MPBT03 Paper III. GENETIC ENGINEERING

UNIT I:

History and scope of genetic engineering. Bacterial vectors- pBR322 and pUC vectors. Phage vectors – Lambda, M13 and Cosmid. Artificial chromosomes – YAC, BAC, PAC and HAC, Expression vectors and Shuttle vectors.

UNIT II:

Enzymes in Genetic engineering – DNA modifying enzymes – i) Restriction enzymes, ii) DNA polymerase –Klenow, DNA polymerase I, T4 DNA Polymerase, iii) Reverse transcriptase, iv) Terminal transferase, v) T4 polynucleotide kinases, vi) Alkaline phosphatase, vii) DNA ligase, viii) Nucleases –Bal 31, S1 nucleases, DNase I, Ribonucleases, EXO III, RNA polymerase, Thermostable enzymes.

UNIT III:

Identifying the genes in genome sequence, determining the function of unknown genes, Studying Transcriptomics, Proteomics and Metabolomics. DNA ligation, adapters and linkers, screening of recombinant DNA, Recombinant vaccines and DNA vaccines

UNIT IV:

Gene silencing – PTGS, Co- suppression, antisense RNA, RNAi, Gene regulation by micro RNA, virus induced gene silencing, Gene editing CRISPER – CAS9 technology

UNIT V:

Transgenic Plants - Transgenic science in plant improvement, insect, herbicide resistant plants, disease resistant plant, stress resistant plants, edible vaccines. Transgenic Animals- Transgenic science for animal improvement, Biopharming- Animals as bioreactor for recombinant protein- Production of recombinant: Insulin, Human growth hormones, Silk protein, Recombinant factor and other proteins.

References Books:

1. *Primrose S.B and Twyman, R.M.* 2006. **Principles of Gene Manipulation and Genomics.** [Seventh Edition]. Blackwell Publishing Co., USA.
2. *Ernst-L.Winnacker.* 2003. **From Genes to Clones.** Panima Publishing Co., Bangalore.
3. *Reece, R.J.* 2004. **Analysis of Genes and Genomes.** John Wiley and Sons Ltd., USA.
4. *Joseph Sambrook and David W. Russell,* 2001. **Molecular cloning – A laboratory manual Volume 1 to 3.** [Third Edition]. Cold Spring Harbor Laboratory Press, New York.
5. *Brown, T.A* .2007. **Genomes.** [Third Edition]. Garland Science, USA.
6. *Micklos, D.A., Freyer, G.A. and Crotty, D.A.* 2003. **DNA science.** [Second Edition]. Cold Spring Harbor Laboratory Press, New York.
7. *James D. Watson, Richard M. Myers, Amy A. Caudy, Jan A. Witkowski.* 2006. **Recombinant DNA.** [Third Edition]. W.H Freeman & Company, New York.

MPBT03 Paper III: MOLECULAR BIOLOGY

UNIT I

Molecular basis of life – an introduction. The structure of DNA and RNA. Chemical structure of nucleic acids- Nucleotides and Nucleosides, central dogma of molecular biology. Replication of DNA - Prokaryotic replication and Eukaryotic replication, DNA polymerases.

UNIT II

Transcription in prokaryotes and eukaryotes – RNA polymerase and promoters. Transcription in Eukaryotes – RNA polymerase, promoters, enhancers and silencer. Post transcriptional modifications-capping, poly adenylation and splicing mechanisms.
Translation –mRNA, tRNA, Ribosome. Post translational modification, Molecular chaperones, protein targeting – Mitochondria, Nucleus, Lysosomes and Peroxisomes.

UNIT III

Isolation and purification of nucleic acid (genomic/plasmid DNA and RNA), Quantification and Storage of nucleic acids, Construction of cDNA library, Construction of Genomic library, Screening and preservation of DNA libraries, **colony hybridization,** Methods of nucleic acid hybridization – Southern, Northern blot analysis.

UNIT IV

PCR – Principle, components of PCR, steps in PCR, Optimization of PCR, Types of PCR. . Cloning of genes by PCR (gene specific and degenerate primers), nested PCR, 5' and 3' RACE-PCR, inverse PCR, hybrid PCR, TAIL PCR, Nested PCR, hot start PCR, Multiplex PCR, Quantitative PCR, Applications of PCR

UNIT V

DNA sequencing – Sanger's method and Maxam and Gilbert method of sequencing, Pyrosequencing and Next generation sequencing. DNA microarray, mRNA differential display, Single strand hybridization probe, Gene therapy: Introduction and Methods, Gene targeting and silencing, Gene therapy in thetreatment of diseases, Challenges and future of gene therapy

References Books:

1. *Peter Snustad, D. and Michael J. Simmon*, 2000. **Principles of Genetics.** [Second Edition]. John Wiley and Sons Publication.
2. *Peter, J. Russell*, 1997. **Genetics.** [Fifth Edition]. Benjamin – Cummings Publishing Company.
3. *Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, HiddePloegh, Paul Matsudaira*, 2007. **Molecular Cell Biology.** [Fifth Edition]. W.H. Freeman and Company. New York.
4. *Robert F. Weaver*, 1999. **Molecular Biology.** [First Edition]. McGraw Hill Publication Company, USA.
5. *Williams. S. Klug and Michael. R. Cummings*, 2004. **Concepts of Genetics**. [Seventh Edition]. Pearson Sons Education (Singapore) Pvt. Ltd., Indian Branch, Delhi.

MPBT03 Paper III: GENO-TOXICOLOGY

Unit I

Principles and mechanisms of toxicity, xenobiotic pathways, process of biotransformation and bioactivation, Dosage and time responserelationships. Toxicity of chemical substances *viz* hydrocarbons, metals, minerals and their effects on living being, dose response curve.

Unit II

Genotoxicity: Target and non-target organ toxicity, hepatotoxicity, nephrotoxicity, neurotoxicity, Immunotoxicity, carcingenecity, mutagenicity, system toxicity, genetic and reproductive toxicity embryotoxicity, teratogeneticity.

Unit III

Biotoxins: Phyto, Zoo and microbial toxins, metabolism of toxic substances by plants /animals/ microbes.Biomagnification of toxicants, Interaction of toxins with other substances such as vitamins, minerals.Food additives as toxicants.

Unit IV

Evaluation of toxicity tests; short-term genetic toxicology- bacterial reverse mutation assay, *in vitro*toxicology testing, In vivo toxicology testing-low dose estimation models; ADI (acceptance daily intake), RfD (Reference dose), BMD (Bone mineral density), comet assay.

Unit V

Genotoxic Chemotherapy, Risk and different treatment like alkylating agents, intercalating agents, enzyme inhibitors;legislation important in toxicology.

References Books:

1. Butler JC, Principle ofToxicology, John Wiley & Sons, NY.
2. Duffers JH, Environmental Toxicology, Edwards Arnold Publ. London 24.
3. De Anil Kumar, Environmental Chemistry, Wiley Eastern Ltd., New Delhi.
4. Hays JW and RR Laws, Handbook ofPesticide Toxicology (vol. I), Academic Press, NY.
5. Li A and Heflich RH, Genetic Toxicology, CRC Press, USA.

MPBT03 Paper III: HERBAL BIOTECHNOLOGY

Unit I:

An introduction to medicinal plants, medicinal plants in traditional system of medicine: Ayurveda, Siddha, Unani, Homeopathy and folklore system of medicine. Diversity hot spots, Endemic plants: endangered and threatened species.

Unit II:

Cultivation of traditional medicinal plants, post harvest technology of medicinal plants, storage of harvested products, processing and packaging of medicinal plant products. Important medicinal phytochemical products and bioactive compounds from plants: Essential oils, volatile and non-volatile oils and oleoresin.

Unit III:

Methods in extraction of phytochemical compounds (Homogenization, Serial exhaustive extraction, Soxhlet extraction, Maceration, Decoction, Infusion, Digestion, Percolation, Sonication, Super Critical Fluid Extraction); Detection of bioactive compounds and qualitative as well as quantitative analysis using GC-MS, HPLC, HPTLC.

Unit IV:

Conservation of medicinal plants- *In situ* & *Ex situ* conservation, Centres for medicinal plant conservation in India, Application of Molecular Biology in authentication of medicinal plants (RAPD, RFLP, AFLP, SSR), Sequence based markers (ITS, 5s rRNA, 18s rRNA, rbcl, trn L, trn F), DNA barcoding.

Unit V:

Plant biomolecules: future prospects in drug industry. Introduction to Human disease management-anti diabetic, anticancer, antiobesity, anti-HIV, antioxidant, antidermatophytes, hypertension.

References Books:

1. P. C. Trivedi. 2006. Medicinal plants – Traditional knowledge. I.K. International publishinghomo Pvt. Ltd.
2. Jitendra Singh. 2007. Medicinal and aromatic crops. Aavishkar Publisher & Distributor, Jaipur
3. Vaidyaratnam P S. 2002. Varier's Indian medicinal plants volume-1-5 a compendium of 500 species -1994, 1995,1996,2001,2002. Arya vaidya sala,orient longman.
4. Anil Kumar. 2010. Medicinal plants. International Scientific Publishing Academy
5. Ravindra Sharma. 2003. Medicinal plants of india – an encylopaedia. Daya Publishing House, Delhi.
6. L. D. Kapoor. 1990. Handbook of Ayurvedic medicinal plants CRC press. Herbal References Library.
7. Kiritikar K.R. and Basu, B.D. 2011. Indian medicinal plants Vol. VIII , CSIR Publications, New Delhi.
8. Janardhan Reddy, K. 2007. Advances in medicinal plants, University Press.
9. Sharma, P.D. 2006. Plant Pathology, Alpha Scientific International, India.
10. Cheng, 1986 3th Edn. Molecular parasitology, Elsevier Publications, London.
11. Lee Lerner and Brenda Wilmoth, 2007. Biotechnology: Industry Vol. III, Thomas-Gale Publications, US.

MPBT03 Paper III: INSECT BIOTECHNOLOGY

Unit-1

General biology of insect, Basic body plan, life cycle and homometabolous and hemimetabolous insects, General classification of insect.

Unit- 2

Neuro-endocrine system in insect, Midgut physiology, Insect hormones, Pheromones, Insect Reproduction.

Unit-3

Insect immunity, Insect Haemocyte, phenol oxidases, Eicosanoids action in insects, immunology, immunity to viruses, Parasitoid poly-DNA viruses and insect immunity RNAi and insect immune system.

Unit-4

Pest Control methods, Integrated Pest Management, Insecticide Resistance- Metabolic, Behavioural and Target site insensitivity. Insecticide Detoxification Enzymes, Gene families involved in Insecticide Resistance.

Unit -5

Insect pathology, Baculoviruses, RNA viruses, Fungal Entomopathogens, Bacterial Entomopathogens, Wolbachia infection in Arthropod host, Defense against microbial Invaders.

Reference Books:

- R.L.Chapman (2001). The insects: structure and function, Cambridge University Press.
- Nancy E. Bekage (2011) Insect immunology IstEdn, Academic press (USA)
- Robert L. Metcalf William H. Luckmann (2011). Introduction to Insect Pest Management 3rd Edn. Wiley India. (New Delhi).
- Alka Fenemore and Prakash (1992). Applied Entomology, Wiley Eastern Limited.

MPBT03 Paper III: MICROBIAL BIOTECHNOLOGY

UNIT: I

Isolation of industrial important microorganisms, Strain improvement, Culture preservation and stability, Preparation and Sterilization of media. Types of fermentation – Batch & Continuous. Immobilization of Enzymes& Cells.

UNIT: II

Microbial synthesis of commercialproduction-pharmaceutical products-Insulin-interferons-rDNA vaccines – HBV and FMD-Gene therapy methods. Enzyme biotechnology-enzyme production from microbes-applications.

UNIT: III

Algal technology-cultivation methods of spirulina- biotechnological potentials of microalgae-Food, Feed and Fuel production. Pharmaceutically Valuable Compounds of microalgae.

UNIT: IV

Production of commercial Products: Antibiotics-Penicillin, Streptomycin, Cephalosporin, Cephamycin. Pharmacologically Active and Related Microbial Products, Anticancer Agents. Production of biotechnological products-SCP (Yeats, Mushroom), Biofertilizer-VAM, Biopesticides-*Bacillus thurinensis*-Biopolymers-*Xanthomonas campestris*.

UNIT: V

Probiotics: Definition and history, Bacterial cell structure, Sources of Probiotics, Mode of action of probiotics. Uses of LAB in food fermentation. Bacteriophages from LAB. Current status of probiotic foods in market.Probiotics in human and animal health, probiotics in feed additives, Probiotics in bioconservation. Probiotic exoenzymes: Enzymes as feed additives.

References Books:

1. Comprehensive Biotechnology. 1-4 Volumes. Murry Moo-Young. Pergamon Press Ltd.
2. Principles of Fermentation Technology. Peter F. Stanbury. Butterworth-Heinemann, Elsevier Science Ltd.
3. Biotechnology: A Text Book of Industrial Microbiology, WulfCrueger and Anneliese Crueger. Science Tech Publishers.USA.
4. Fermentation Biotechnology. JayantoAchrekar. 2006. Dominant Publishers and Distributors. New Delhi.
5. Separation Process in Biotechnology. Juan.A.Asenjo. 2007. Taylor & Francis group.
6. Fermentation and Biochemical Engineering Handbook. Henry C.Vogel& Celeste L. Torado. 2005. Standard Publishers Distributors. New Delhi.
7. Patel, A.H. (2005). Industrial Microbiology. Mac Millan India Ltd, New Delhi.

MPBT03 Paper III: PHARMACEUTICAL BIOTECHNOLOGY

UNIT I

History & Principle of pharmacology. Drug names & Classification systems. General Principles of Drug action Pharmaco kinetics, Pharmaco dynamics, measurement of drug action.

UNIT II

Chemo therapeutic drugs- Protein synthesis inhibitors, Anti mycobacterial, anti fungal, anti protozoal, antiviral, Antihelmithic, anticancer, anti inflammatory drugs.

UNIT III

Techniques of r-DNA technology for production of Biologicals: Human Insulin, HGH, GRF, Erythropoietins, IFN, TNF, Interleukins, Clotting factor VIII.

UNIT IV

Production of Ergot alkaloids. Anticancer agents and anti-inflammatory agents in chemotherapy.Biochips,Biofilms, Biosurfactants, Biorepellents.

UNIT V

Protein Engineering, Tissue Engineering. Quality assurance and control – concept of good manufacturing practices, role of FSSAI and HACCP, test marketing and release into the market, Hormones. Quality assurance, Drug metabolism – biotransformation of drugs, microsomal and non-microsomal mechanisms, Pharmacology - pharmacodynamics pharmacokinetics.

References Books:

1. Pharmaceutical Biotechnology – S.S. Purohit, Kaknani, Saleja
2. Pharmacology – Mary J. Myuk, Richard A.Hoarey, PamalaLippinwitt Williams edition.
3. Pharmacology – H.P. Rang, M.M. Pale, J.M. Moore, Churchill Livingston.
4. Integrated pharmacology – Page, Curtis, Sulter, Walker, Halfman. Mosby Publishing co.
5. A concise Text Book of Pharmacology. N.Murugesh. Sixth edition. Sathya Publishers, Madurai.

6.A Text Book of Biotechnology. R.C. Dubey. S.Chand& Co Ltd, New Delhi.

MPBT03 Paper III: ENVIRONMENTAL BIOTECHNOLOGY

UNIT-I

Eco system, Food Chain, Food web, Energy flow, Environment:Basic concepts and issues. Environmental pollution: Types of pollution, Methods for measurement of pollution.

UNIT-II

Water pollution and its control: Need for water management, Types ofWaste water treatment – physical,chemical and biological treatment processes. Microbiology of waste water treatments: Aerobic process, Activated sludge, Trickling filters, towers, rotating discs, rotating drums, oxidation ponds.

UNIT-III

Anaerobic processes: Anaerobic digestion, Anaerobic filters, Upflowanaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries.

UNIT-IV

Microbiology of degradation of xenobiotics in environment: Ecological considerations, decay behavior & degradative plasmids; Hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides. Bioremediation of contaminated soils and wasteland. Biopesticides in integrated pest management.

UNIT-V

Solid wastes: Sources and management (composting, vermiculture and methane production).Global environmental problems: Ozone depletion, UV- B, Green house effect and acid rain, their impact and biotechnological approaches for management.

References Books:

1. Environmental Science and Biotechnology: Theory and Techniques, A.G.Murugesan and C.Rajakumari, (2005).
2. Environmental microbiology, K.VijayaRamesh(2004).
3. Industrial and Environmental Biotechnology,Wise(2005)
4. Encyclopaedia of Environmental Biology, Chhatwal(2005).
5. Environmental Biology, P.D.Sharma(1994) Rastogi Publications.
6. Environmental Biotechnology and cleaner Bioprocesses, Eugenia J.Olguin(2000) Tayloir and Francis.
7. Principle Environmental Science, William P. Conningham and Mary Ann Conningham (2003) Tata McGraw-Hill publishing Company.
8. Environmental Biotechnology, K.V. Agarwall(2005) Nidhi Publishers.
9. Introduction to Environmental Biotechnology, A.K. Chatterji(2002) Prentice- Hall of India.
10. Environmental Biotechnology, Hans-Joachim Jordening, Josefwinter (2005).
11. Environmental Biotechnology by Jogdan.
12. Microbial Ecology, Atlas and Bhartha.2005. Pearson Education.

MPBT03 Paper III: CANCER BIOLOGY

UNIT – I

Introduction, definition, classification, description of cancer and Hallmarks of malignant disease. Growth characteristics of cancers cells; Morphological and ultrastructural properties of cancer cells. Types of growth-hyperplasia, dysplasia, anaplasia and neoplasia. Differences between benign and malignant tumors.

UNIT – II

Epidemiology of cancer. Aberrant metabolism during cancer development; Paraneoplastic syndromes. Biomarkers for cancer. Cellular protooncogenes- oncogene activation. Growth factors-EGF, TNF-α &TGF-β and growth factor receptors–Signal transduction in cancer. Role of transcription factors.

UNIT – III

Carcinogenesis: Radiation and Chemical carcinogenesis. Stages in chemical carcinogenesis-Initiation, promotion and progression. Free radicals, antioxidants in cancer. Viral carcinogenesis -DNA and RNA Viruses and human cancer.

UNIT – IV

Cell Cycle Regulation: Tumorsuppressor genes p53, p21. Cell - Cell interactions, cell adhesion-invasion and metastasis. VEGF signaling, Angiogenesis, Epigenetics-Role of DNA methylation in gene silencing. Apoptosis in Cancer-Cell death by apoptosis - role of caspases. Death signaling pathways-mitochondrial and death receptor pathways.

UNIT – V

New technologies for Prevention, assessing, risk diagnostic and treatment of cancer. Cancer therapy; Treatment- Traditional, Chemotherapy, Immunotherapy, Radiotherapy,Targeted gene therapy and Proteomic technologies. Stem cell and its cancer treatment.

References Books:

1. *Momna hejmadi.* 2010. **Introduction to cancer biology.** 2nd edition,Book boonpublishers, London.
2. *Raymond W. Ruddon.* 2007. **Cancer Biology.** 4th edition, Oxford University publishers, New York.
3. *Macdonald, F, Ford,C.H.J and Casson, A.G.* 2005. **Molecular Biology of Cancer.** 2nd edition,Garland Science/BIOS Scientific Publishers, London and New York.
4. *Weinberg, R.A.* 2006. **The Biology of Cancer** Garland Science.
5. *McKinnell, R.G, Parchment, R.E, Perantoni, A.O, Barry Pierce, G and Damjanov, I.* 2006. **The Biological Basis of Cancer.** 2nd edition, Cambridge University Press.

MPBT03 Paper III: MEDICAL BIOTECHNOLOGY

UNIT – I

Medical Biotechnology- Need and Scope, Genetic disease and its classification, Molecular basis of single gene disorder, lysosomal storage disease, single gene disorder with non classical patterns of inheritance- mutation in mitochondrial genes, trinucleotide repeat expansion disorder.

UNIT – II

Disease diagnosis and medical forensics – Detecting infectious disease: detection and identification of microorganisms – sample preparation, bacterial targets of molecular based tests. Antimicrobial agents,Molecular epidemiology, virus – nucleic acid blotting techniquefor virus detection. Detection of inherited diseases – Molecular diagnosis of single gene disorders i) Factor V ii) Cystic fibrosis.

UNIT – III

Molecular oncology: Classification of neoplasms, molecular basis of cancer, Analytical targets for molecular testing, Gene rearrangements in Leukemia and lymphoma. DNA based tissue typing: HLA polymorphism.

UNIT – IV

Nanodrug-definitions, Bionanoparticles– nano-composites, Nanobiosensors. Biology inspired concepts – Biosystems, biological networks, biological neurons, neurotransmitters. Protein interactions modulated by chemical energy:- actin, myosin and molecular motors.

UNIT – V

Drug delivery systems – polymer therapeutics:- polymer drug conjugates; polymeric micelles; liposomes. Determination of mechanical properties:- mechanical testing; elasticity; toughness; effect of fabrication on strength. Application of materials in medicine:- cardiovascular medical devices; tissue regeneration (tissue engineering). Dendrimers as nanoparticulate drug carriers. Bioresponsive hydrogels.

REFERENCE BOOKS:

1. *Jean-Louis Sersa.* 2002. **Diagnostic techniques in genetics**. John wiley and sons, Ltd.
2. *Danny L. Wiedbrauk*and *Daniel H. Farka.*, 1995. **Molecular Methods for virus detection**. Academic press.
3. *Brown.T.A.* 2005. **Genomes.** [Third Edition]. New York : Garland Science Pub.
4. *Primrose ,S.B.* and *Twyman,R.M.* 2006. **Principles of gene manipulation and genomics**. [Seventh Edition]. Blackwell Publication.
5. *Sathyanarayana, U.* 2009. **Biotechnology**. Books and Allied Private Ltd, Kolkatta.
6. *Reece,R.J.* 2004. **Analysis of Genes and Genomes**. John wiley& Sons. Inc.
7. Molecular Design and Synthesis of Biomaterials Biological Engineering Division, MIT Open Course Ware, 27th May 2005.

8. Biomaterials Sciences: An Introduction to Materials in Medicine 2nd Edition, Buddy D.Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons
9. Nanotechnology: A Gentle Introduction to the Next Big Idea Mark Ratner and Daniel Ratner. Pearson Education Publishers, 2002.
10. Encyclopedia of Nanoscience &Nanotechnology,H.S. Nalwa (Ed.,),American Scientific Publishers, California, 2004.
11. Lehninger's Principles of Biochemistry, 4th Edition, David L. Nelson and Michael M. Cox, 2006.
12. Nano biotechnology : concepts, applications and perspectives. Christof M.Niemayer,ChadA.Mirkin ,Wiley VCH publishers 2004.
13. Bionanotechnology: Lessons from Nature,David .S.Goodsell,Jhonwiley 2006.
14. *Lela Buckingham* and *Maribeth L. Flaws.* 2007. **Molecular diagnostics- Fundamentals, methods and clinical applications.** FA Davis Company. Philadelphia.