

Syllabus for M.Tech Biotechnology

(APPROVED BY SYLLABUS COMMITTEE)

MEETING HELD ON 25TH AUGUST 2014



SCHOOL OF BIOTECHNOLOGY
(An Autonomous University Teaching Department)
RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA

**(STATE TECHNOLOGICAL UNIVERSITY OF MADHYA PRADESH)
AIRPORT ROAD, BHOPAL-462033**

CURRICULUM OUTLINE

M. Tech. [BIOTECHNOLOGY]

Core Subject

SEMESTER-I

- » MBT-101 Engineering Mathematics
- » MBT-102 Cell & Molecular Biology
- » MBT-103 Bioprocess Engineering
- » MBT-104 Advance Biochemistry
- » MBT-105 Genomics & Genetic Engineering

SEMESTER-II

- » MBT-201 IPR, Bioentrepreneurship &
Bio-safety
- » MBT-202 Metabolomics & Tissue
Engineering
- » MBT-203 Immunotechnology
- » MBT-204 Stem Cell Technology
- » MBT-205 Proteomics & Protein
Engineering

SEMESTER-III

- » MBT-301 Research Methodology
- » MBT-302 Scientific skills
- » MBT-303 Seminar
- » MBT-304 Comprehensive analysis
- » MBT-305 Project synopsis

SEMESTER-IV

- » MBT-401 Dissertation

GUIDE LINES FOR PROJECT WORK

- For M. Tech. II year (III & IV Semester) students a project work shall be compulsory.
- The project shall be carried out under the supervision of departmental faculty members or in collaboration with industry / national / international academic institutions.
- The project work shall be of one year duration of one project divided in two semesters III & IV.
- The project synopsis and research methodology in III semester of the same project shall be evaluated by the two external examiners of the national repute.
- The seminar based on research paper that is one of the base papers of the same project shall also be evaluated by the external examiner of national/ international standing.
- The candidate shall be required to submit the one project report in triplicate after publication of one research and one review article in the peer reviewed journals at the end of the fourth semester/ before obtaining the M.Tech degree.
- There shall be thesis evaluation by external examiner of national / international status.
- After receiving the evaluation report from the concerning examiner, suggestion/s suggested by the concerning examiner (if any) should be incorporated in the thesis.
- Then the candidate shall be eligible for examination and defense / viva-voce of research project at the end of the IV semester.

ATTENDANCE

- Candidates appearing as regular students for any semester examination shall be required to attend at least 75% of lecturers delivered and of the practical's held, separately in each paper, provided that a short fall in attendance up to 5% can be condoned by the Vice Chancellor of Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal respectively for satisfactory reasons.

Note: If a candidate has passed a semester examination in full he/she shall not be permitted to reappear in the examination for improvement of division/marks of any other purpose.

CRITERIA FOR PROMOTION TO HIGHER SEMESTER

According to Ordinance No.8 (A) for degree in Master of Engineering/Technology/Master of Architecture (M.E/M.Tech/M.Arch.) for the Candidates admitted in 1st year on/after July, 2010, under **Credit Based Grading System** applicable from July, 2010, the criteria for promotion to higher semester is as follows:

- For the award of degree minimum Cumulative Grade Point Average (CGPA) required is 5.0.
- To pass a particular subject of the course the minimum required grade is D. However, the candidate should also separately score minimum required of grade D in both mid and end semester examinations of theory and practical parts of the subject individually.
- The distribution of weightage/marks for each component are as following :

Theory Block

i) Quizzes, assignments and regularity	10%
ii) Mid-semester tests	20%
iii) End-semester Examination	70%
Total	100%

Practical Block

i) Lab work and performance, quizzes, assignments and regularity	40%
ii) End-semester examination	60%
Total	100%

- Project work shall be treated as practical subject.

The grades to be used and their numerical equivalents are as under:

Credit Based Grading System

Grade	% Marks range (based on absolute marks system)	Grade Point	Description of performance
A+	91-100	10	Outstanding
A	81-90	9	Excellent
B+	71-80	8	Very Good
B	61-70	7	Good
C+	51-60	6	Average
C	41-50	5	Satisfactory
D	40 only	4	Marginal
F	Below 40	0	Fail
I		0	Incomplete
W		0	Withdrawal

SEMESTER-I

MBT 101- 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.

Module-II

Statistics- Measures of central tendencies and distribution; Coefficient of variation; Theoretical distribution- Binomial, Poisson, Normal and Standard normal distribution. 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.

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.
- c) Exercises based on biostatistics.

Text

1. **B.S. Grewal. Higher Engineering Mathematics, Khanna publishers, New Edition.**
2. **P.S.S. Sunder Rao, P.H.Richard, J.Richard. An introduction to Biostatistics, Prentice Hall of India (P) Ltd., New Delhi, New Edition.**
3. **Gupta S.P. Statistical Methods, Sultan Chand & Sons, New Delhi, New Edition.**

References

1. **Rangaswamy R. A text book of Agricultural Statistics, New Age International (P) Ltd., New Delhi, New Edition.**
2. **Panse V.G.Panse, P.V. Sukhatme. Statistical methods for Agricultural Workers, ICAR Publications, New Delhi, New Edition.**
3. **Jerrold H. Zar. Bio Statistical Analysis, Tan Prints (I) Pvt. Ltd., New Delhi, New Edition.**
4. **Chandel, S.R.S. A Hand Book of Agricultural Statistics, Achal Prakashan Mandir, Kanpur, New Edition.**
5. **C.N. R. Rao. University General Chemistry, Mc Millan Publication, New Edition.**
6. **A.S.Negi & S.C.Anand. A Text Book of Physical chemistry, New Edition.**
7. **Rob lewis and Wynne evans. Chemistry, Palgrave foundations, New Edition.**
8. **Selected papers from scientific journals.**

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 Books

1. **Albert et al., Molecular Biology of the Cell, Garland, New Edition.**
2. **G. Karp. Cell and Molecular Biology, John Wiley & Sons. New Edition**
3. **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, New Edition**
4. **Benjamin Lewin. Gene IX, Jones and Barlett Publishers, New Edition.**

Reference Books

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

BIOPROCESS ENGINEERING

Module I

Enzyme and Microbial Technology

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

Enzyme Technology: Introduction, how enzyme works, Enzyme Kinetics, Methods of plotting Enzyme Kinetics Data, Effects of pH and temperature on Enzyme stability and activity.

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; Oxygen uptake rate; K_{La} determination Sensors; Instrumentation; Culture-specific design aspects: plant/mammalian cell culture reactors.

Module III

Upstream processing & Scale up

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.

Module IV

Bioseparations / Downstream Processing

Biomass removal: 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), 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.

Text Books

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.**

Reference Books

1. **Ratledge C., Kristiansen B. Basic Biotechnology, Cambridge University Press, New Edition.**
2. **Harrison R. et al., Bioseparations Science and Engineering, Oxford University Press, New Edition.**
3. **Harris and Angal S. Protein Purification Methods, Ed. IRL Press at Oxford University Press, New Edition.**
4. **Belter P.A., Cussler E.L., and Hu Wei-Shou. Bioseparations-Downstream Processing for Biotechnology, Wiley-Interscience Publication, New Edition.**
5. **Bailey J. E. and Ollis D. F. Biochemical Engineering Fundamentals, Mc-Graw Hill, Inc., New Edition.**

- 6. Scopes R. K., Berlin. Protein Purification: Principles and Practice, Springer, New Edition.**
- 7. Biotol series. Product Recovery in Bioprocess Technology, Butterworth Heinemann Ltd., New Edition.**
- 8. Relevant articles from Bioprocess journals.**

Advance Biochemistry

Module I

Carbohydrates and Lipids

Carbohydrates: Introduction and biological importance. Structure and properties of - Aldose, Ketose; open chain and ring structure pyranose and furanose, Monosaccharide sugars (glyceraldehydes, Di hydroxy acetone, erythrose, ribose, glucose, fructose, concept of reducing and non reducing sugars), Disaccharide (maltose, sucrose, lactose), Oligosaccharide (raffinose) and Polysaccharide (starch, amylose and amylopectin, glycogen, peptidoglycan, cellulose, proteoglycan matrix) Lipids: Introduction, Classes, Fatty acids [saturated, unsaturated, branched, even chain and odd chain, essential fatty acids, Physical properties, Chemical properties, Saponification value, acid value, iodine number, rancidity]. Structure and function of phospholipids, Sphingolipids and cholesterol.

Module II

Proteins

Amino acids and their & their physical & chemical properties, titration of amino acids, separation and identification of amino acids, classification of proteins based on chemical nature and conformation, ionic status, peptides, primary structure, determination of amino acid sequencing, Ramachandran plot, secondary structure (α -helix, β -strand, β -sheet, turns and loops), tertiary structure (ion-ion, ion-dipole and dipole-dipole interactions), quaternary structure globular and fibrous proteins, structure of hemoglobin and myoglobin

Module III

Enzymes

Outlines of enzyme classification. Active site, energy of activation, transition state hypothesis, lock and key hypothesis, induced fit hypothesis.. Enzyme activation, various types of enzyme inhibition and identification using double reciprocal plot. Introduction to Allosteric enzymes. Definition of holoenzyme, apoenzyme, coenzyme, cofactor, prosthetic group and their examples. Concept of ribozyme, multiple forms, isozymes and abzymes.

Module IV

Bioenergetics

TCA cycle and glycolytic cycle (outline), biological order and energy, coupled reaction, electrochemical potential and redox reaction,. osmosis, dialysis, Donnan equilibrium, membrane transport, Mitochondrial electron transport chain, oxidative phosphorylation, chemical coupling, conformation coupling and chemiostatic theories for oxidative phosphorylation, uncouplers and inhibitors of respiratory chain.

Module V

Medical Biochemistry

Biochemical and Molecular Bases of Disease. Metabolic disorders of carbohydrates galactosemia, glycogen storage disease, deficiency of glucose-6-phosphate

dehydrogenase, Hypoglycemia, Diabetes mellitus. Metabolic disorder of lipid: Tay-Sachs disease, Nieman Pick disease. Metabolic disorder of amino acid: phenylketonuria, alkaptonuria, Maple syrup urine disease. Metabolic disorder of nucleotides: gout, Lesch-Nyhan Syndrome.

Function of liver in health and disease: Jaundice, Hepatitis; liver function test. Evaluation of organ function test: Assessment and clinical manifestation of renal, hepatic, pancreatic, gastric & intestinal function, enzyme of pancreatic origin and biliary tract, test of myocardial infarction. Enzymes as clinical diagnostic tools.

Lab on Advance Biochemistry

1. Qualitative analysis of Carbohydrates, Proteins and Lipids.
2. Quantitative estimation of Protein by Folin-Lowry unitary method.
3. Quantitative estimation of sugar by Nelson Somogy's unitary method.
4. Quantitative estimation of sugar by DNS method.
5. Analyzing the enzyme activity.
6. Study the effect of pH on enzyme activity.
7. Study the effect of temperature on enzyme activity

Text Books

1. **Principles of Biochemistry - L. Stryer (W.H. Freeman & Co.). New Edition.**
2. **Principles of Biochemistry - A.L. Lehninger, D.W. Nelson & M.M. Cox (Macmillan). New Edition.**

Reference Books

1. **Biochemistry - D. Voet & J.G. Voet (John Wiley). New Edition.**
2. **Harper's Illustrated Biochemistry - R.K. Murray et al. (McGraw Hill). New Edition.**
3. **Outline of Biochemistry - Conn & Stump (John Wiley & Sons). New Edition.**
4. **Protein Science - A.M. Lesk (Oxford Univ. Press). New Edition.**
5. **The Enzyme – Dixon & Webb. New Edition.**

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; Cloning of PCR products; Cloning vectors for direct cloning of PCR parts.

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); 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).

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; Metagenomics, codon optimization.

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 Genomics and 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 Books

1. **S.B. Primrose, R.M. Twyman and R.W.Old. Principles of Gene Manipulation. S.B.University Press, New Edition.**
2. **Brown TA, Genomes. 3rd ed. Garland Science. New Edition.**

Reference Books

1. **J. Sambrook and D.W. Russel. Molecular Cloning: A Laboratory Manual, CSHL, New Edition.**
2. **Robert G. Kunz. Nanotechnology: Environmental Implications and Solutions by Louis Theodore, May 2005.**
3. **Challa S. S. R. Kumar. Biological and Pharmaceutical Nanomaterials, December 2005.**
4. **David S. Goodsell, Bionanotechnology: Lessons from Nature, New Edition.**

- 5. Challa S.S.R. Kumar, Josef Hormes, Carola Leuschner. Nanofabrication Towards Biomedical Applications: Techniques, Tools, Applications, and Impact, February 2005.**
- 6. Rheis. Analysis of genes and genome, New Edition.**
- 7. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.**
- 8. Selected papers from scientific journals.**

SEMESTER-II

IPR, BIOSAFETY AND BIOENTREPRENEURSHIP

Module-I Patent filing procedures

Introduction to Intellectual Property. Introduction to Patents; Types of patent applications National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes. Patent licensing and agreement Patent infringement- meaning, scope, litigation, Deliberate testing-Transgenic testing, Centers in India for Testing.

Module-II

Biosafety

Introduction; Principles of laboratory biosafety and biosecurity; Risk assessment: Occupational health hazards and laboratory associated infections (LAIs); Laboratory biosafety level criteria and biosafety laboratory design; Primary containment for biohazards: Selection, installation and used of biosafety cabinets; Decontamination and disinfection; Safe working practices in biorisk areas and waste management of biohazards; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Institutional Biosafety Committee (IBSC), Institutional Animal Ethics Committee (IAEC), Review Committee for Genetically Modified organisms (RCGM), Genetic Engineering Approval Committee (GEAC) etc. for GMO applications in food and agriculture; Environmental release of GMOs. Handling and transportation of infectious material and genetically modified products.

Module-III

Fundamentals of Entrepreneurship

Support mechanism for entrepreneurship in India. How to use IT for business administration; Use of IT in improving business performance; Available software for better financial management; E-business setup, management. Leadership skills; Managerial skills; Organization structure, pros & cons of different structures; Team building, teamwork; Appraisal; Rewards in small scale set up. With financiers, bankers etc.; with government/law enforcement authorities; With companies/Institutions for technology transfer; Dispute resolution skills; External environment/changes; Crisis/ Avoiding/Managing; Broader vision–Global thinking

Module IV

Accounting and Finance

Taking decision on starting a venture; Assessment of feasibility of a given venture/new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/Plan for seeking loans from financial institution and Banks; Funds from bank for capital expenditure and for working; Statutory and legal requirements for starting a company/venture; Budget planning and cash flow management; Basics in accounting practices: concepts of balance sheet, P&L account, and double entry bookkeeping; Estimation of income, expenditure, profit, income tax etc.

Module V

Marketing

Assessment of market demand for potential product (s) of interest; Market conditions, segments; Prediction of market changes; Identifying needs of customers including gaps in the market, packaging the product; Market linkages, branding issues; Developing distribution channels; Pricing/Policies/Competition; Promotion/Advertising; Services Marketing

Case studies

Text Books

1. **BAREACT, Indian Patent Act 2005, Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007.**
2. **Kankanala C. Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007.**
3. **Shkula. S. M. Advanced Accountancy, Masherwari, Sahitya Bhawan, Agra.**
4. **Kotler. P. Marketing Management, Prentice Hall of India Limited.**
5. **Staton. E.J. Fundamentals of Marketing Tata McGraw Hill.**

Reference Books

6. **M. K. Sateesh I. K. International Pvt. Ltd. Bioethics and Biosafety, 2008.**
7. **Frederic H. Erbisch, Karim M. Maredia. Intellectual property rights in agricultural biotechnology, CAB International publication, USA, New Edition.**
8. **Rajmohan Joshi. Biosafety and Bioethics, Gyan Publishing House, 2006.**

9. Selected papers from scientific journals.

Important Links:

- 1. <http://www.w3.org/IPR/>**
- 2. <http://www.wipo.int/portal/index.html.en>**
- 3. http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html**
- 4. www.patentoffice.nic.in**
- 5. www.iprlawindia.org/ - 31k - Cached - Similar page**
- 6. <http://www.cbd.int/biosafety/background.shtml>**
- 7. <http://www.cdc.gov/OD/ohs/symp5/jyrttext.htm>**
- 8. <http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html>**

METABOLOMICS & TISSUE ENGINEERING

Module-I

Metabolomics fundamentals

Overview: Background and definitions of Metabolomics, importance of Metabolomics. Metabolic pathway databases EcoCyc, MetaCyc & KEGG

Module-II

Metabolic pathways

Carbohydrate metabolism: HMP, uronic acid pathway, glycogenolysis and glycogen storage diseases. *Lipid metabolism*: Synthesis of essential fatty acids. *Protein metabolism*: Biosynthesis of essential amino acids. Metabolic breakdown of amino acids leading to Krebs cycle intermediate. Disorders of amino acid metabolism; *Nucleic acid metabolism*: Biosynthesis and degradation of purines and pyrimidines with regulation, disorders of Nucleic acid metabolism.

Module-III

Analytical techniques and Applications of Metabolomics

Technologies-Mass spectrometry: principles, definitions, nomenclature, Metabolite isolation and analysis by Mass Spectrometry, metabolite library, HPLC- capillary electrophoresis coupled with Mass spectrometry; Metabolome informatics, data integration and mining, *Applications* of Metabolomics to biology.

Module-IV

Fundamentals of tissue engineering

Introduction, Basic requirements for tissue engineering; Cell culture media and reagents. *Types of culture & Culture Techniques*: **Animal**-Primary culture & secondary culture; Continuous cell lines; Suspension cultures; cell, tissue and organ cultures, Commercial scale production of animal cell, Testing of toxicity of environmental pollutants in cell culture; Cell line engineering (GS and DHFR system)

Plant-Virus free culture, Protoplast culture, Somatic cell cloning and hybridization; Cyto-differentiation; Organogenesis; Somatic embryogenesis; Artificial seed production; Micropropagation; Somaclonal variation; Androgenesis Germplasm conservation and cryopreservation, Protoplast isolation; Somatic hybridization, Cybrids.

Module-V

Applications of culture techniques

Application of animal cell culture for in vitro testing of drugs; Application of cell culture technology in production of human and animal vaccines and pharmaceutical proteins. Role of tissue culture in agriculture, horticulture and forestry.

Case studies

Lab on Metabolomics & Tissue Engineering

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).
11. Study of metabolic pathways using databases MetaCyc & KEGG
12. Fatty acid extraction from Arabidopsis seedlings
13. Extraction of Alkaloids
14. HPLC analysis of Alkaloids

Text Books:

1. [David L. Nelson](#), Michael M. Cox. Principles of Biochemistry. New Edition
2. **Bhjawani and Razdan. Plant Tissue Culture, Elsevier publication, New Edition.**
3. **H.S.Chawla. An Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd. New Edition.**

Reference Books:

1. **Adrian Slater, Nigel Scott and Mark Fowler. Plant Biotechnology: The genetic manipulation of plants, Oxford University Press, New Edition.**
2. **Freshney I. Culture of Animal cells, Wiley-liss, New Edition.**
3. **Bruce Alberts. The Cell, New Edition.**
4. **J. P. Mather, P. E. Roberts. Introduction to Cell and Tissue Culture. Plenum Press. New Edition.**
5. **[John C. Lindon](#) (Editor), [Jeremy K. Nicholson](#) (Editor). The Handbook on Metabonomics and Metabolomics. New Edition**
6. **Selected papers from scientific journals.**

IMMUNOTECHNOLOGY

Module I

Introduction

Immunology- fundamental concepts and anatomy of the immune system, Immune memory, Immune tolerance; Phagocytosis; Complement and Inflammatory responses; Haematopoiesis; Mucosal Immunity; Antigens - immunogens, haptens; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing.

Module II

Hybridoma Technology & Antibody Engineering

Hybridoma techniques and monoclonal Ab production- myeloma cell lines, fusion of myeloma cell lines with Ab producing B cells , fusion methods, selection and screening methods, for positive hybrids, -cloning methods- production and purification and characterization of MAb. Application of MAb in biomedical research, in clinical diagnosis and treatment. Production of human MAb and their applications. Production of polyclonal Ab with different type of Ag: Ag preparation and modification, adjuvants, dose and route of Ag administration, collection of sera. Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies; Catalytic antibodies and generation of immunoglobulin gene libraries.

Module III

Immunotechniques-Antigen-Antibody interactions

Immunoprecipitation- mancini method, ouchterloney method, immune electrophoresis, rocket immunoelectrophoresis, crossed immunoelectrophoresis, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT and ELAST assay, peptide based immuno binding assay, peptide mapping, epitope mapping, fluorescence and photo illumination based immunoassay, DELPHIA and SLFIA, concept of immunohisto / cyto-chemistry, immunofluorescence, flow cytometry and immunoelectron microscopy; detection of molecules in living cells, *in situ* localization by techniques such as FISH and GISH. Surface plasmon resonance, Biosensor assays for assessing ligand-receptor interaction, CMI techniques- lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays.

Module IV

New generation Vaccines: Immunobiotechnology

Vaccines and Vaccination, types of vaccines including new generation vaccines. Tumor immunology. Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines;

Module V

Clinical Immunology

Hypersensitivity – Type I-V; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Transplantation – Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy; Tumor immunology – Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy; Immunodeficiency-Primary immunodeficiencies, Acquired or secondary immunodeficiencies.

Case studies

Lab on Immunotechnology:

1. Single Radial Immuno Diffusion.
2. Double diffusion.
3. Rocket Immunoelectrophoresis.
4. Counter- Current Immunoelectrophoresis.
5. Characterization of Immunoglobulins by SDS-PAGE.
6. Antibody titre by ELISA method.
7. Isolation of Lymphocytes from human blood and Culture
8. Culturing and maintenance of cell lines
9. Immunoblotting, Dot blot assays.
10. Abs Production.

Text Books

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne. Immunology, New Edition.

2. **Brostoff J, Seaddin JK, Male D, Roitt IM. Clinical Immunology, Gower Medical Publishing, New Edition.**

Reference Books

1. **Janeway et al., Immunobiology, Current Biology publications. New Edition.**
2. **Paul. Fundamental of Immunology, Lippencott Raven, New Edition.**
3. **Goding. Monoclonal antibodies, Academic Press. New Edition.**
4. **P. Delves, S. Martin, D. Burton and I. Roitt. Essential Immunology, Eleventh Edition (2006) Wiley-Blackwell Publishers, UK.**
5. **J. Kuby. Immunology, W H Freeman & Co Publishers. New Edition.**
6. **Hay F.C. and Westwood O.M.R. Practical immunology, Wiley-Blackwell Publishers, New Edition.**
7. **E. Benjamin, G. Sunshine, and S. Leskowitz. Immunology - A Short Course, Wiley-Liss Publishers, New York. New Edition.**
8. **D.P. Stites, J.D. Stobo and J.V. Wells. Basic and Clinical Immunology, Appleton & Lange Publishers. New Edition.**
9. **Selected papers from scientific journals.**

STEM CELL TECHNOLOGY

Module-I

Introduction to Stem Cells

Stem Cells: Definition, Classification and Sources, Blastocyst Culture, Xeno-free Derivation and Cryopreservation, Properties and Applications of Embryonic Stem Cells, Characterization of Human Embryonic Stem Cells, Stem Cells and their Developmental Potential. Culture, Subcloning, Spontaneous and Controlled Differentiation of Human Embryonic Stem Cells, *In Vivo* and *In Vitro* Differentiation of Human Embryonic Stem Cells, Feeder-free Culture of Human Embryonic Stem Cells,

Module-II

Standardization and Quality Assurance

Generation and Expansion of pluripotent Stem cells, Epigenesis in Pluripotent Cells, Organogenesis, Mammalian Nuclear Transfer Technology, Novel Strategies for the mobilization of HSC, GMP : clinical scale production of MSCs,

Module-III

Regenerative Medicine

Stem Cell therapy for Neurodegenerative Diseases: Parkinson's, Alzheimer, Spinal Cord injuries and other brain syndromes, Tissue system failures, Diabetic Cardiomyopathy, kidney failure, liver failure, Leukaemia, transplantation.

Module-IV

Cancer stem cells

Purification and characterization of cancer stem cells, therapeutic implications of cancer stem cells: Preventative and therapeutic strategies for cancer stem cells, Targeting acute myelogenous leukaemia stem cells, targeting cancer stem cell pathways: Hedgehog/GLI signalling, Notch signalling pathway, Wnt.

Module-V

Human Embryonic Stem Cells and society

Human Stem cells research: ethical considerations, stem cell religion consideration, Stem Cell based therapies: pre clinical regulatory consideration and patient advocacy, Intellectual property issues surrounding Human Embryonic Stem cells study.

Case studies

Lab on Stem Cell Technology:

1. Preparation of feeder cell culture.
2. Culturing of Stem cell line.
3. Isolation of cells from blastocyst.
4. Growing mesenchymal stem cell.
5. Preservation of cord blood.
6. Stem cell isolation from umbilical cord.
7. Types of cleavage, invertebrates, vertebrates, and permanent preparations – stains of stages of blastula
8. Development of Amphibian – Gestulation – Metamorphosis
9. Sex determination – Drosophila (Prescribed assignments with problems in genetic)
10. Stem cells – Identification of cells by staining of bone marrow – (Animal example)

Text Books

1. Ariff Bongso, Eng Hin Lee. **Stem cells from Bench to Bedside. World Scientific Publishing Co. Pte. Ltd. New Edition.**
2. Stewart Sell. **Stem cells Hand Book. Humana Press. Totowa, New Jersey. New Edition.**

Reference Books

3. S.F. Gillert, Sinauer. **Developmental Biology, Associates inc., Massachusetts. New Edition.**

- 4. Ethan Bier. The cold spring Cold Spring Harbor Lab Press, New York. New Edition.**
- 5. Freshney, R. I. Culture of Animal Cells. Wiley-Liss. New Edition.**
- 6. Masters, J. R. W. Animal Cell Culture – Practical Approach, Oxford Univ. Press. New Edition.**
- 7. Basaga, R. Cell Growth and Division: A Practical Approach. IRL Press. New Edition.**
- 8. Butler, M and Dawson, M. Cell Culture Lab Fax, Eds., Bios Scientific Publications Ltd., Oxford. New Edition.**
- 9. Clynes, M. Animal Cell Culture Techniques. Springer. New Edition.**
- 10. Mather, J.P and Barnes, D. Methods in Cell Biology, Animal Cell Culture Methods. Academic Press. New Edition.**
- 11. Marshak. Cold spring Harbar Symposium Publication. New Edition.**
- 12. Scott F. Gilbert. Development Biology, New Edition.**
- 13. Selected papers from scientific journals.**

PROTEOMICS & PROTEIN ENGINEERING

Module I

Architecture of Proteins: Amino acids, classification of proteins, Protein Structure: primary, secondary, tertiary and quaternary. Protein folding, thermodynamics and kinetics of protein folding, Protein Stability: protein stability & associated factors. Detection, identification and quantification of amino acids and proteins, *In-silico* protein modeling.

Module II

Control of Protein Function: Mechanisms of Regulation, Protein Interaction Domains, Regulation by Location, Effector Ligands: Competitive Binding and Cooperativity, Conformational Change and Allostery, Protein Switches Based on Nucleotide Hydrolysis, GTPase Switches: Small Signaling G Proteins, Signal Relay by Heterotrimeric GTPases, Protein Synthesis, Motor Protein Switches, Regulation by Degradation, Control of Protein Function by Phosphorylation, Regulation of Signaling Protein Kinases: Activation Mechanism, Cdk Activation, Two-Component Signaling Systems in Bacteria, Control by Proteolysis, Protein trafficking.

Module III

Protein – Protein Interactions:

Charting protein–protein interactions: Topoisomerase-based cloning, Univector plasmid-fusion system, Two-hybrid analysis protein-protein interactions in yeast, viral, bacteria systems. Use of phage display to detect protein-ligand interactions, Detecting interactions by protein fragment complementation assays.

Module IV

Protein Engineering & Protein Design:

Outline of bioengineering of macromolecules a multidisciplinary approach; Methods to alter primary structure of protein: site directed mutagenesis; examples of engineered proteins, protein design, principles and examples. Steps involved in protein engineering and protein modeling to the desired needs. Protein characterization: Amino acids sequencing, Peptide finger mass printing, Mass Intact protein, Glycan analysis.

Module V

Techniques: Protein engineering

Physical methods of determining the three-dimensional structure of proteins (X-ray crystallography, Nuclear magnetic resonance spectroscopy, Cryoelectron microscopy, Neutron diffraction, Optical spectroscopic techniques, Vibrational spectroscopy, Raman spectroscopy), Use of 2-D PAGE, sensitivity and resolution and representation of 2-D gels, multiplexed analysis to show expression profiles; circular dichroism (CD), MALDITOF and MALDITOFTOF, special strategies for qualitative and quantitative analysis. Protein array for expressional analysis, profiling and functional analysis, application of proteomics to medicine.

Case studies.

Lab on Proteomics & Protein Engineering

1. Using absorbance coefficients and extinction coefficients to estimate protein concentration
2. Protein quantitation when contaminating nucleic acids are present
3. Measuring protein concentration by colorimetric assay - the Bradford assay
4. The nitric acid method for protein estimation in biological samples
5. Quantitation of Tryptophan in Proteins
6. The CAT (chloramphenicol acetyltransferase) Assay
7. Use of Luciferase in a reporter assay
8. *In vitro* translation - Determining amino acid incorporation
9. Casting Immobilized pH Gradients (IPGs)
10. Carboxymethylation of cysteine using iodoacetamide/iodoacetic acid
11. Analyzing Protein Phosphorylation

Text Books

1. **TE Creighton. Protein Function A Practical Approach, 2005. W.H. Freeman & Company. New Edition.**
2. **Thomas E Creighton , Creighton. Proteins: Structures and Molecular Properties, W.H. Freeman & Company. New Edition.**
3. **N J Darby, T E Creighton. Protein Structure (In Focus), W.H. Freeman & Company. New Edition.**

Reference Books

1. **Charles J Dutton, Mark A Haxell, Hamish A. I. McArthur and Richard G. Wax Marcel Dekker. Peptide Antibiotics - Discovery, Modes of Action, and Applications, New Edition.**
2. **Peter Goodenough. Protein Engineering II CPL Press. New Edition.**

- 3. Lilia Alberghina. Protein Engineering for Industrial Biotechnology, CRC Press. New Edition.**
- 4. Loïc Faye and Véronique Gomord. Recombinant Proteins From Plants - Methods and Protocols, Humana Press. January 2009.**
- 5. Sheldon J Park, Jennifer R Cochran. Protein Engineering And Design, CRC Press. New Edition.**
- 6. Paul R Carey. Protein Engineering And Design, Academic Press. New Edition.**
- 7. Paul Wrede, Gisbert Schneider, Walter De Gruyter. Concepts in Protein Engineering and Design: An Introduction, New Edition.**
- 8. Nediljko Budisa, Wiley-VCH Verlag GmbH. Engineering The Genetic Code: Expanding The Amino Acid Repertoire For The Design Of Novel Proteins. New Edition.**
- 9. Selected papers from scientific journals.**

