

SEMESTER-I

MBT101 - ENGINEERING MATHEMATICS

Module-I

Differentiation; Integration; Maxima and minima; First and second order differentiation; Linear equation with constant and variable coefficient. Probability- Axiomatic definition; Addition theorem; Conditional probability; Bayes' theorem; Random variable; Mathematical expectation; Theoretical distribution- Binomial, Poisson, Normal and Standard normal distribution

Module-II

Statistics- Measures of central tendencies and distribution; Coefficient of variation; Sampling parameter; Static and standard error; Census and Sample methods; Method of sampling (Probability and non probability sampling).

Module-III

Testing of hypothesis; Null and alternative hypothesis; TypeI and typeII errors; Level of significance; Large sample test; Test of significance of single and two sample means; Test of significance of single and two proportion.

Small sample tests- F test; T test (Paired, unpaired); Chi square test goodness of fit.

Module-IV

Correlation (Partial and Multiple correlation); Regression (Sample linear, non linear and multiple regression); Analysis of variance (One way and Two way).

Module-V

Mole concept, Determination of mole wt. by gram molecular volume relationship, problems based on mole concept, Solutions, colligative properties, Methods of expressing concentrations, strength, Normality, Molarity & Molality, ppm. Standardization of solutions, Colloids, pH, buffer systems, dissociation constant, pK value, Preparation of standard solution of acids and bases, problems related to acid base titrations, volumetric experiments-acidimetry, alkalimetry, permanganometry, dichrometry, iodometry., Methods of plotting Enzyme Kinetics Data, Effects of pH and temperature on Enzyme stability and activity.

Case studies.

Practicals:

- a) Preparation of standard acid (succinic acid) and alkali and their standardization.
- b) Preparation of various solutions (normal, molar, and percent) and ppm/ppb by serial dilutions.

Text/References:

1. P.S.S. Sunder Rao, P.H.Richard, J.Richard. An introduction to Biostatistics, Prentice Hall of India (P) Ltd., New Delhi, New Edition.
2. Rangaswamy R. A text book of Agricultural Statistics, New Age International (P) Ltd., New Delhi, New Edition.
3. Gupta S.P. Statistical Methods, Sultan Chand & Sons, New Delhi, New Edition.
4. Panse V.G.Panse, P.V. Sukhatme. Statistical methods for Agricultural Workers, ICAR Publications, New Delhi, New Edition.
5. Jerrold H. Zar. Bio Statistical Analysis, Tan Prints (I) Pvt. Ltd., New Delhi, New Edition.
6. Chandel, S.R.S. A Hand Book of Agricultural Statistics, Achal Prakashan Mandir, Kanpur, New Edition.
7. B.S. Grewal. Higher Engineering Mathematics, Khanna publishers, New Edition.
8. C.N. R. Rao. University General Chemistry, Mc Millan Publication, New Edition.
9. A.S.Negi & S.C.Anand. A Text Book of Physical chemistry, New Edition.
10. Rob lewis and Wynne evans. Chemistry, Palgrave foundations, New Edition.
11. Selected papers from scientific journals.

MBT102- CELL AND MOLECULAR BIOLOGY

Module-I

Cell cycle and Genome Organization

Genome Organization in prokaryotes and eukaryotes - DNA content and C-value paradox - methods to measure DNA content variation - Various types of DNA sequences – simple sequences, repetitive sequences, Junk DNA or selfish DNA, tandem gene clusters, satellites Variety of DNA structures: double helix, Z-DNA, B-DNA, Mechanism of DNA replication: prokaryotes and eukaryotes, Overview of the cell cycle, Factors involved in cell cycle, Mitosis, Meiosis, cell cycle control, cell check points.

Module –II

Replication and Cell Signaling Mechanisms

DNA replication models, mode of action, DNA damage, DNA repair and recombination, Organization structures and function of ribonucleoproteins; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; Gene targeting; Gene disruption; Signal transduction, primary and secondary messengers, involvement of G proteins, protein kinases, serine, threonine and tyrosine kinases, mechanism of signaling by steroids, cell death.

Module – III

Prokaryotic & Eukaryotic Transcription

Prokaryotic Transcription; Regulation of transcription, Termination-Rho-dependent and independent, Attenuation; Transcriptional regulation-Positive and negative; Operon concept-lac, trp, ara, his, and gal operons; Transcriptional control in lambda phage; Anti-termination, Transcript processing; Processing of tRNA and rRNA Eukaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; Eukaryotic promoters and enhancers; General Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF); Activators and repressors; Transcriptional and posttranscriptional gene silencing

Module – IV

Post Transcriptional Modifications

Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA.

Translation & Transport

Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Isoaccepting tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co- and post-translational modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation.

Module – V

Diverse type of oncogenesis

Viral and cellular oncogenes; Tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes; DNA virus/ cell immortalization, Oncogenes as transcriptional activators.

Strategies of chemotherapy and gene therapy against cancer; translating therapies from laboratory to clinic; Gene discovery in cancer research, Mechanisms of diverse type of cancers.

Case studies.

Lab on Cell & Molecular Biology

1. Isolation and Quantitation of cellular macromolecules (DNA, RNA and Protein).
2. cDNA Synthesis
3. Transformation and Preparation of competent cells.
4. Antibiotics sensitivity test on microbial cultures
5. Agarose gel electrophoresis of DNA fragments.
6. SDS PAGE for resolution of proteins.
7. Elution of DNA from an agarose gel.
8. Preparation of metaphase Chromosome.
9. Karyotyping and banding Pattern (G-banding).
10. Preparations of blood smear for study of sex chromatin.

Text/References:

1. Benjamin Lewin. Gene IX, Jones and Barlett Publishers, 2007.
2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner. Molecular Biology of the Gene, Benjamin Cummings Publishing Company Inc, 2007.
3. Albert et al., Molecular Biology of the Cell, Garland, New Edition.

4. **Rober A. Meyers. Encyclopedia of Molecular Cell Biology and Molecular Medicine, Wiley-VCH Verlag GmbH & Co. KGaA. New Edition.**
5. **J.M. Walker, R. Rapley. Molecular Biology and Biotechnology, Royal Society of Chemistry, New Edition.**
6. **G. Karp. Cell and Molecular Biology, John Wiley & Sons. New Edition.**
7. **Gabi Nindl Waite, Lee R. Waite. Applied Cell and Molecular Biology for Engineers, McGraw Hill. New Edition.**
8. **Thomas Pollard, Saunders. Cell Biology, New Edition.**
9. **Dornall and Baltimore. Scientific publisher, USA. New Edition.**
10. **Lodish et al., Molecular cell Biology. Freeman & Company. New Edition.**
11. **Becker, Klein Smith and Hardin. The world of the cell. Pearson education Inc. 2007.**
12. **De Roberties F. D. P. and De Roberties Junior E.M.F. Cell and molecular biology, Sounder, Philadelphia. New Edition.**
13. **Selected papers from scientific journals.**

MBT103 -BIOPROCESS ENGINEERING

Module I

Fundamentals of Bioprocess engineering

Microbial growth, Factors affecting growth, Growth kinetics and metabolism, Stoichiometry: Material and energy balance calculations, Transport phenomenon (mass and energy transfer).

Module II

Bioreactors

Introduction to bioreactors: General design information; Selection of bioprocess equipment (upstream and downstream); Specifications of bioprocess equipment; Batch and Fed-batch bioreactors, Continuous bioreactors; Bioreactor operation; Sterilization; Aeration; Sensors; Instrumentation; Culture-specific design aspects: plant/ mammalian cell culture reactors.

Module III

Upstream processing

Effect of scale on oxygenation, mixing, sterilization, pH, temperature, inoculums development, Media Formulation, nutrient availability and supply; Strain improvement; Bioreactor scale-up based on constant power consumption per volume; mixing time; impeller tip speed (shear), mass transfer coefficients; Process economy.

Module IV

Bioseparations / Downstream Processing

Biomass removal and disruption: Filtration; centrifugation; distillation; adsorption; Extraction (solvent, aqueous two phase, super critical), Chromatographic Techniques(Ion exchange, gel filtration, affinity, HPLC, TLC, GC); Cell disruption (Physical, chemical, enzymatic); Membrane based purification (Ultrafiltration, Reverse Osmosis, Dialysis), Process configurations (packed bed, expanded bed, simulated moving beds); Precipitation (Ammonium Sulfate, solvent); Electrophoresis (SDS-PAGE, isoelectric focusing, 2D-gel, capillary);

Crystallization; Drying.

Module V

Description of industrial processes

Microbial processes for production of organic acids (citric acid, acetic acid), amino acids (Lysine, isoleucine, glutamic acid, Arginine), antibiotics (Penicillin, Cephalosporin C, actinomycin), alcohol, enzymes. Recombinant protein production in microbes e.g. recombinant insulin; Waste treatment, Process economics.

Case studies.

Lab on Bioprocess Engineering

1. Microbial growth and product formation kinetics.
2. Conventional filtration.
3. Effects of inhibitor on microbial growth.
4. Enzyme immobilization techniques.
5. Bioconversion using immobilized enzyme preparation.
6. Bioconversion in batch.
7. Mixing and agitation in fermenters.
8. Protein precipitation and its recovery.
9. Membrane based filtration-ultra filtration in cross flow modules and micro filtration.
10. Enzyme purification and estimation of enzyme kinetics.

Texts/References

1. **Shuler M. and Kargi F. Bioprocess Engineering: Basic Concepts, Prentice Hall, Englewood Cliffs, NJ. New Edition.**
2. **Doran P., Bioprocess engineering principles, Academic Press, New Edition.**
3. **Ratledge C., Kristiansen B. Basic Biotechnology, Cambridge University Press, New Edition.**
4. **Harrison R. et al., Bioseparations Science and Engineering, Oxford University Press, New Edition.**
5. **Harris and Angal S. Protein Purification Methods, Ed. IRL Press at Oxford University Press, New Edition.**

6. Belter P.A., Cussler E.L., and Hu Wei-Shou. **Bioseparations-Downstream Processing for Biotechnology**, Wiley-Interscience Publication, New Edition.
7. Bailey J. E. and Ollis D. F. **Biochemical Engineering Fundamentals**, Mc-Graw Hill, Inc., New Edition.
8. Scopes R. K., Berlin. **Protein Purification: Principles and Practice**, Springer, New Edition.
9. Biotol series. **Product Recovery in Bioprocess Technology**, Butterworth Heinemann Ltd., New Edition.
10. **Relevant articles from Bioprocess journals.**

MBT104 -CELL & TISSUE CULTURE

Module-I:

Culture Technique: Animal

Structure of animal cell; History of animal cell culture; Basic requirements for animal cell culture; Cell culture media and reagents; Animal cell, tissue and organ cultures; Primary culture, secondary culture; Continuous cell lines; Suspension cultures; Somatic cell cloning and hybridization; Transfection and transformation of cells.

Module-II:

Applications of culture techniques: Animal

Commercial scale production of animal cell, Stem cells and their application; Application of animal cell culture for *in vitro* testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal vaccines and pharmaceutical proteins.

Module-III:

Culture Techniques: Plant

Totipotency, Cyto-differentiation; 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, Virus free culture and its applications.

Module-IV:

Plant Tissue Culture: Protoplast Culture and Somatic Hybridization

Protoplast isolation; Culture and usage; Somatic hybridization - methods and applications; Cybrids and somatic cell genetics and its application, cytoplasmic sterility, secondary metabolite production.

Module-V:

Applications of Plant tissue culture

Role of tissue culture in agriculture, horticulture and forestry, Transgenic plants Technique of transformation– Agrobacterium mediated, Applications of transgenic plants. Edible Vaccines from plants – Banana, Watermelon.

Case studies.

Lab on Tissue Culture

1. Aseptically media preparations.
2. Cryopreservation of cells and retrieval of cells.
3. Maintenance and development of cell passage.
4. Handling of secondary animal cell culture.
5. Identification of contaminants in animal cell culture.
6. Subculturing of continuous cell line growing in monolayer and suspension.
7. Construction and analysis of growth curve.
8. Isolation of primary cell culture.
9. Plant Protoplast Isolation.
10. Plant propagation through Tissue culture (shoot tip and Nodal culture).

Texts/References:

1. **Adrian Slater, Nigel Scott and Mark Fowler. Plant Biotechnology: The genetic manipulation of plants, Oxford University Press, New Edition.**
2. **Bhjawani and Razdan. Plant Tissue Culture, Elsevier publication, New Edition.**
3. **Freshney I. Culture of Animal cells, Wiley-liss, New Edition.**
4. **Bruce Alberts. The Cell, New Edition.**
5. **H.S.Chawla. An Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd. New Edition.**
6. **J. P. Mather, P. E. Roberts. Introduction to Cell and Tissue Culture. Plenum Press. New Edition.**
7. **Selected papers from scientific journals.**

MBT105 -GENOMICS AND GENETIC ENGINEERING

Module-I

Genetic engineering tools

Restriction Enzymes; The range of DNA manipulative enzymes (Nucleases, Ligases, Polymerases, Modifying enzymes, Topoisomerases); Cohesive and blunt end ligation (Linkers, Adaptors, Homopolymer tailing); Labeling of DNA (Radioactive and Non-radioactive); Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors SV-40; Expression vectors (pMal, GST, pET-based vectors); Protein purification (His-tag, GST-tag, MBP-tag); Inclusion bodies; Baculovirus vector system, Yeast vectors, Shuttle vectors; Principles in maximizing gene expression.

Module- II

Genomic Analysis

Insertion of Foreign DNA into Host Cells; Construction of libraries; Isolation of mRNA and total RNA; cDNA synthesis and cloning; genomic libraries; Expression cloning; jumping or hopping libraries; Southwestern and Farwestern cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Hybridization Techniques (Colony Hybridization, Fluorescence in situ Hybridization); DNA-Protein Interactions (EMSA-Electrophoretic mobility shift Assay; DNaseI footprinting, Chromatin Immunoprecipitation);

Module- III

PCR and Its Applications

Primer design; Fidelity of thermostable enzymes; Types of PCR (multiplex PCR, nested PCR, reverse transcriptase PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR); cloning of PCR products; vectors for cloning; Proof reading enzymes; PCR in gene recombination (Deletion; addition; Overlap extension; and SOEing, Site specific mutagenesis); PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test); Cloning vectors for direct cloning of PCR parts.

Module-IV

Post Genomic analysis

Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Gene silencing techniques; siRNA & stRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts; Creation of knock out mice; Identification and classification using molecular markers- ribosomal typing/sequencing.

Module- V

Genetic engineering applications

Gene therapy in Disease models (Cancer, Diabetes, AIDS, Thalassaemia); Somatic and germ-line therapy- *in vivo* and *ex-vivo*; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

Case studies

Lab on Genetic Engineering

1. Plasmid DNA isolation and DNA quantitation.
2. PCR amplification of genes and analysis by agarose gel electrophoresis.
3. Cloning using pUC18 and pBR 322.
4. Transformation of recombinant plasmid in to host.
5. Non-radioactive Random Primer labeling.
6. Blotting techniques: (Southern, Western, Northern)
7. Southern hybridization with genomic DNA with non radioactive labeled probe detection.
8. RFLP analysis of the PCR product.
9. Introduction of DNA into mammalian c ells; Transfection techniques;
10. Preparation of genomic DNA library in plasmid vector.

Text/References:

1. **S.B. Primrose, R.M. Twyman and R.W.Old. Principles of Gene Manipulation. S.B.University Press, New Edition.**
2. **J. Sambrook and D.W. Russel. Molecular Cloning: A Laboratory Manual, CSHL, New Edition.**

3. Brown TA, Genomes. 3rd ed. Garland Science 2006.
4. Robert G. Kunz. Nanotechnology: Environmental Implications and Solutions by Louis Theodore, May 2005.
5. Challa S. S. R. Kumar. Biological and Pharmaceutical Nanomaterials, December 2005.
6. David S. Goodsell, Bionanotechnology: Lessons from Nature, New Edition.
7. Challa S.S.R. Kumar, Josef Hormes, Carola Leuschner. Nanofabrication Towards Biomedical Applications: Techniques, Tools, Applications, and Impact, February 2005.
8. Rheis. Analysis of genes and genome, New Edition.
9. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.
10. Selected papers from scientific journals.