

Credits- 04
Max M. 100

1. Isolation of amylase producing bacteria from soil by serial dilution using starch as a carbon source.
2. Growth curve analysis of *E. coli* using Luria Bertini broth.
3. Isolation of protease producing micro-organisms from garden soil by serial dilution using casein as a carbon source.
4. Isolation of lactic acid bacteria from yogurt and fermentation of lactic acid using different carbon sources.
5. Alcohol fermentation by *Sacharomyces cerevisiae* using different simple and complex carbon sources. Preparation of protoplast culture media and in vitro culturing of protoplasts.
6. Isolation, purification and characterization of protoplasts.
7. Preparation of artificial seeds loaded with growth promoters.
8. Isolation of chloroplast and thylakoids from plants.
9. Separation of photosynthetic pigment complexes by Blue Native-PAGE.
10. Estimation of Dissolved Oxygen in different water samples
11. Estimation of Biological Oxygen Demand and sag curve analysis in water samples
12. Study of stress related parameters (cysteine or proline) under abiotic stress (2 experiments)
13. Determination of microbial load and confirmation analysis in collected water samples
14. Analysis of plant growth under metal stress and its remediation potential (phytoremediation exp.)
15. Isolation of DNA from blood by phenol chloroform method
16. To study the Reverse-transcriptase-PCR and its significance
17. To study the PCR-RFLP, restriction digestion
18. To perform the DNA finger printing using different samples
19. Cytotoxic potential of anti-cancer drugs/plant extracts/ natural compounds through MTT assay
20. Isolation of RNA from cell line and real-time PCR for a particular gene
21. To identify a fragment of DNA in the unknown sample through Southern blotting
22. Immunohistochemistry for checking differential expression of cancer markers
23. Synthesis of silver nanoparticles
24. Characterization of synthesized nanoparticles
25. Antimicrobial activity of nanoparticles