

**PUNJAB TECHNICAL UNIVERSITY**  
**Scheme and Syllabus of**  
**M.Tech. Biotechnology Batch 2010**

**First Semester**

Course Code	Course Title	Load Distribution			Marks Distribution		Total Marks
		L	T	P	Internal	External	
MTBT 101	Microbial biotechnology	3	-		50	100	150
MTBT 103	Biomolecules & Biotechnology	3	-		50	100	150
MTBT 105	Bioprocess engineering & technology	3	-		50	100	150
MTBT 107	Biostatistics	3	-		50	100	150
MTBT 109 *	Pharmaceutical Biotechnology	3	-		50	100	150
MTBT 111*	Environmental Engg. And Waste Management	3	-				
MTBT 113	LAB-I (Biomolecules And Microbial Biotechnology Lab)			8	50	50	100
MTBT 115	LAB – II (Bioprocess Engineering And Technology Lab)			8	50	50	100
<b>TOTAL</b>							<b>950</b>

**TOTAL LOAD: 31 Hrs.**

**Note: \* These are Special Papers. Students have to opt any one out of MTBT 109 and MTBT 111**

## Second Semester

**TOTAL LOAD: 31 Hrs.** \*These are Special Papers. Students have to choose any one out of MTBT-110 and MTBT-112

Course Code	Course Title	Load Distribution			Marks Distribution		Total Marks
		L	T	P	Internal	External	
MTBT – 102	Applied Immunology	3	-		50	100	150
MTBT – 104	Applied Biotechnology	3	-		50	100	150
MTBT – 106	Fermentation Technology	3	-		50	100	150
MTBT – 108	Bio-Analytical Techniques	3	-		50	100	150
MTBT – 110*	Stem Cell Technology	3	-		50	100	150
MTBT – 112*	Intellectual Property Rights, Bioethics and Biosafety	3	-				
MTBT – 114	LAB – I (Applied Biotechnology and Bio-Analytical Techniques Lab)		-	8	50	50	100
MTBT – 116	LAB – II (Applied Immunology Lab)			8	50	50	100
<b>Grand Total</b>		<b>15</b>		<b>16</b>	<b>350</b>	<b>600</b>	<b>950</b>
<b>TOTAL</b>							<b>950</b>

3<sup>rd</sup> Semester

Total Load: 32

SCHEDULE OF TEACHING AND EXAMINATION FOR  
M.TECH. (BIOTECHNOLOGY)

Course Code	Course Title	Load Distribution			Marks Distribution		Total Marks
		L	T	P	Internal	External	
MTBT – 201	Cell and Tissue Culture	4	-	-	50	100	150
MTBT – 203	Advanced Bioinformatics	4	-	-	50	100	150
MTBT – 205	Major Project	-	-	12	50	100	150
MTBT – 207	Lab – I ( Cell and Tissue Culture )	-	-	6	50	50	100
MTBT – 209	Lab – II ( Advanced Bioinformatics )	-	-	6	50	50	100
	<b>Total</b>	<b>8</b>		<b>24</b>	<b>250</b>	<b>400</b>	<b>650</b>
<b>GRAND TOTAL</b>							<b>650</b>

#### 4<sup>TH</sup> SEMESTER

SUBJECT CODE	SUBJECT	Schedule of Teaching				Schedule of Examination		
		L	T	P	Total	Theory/ Practical	Sessional	Total
MTBT - 202	Thesis*	0	0	28	28	-	-	-

\* The students will complete their Thesis work and submit copies of the Thesis report to the University as per its existing procedures. The Internal and External Examiners appointed by the University will evaluate the same through a Viva-voce examination and award **Satisfactory / Unsatisfactory** to the Thesis.

- **Structure and Function** of Carbohydrates, Lipids, Proteins, Amino acids and Nucleic acids.
- **Bioenergetics and Thermodynamics:** Common biochemical reactions, Phosphoryl group transfer, biological oxidation- reduction reactions.
- **Biosignalling:** General features, G-proteins, Tyrosine kinase based signaling, multivalent adaptor proteins, gated ion channels, integrins, signalling in micro-organisms and plants.
- **Enzymes:** Catalytic mechanism of few enzymes: Lysozyme, Chymotrypsin and serine protease, different classes of enzymes and their industrial application, application of enzymes in solution and in immobilized state, use of enzyme inhibitors as therapeutic agents.
- **Salient features** of carbohydrate, lipid, amino acid & nucleic acid metabolism
- **Metabolic Regulations:** Different Modes of regulation, Hormonal regulation and integration of metabolism
- **Biotechnology:** Biotechnology-an interdisciplinary pursuit, conventional & modern biotechnology, various natural raw materials for biotechnology, genetics & biotechnology, current trends and underlying principles of microbial, plant, animal & environmental biotechnology; safety, social, moral & ethical aspects of biotechnology

**References:**

1. Principles of Biochemistry by A. Lehninger revised by Nelson and Cox, 2008.
2. Biochemistry by Mathews, Van Holde and Ahern. 3rd Edition.
3. Biochemistry by White, Handler and R.B.Smith 7th Ed.
4. Biochemistry by L.Stryer Third Edition.
5. Fundamentals of Biochemistry by Conn and Stumph.
6. Biotechnology, 3rd Edition by J.E. Smith, Cambridge Univ. Press (1996)
7. Biotechnology-an Introduction by S.R. Barnum, Thompson Brooks/Cole (2007)
8. Plant Biotechnology-the genetic manipulation of plants, 2nd Edition by A Slater, N.W. Scott M.R. Fowler, Oxford Univ Press (2008)

**Role & Importance of Microbes in the field of Biotechnology:** Microbial Technology, Human Therapeutics, Agriculture, Waste Water Treatment, Hazardous Waste Management, Feedstock.

- **Industrially Important Microbes:** *E coli*, *Saccharomyces*, *Penicillium*, (morphology, growth requirements and genetics)
- **Screening of Microbes of Industrial Importance:** Primary and Secondary Screening, Potential of Thermophilic Archae in biotechnology.
- **Strain improvement techniques:** Introduction, Bioprospecting, Genetic manipulation of micro-organisms (Mutation, protoplast fusion, r-DNA technology, modification of gene expression), Preservation of micro-organisms.
- **Industrial importance of microbes in production of :**
  - **Enzymes** (Amylase, Invertase, Proteolytic),
  - **Vaccines** (Recombinant and Synthetic Vaccines) ,
  - **Antibiotics** (penicillin, streptomycin),
  - **Biomass, Organic acids** (citric acid, acetic acid, gluconic acid and  $\alpha$ - keto glutaric acid),
  - **Vitamins** (Vitamin B<sub>12</sub>, Vitamin A, Riboflavin),
  - **Ethanol Production**,
  - **Biofertilizers** (Nitrogen- fixing, phosphate solubilizing),
  - **Biodegradable plastics** (3- Hydroxybutyrate, 3-Hydroxyvalerate),
  - **Bio-insecticides** (*Bacillus sp.*, Baculovirus),
  - **Probiotics.**
- **Introduction and role of microbes in the degradation of pollutants / toxic compounds.**

#### References:

1. Microbiology VI Edition, M.J. Pelczar, E.C.S. Chan and N.R. Kreig, Tata McGraw Hill.
2. Microbiology by L.M.Prescott, J.Harley, D.A.Klein 6<sup>TH</sup> Ed., Mc Graw- Hill International edition, 2005..
3. General Microbiology, R.Y. Stanier, J.L. Ingraham, M.L.Wheelis and P.R. Painter, Macmillian
4. Principles of Microbiology, R.M. Atlas, Wm C. Brown Publisher.
5. Microbial Biotechnology:Fundamentals of Applied Microbiology, A.N. Glazer and Hiroshi Nikaido, 1994
6. The microbes – An Introduction to their Nature and Importance, P.V. Vandenmark and B.L. Batzing, Benjamin Cummings.
7. Industrial microbiology- L.E. Casida, New Age International Publishers.2005

- **Microbial Growth Kinetics**
- Factors affecting Microbial Growth; Stoichiometry: Mass Balances; Energy Balances; Growth Kinetics; Batch Culture , Continuous Culture , Fed Batch Culture, Feedback culture.
- Fermentation Kinetics: Framework for Kinetic Models ,Mass Balances for Bioreactor, Structure Compartmental & Unstructured Models
- Fermentor: Sterilization of air & Sterilization of Media, Aeration and Agitation;
- Bioprocess Control: Controllers, Process control and Cascade control, Direct Regulatory Control and Advanced Control,
- Operation of Aseptic Aerobic Fermentation Process
- Bioseparation, Biomass removal and Disruption; Centrifugation; Sedimentation; Flocculation; Microfiltration; Sonication; Bead Mills; Homogenizers; Chemical Lysis; Enzymatic Lysis, Precipitation (Ammonium Sulfate), Extraction(solvent, aqueous two phase, super critical),
- Membrane based purification: Ultrafiltration ; Reverse osmosis; Dialysis ; Preevaporation; Perstraction
- Chromatography: Adsorption, Size Exclusion, HPLC, Electrophoresis, Drying and Crystallization

#### **References**

1. Michael Shuler and Fikret Kargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ, 2002.
2. Pauline Doran, Bioprocess engineering principles, 1 Edition, Academic Press, 1995.
3. Colin Ratledge, Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge University Press, 2001.
4. Roger Harrison et al., Bioseparations Science and Engineering, Oxford University Press, 2003.
5. E L V Harris and S. Angal, Protein Purification Methods, Ed. IRL Press at Oxford University Press, 1989.
6. P.A. Belter, E.L. Cussler and Wei-Shou Hu., Bioseparations-Downstream Processing for Biotechnology, Wiley-Interscience Publication, 1988.
7. J. E. Bailey and D. F. Ollis, Biochemical Engineering Fundamentals, 2nd Edition, Mc-Graw Hill, Inc., 1986.

- **Probability**

**Counting and Probability:** Addition rules; Permutations; Combinations; Inclusion-Exclusion Rule; Sampling with and without replacement; Conditional Probability: Bayes' Theorem; Independence

- **Descriptive Statistics**

Descriptive Statistics and Random Variables; Measures of Central Tendency: Mean, Median, Mode; Measures of Spread: Range, Percentile, Standard Deviation; Displaying Data: Histograms, Stem and-Leaf Plots, Box Plots, Frequency Distributions; Geometric Distributions: Continuous Random Variables: Normal, Exponential Distributions, Standard Normal Distribution, Binomial Distribution, Poisson Distribution.

- **Skewness, Kurtosis, Moments**

Measures of Skewness, Karl Pearson's Coefficient of Skewness, Moments about Arbitrary origin, Moments about zero, Sheppard's correction for grouping errors, Measures of kurtosis

- **Inferential Statistics and one sample Hypothesis Testing**

Samples and populations: Random, stratified and cluster sampling; Single- and Double-blind experiments; Sampling distributions: students  $t$ , chi-square, F distributions; Hypothesis testing: null and alternative hypotheses, decision criteria, critical values, type I and type II errors, Meaning of statistical significance; Power of a test; One sample hypothesis testing

- **Multi-Sample and Nonparametric Hypothesis Testing**

Two sample hypothesis testing; Nonparametric methods: Signed rank test; Analysis of variance: One-way ANOVA, two-way ANOVA.

- **Curve Fitting**

Regression and correlation: simple linear regression; Least squares method; Polynomial curve fitting.

- **Design of Experiments**

Single factor experiments; Randomized block design; Factorial designs

**References**

1. S. P. Gupta, Statistical Methods. S. Chand & Sons, 2008
2. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley, 2006.
3. Bernard Rosner, Fundamentals of Biostatistics, 5th Edition, Thomson Brooks/Cole, 2000.
4. G. Prabhakara. Biostatistics.



- **Pharmaceuticals, Biologics and Biopharmaceuticals**  
An Overview Pharmaceutical Biotechnology; Biopharmaceuticals - Current Status and Future Prospects
- **The Drug Discovery & Development Process**  
Drug Discovery: High Throughput and Rational Drug Design; Pre-clinical, IND; Drug Development: Clinical Trials; NDA; Role of Regulatory Authorities in drug approval (US and Europe)
- **Strategies for search of new lead drugs/compounds**  
Improvement of Existing Drugs; Systematic Screening including High-Throughput Screening
- **Biologics**  
Proteins based drugs (Sources, Structure, Folding and Stability); Therapeutic Proteins, Pharmacokinetics and Pharmacodynamics of peptides and protein, Protein Engineering, Peptidomimetics.
- **Production and formulation of Biotech Compounds**  
Cultivation, Production and Purification, Downstream Processing, Excipients, Microbiological consideration, Shelflife, Doses, Therapeutic Response, Route of Drug administration, Delivery system.
- **Generics and Biosimilars**  
Therapeutic Equivalence, Regulatory approval (US and Europe)

**References:**

1. Pharmaceutical Biotechnology: Concepts and Applications, Gary Walsh, Wiley John & Sons, Inc. (2007)
2. Biopharmaceuticals, Gary Walsh, Wiley John & Sons, Inc. (2003)
3. Pharmaceutical Biotechnology by Dann, J.A, Cremmelin & Robert D., Sindelar, Taylor & Francis (2002)
4. Biopharmaceuticals and industrial prospective, Gary Walsh & B. Murphy, Kluwer publishers (1999)

- **Ecology and Environment:** Sources of Air, Water and Solid Wastes.
- **Air Pollution:** Micrometeorology and Dispersion of pollutants in environment. Fate of pollutants.
- **Air Pollution Control Technologies:** Centrifugal Collectors, Electrostatics, Precipitator, Bag filter and Wet Scrubbers. Design and efficiencies. Combustion generated pollution, vehicle emission control. Case studies.
- **Water pollution:** Water quality modeling for streams. Characterization of effluents, effluent standards.
- **Treatment methods:** Primary methods; setting, pH control, chemical treatment. Secondary methods; Biological treatment, Tertiary treatments; like ozonization, disinfection, etc.
- **Solid Waste Collection:** Treatment and Disposal. Waste Recovery System.
- **Biofuels :** Microbes as source of energy
- **Bioremediation**
- **Environmental modelling:** Biofilter Technology, Sewage Treatment, Hospital Waste Management

**References:**

- Introduction to environment engineering by P.A. Vesilind, S.M. Morgan and L.G. Heine.2009,Cengage Learning
- L.Canter "Environment Impact Assessment", *McGraw Hill*.
- E.P.Odum "Fundamentals of Ecology " *V.B.Saunders and Co. 1974*.
- W.J.Weber "Physics-Chemical Process for water quality control, *Wiley-international* Ed.
- L.L.Gaccio water and water population Handbook *Marcel Dekkar*, New York
- Microbial Biotechnology:Fundamentals of Applied Microbiology, A.N. Glazer and Hiroshi Nikaido, 1995

**MTBT – 113****BIOMOLECULES AND MICROBIAL BIOTECHNOLOGY LAB**

1. Isolation of industrially important micro organisms for microbial processes.
2. Determination of phenol coefficient.
3. Strain Improvement Techniques
4. Production and estimation of alkaline protease, Microbial production of antibiotics (Penicillin)
5. Microbial production of organic acids
6. Degradation of toxic compounds by microbes
7. Proteins: Separation of proteins by SDS-PAGE.
8. Biochemical estimation of DNA by diphenylamine reagent,
9. Biochemical estimation of RNA by orcinol reagent.
10. To check purity of DNA.
11. Separation of DNA samples on Agarose gel.

**MTBT – 115****BIOPROCESS ENGINEERING AND TECHNOLOGY LAB**

1. Study of the Rheology of the fermentation fluids.
2. Study of the fermentation by using both shake flask method and lab bioreactor.
3. Determination of growth curve of a supplied micro organism and also determine substrate degradation profile and to compute specific growth rate and growth yield from the data obtained.
4. Comparative studies of ethanol production using different substrates,
5. Conventional filtration and membrane based filtration
6. Chromatographic techniques (paper – ascending and descending, TLC, Column)

- **Introduction**

- **Immune Responses Generated by B and T Lymphocytes**

Kinetics of Immune Response; Memory B cell maturation, activation and differentiation; Generation of antibody diversity; Immunological basis of self and non-self discrimination; T-cell maturation, activation and differentiation; T-cell receptors; Functional T-cell subsets; Cell-mediated Immune Responses: T cell mediated, NK cell mediated and ADCC; Cytokines: Properties, receptors and therapeutic uses; Antigen processing and presentation: Endogenous antigens, exogenous antigens, non-peptide bacterial antigens, Super-antigens; Cell-cell co-operation; Hapten-carrier system

- **Antigen-Antibody Interactions**

Precipitation, Agglutination and Complement mediated immune reactions; Advanced immunological techniques: ELISA, PCR-ELISA, RIA, Western blotting, ELISPOT assay, Immunofluorescence, Flow Cytometry and Immunoelectron microscopy; Surface plasmon resonance, Biosenor assays for assessing ligand –receptor interaction, CMI techniques, lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Catalytic antibody.

- **Vaccinology**

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; Antibody genes and antibody engineering: Chimeric and Hybrid Monoclonal Antibodies; Generation of immunoglobulin gene libraries.

- **Clinical Immunology**

Immunity to Infection: Bacteria, Viral, Fungal and Parasitic Infections (with examples from each group); Hypersensitivity: Type I - IV; 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, Apoptosis, Cancer immunotherapy; Immunodeficiency-Primary immunodeficiencies, Acquired or Secondary immunodeficiencies.

**References**

1. Kuby Immunology by *Thomas J. Kindt, Richard A. Goldsby, Barbara Anne Osborne, Janis Kuby* (2007) Freeman
2. Cellular and Molecular Immunology by *Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai* (2007) S. Elsevier
3. Clinical Immunology, (6th edition). by *Brostoff J, Seaddin JK, Male D, Roitt IM.* (2002) Gower Medical Publishing
4. Immunobiology, (4th Edition) by *Janeway et al.* (1999) Current Biology Publications
5. Practical Immunology (4<sup>th</sup> edition). *F C Hay* (2002) OMR Westwood

- **Gene Cloning Techniques:** Use of restriction enzymes, modification enzymes ligation, transformation, gel electrophoresis; Hybridization Techniques: Northern, Southern, and Fluorescence *in situ* hybridization (FISH)
- **Different Types of Vectors:** Cloning and Expression vectors: pBR322, pUC,  $\lambda$  and M13 based vectors; Cosmids; Artificial chromosomes: YAC, BAC, HAC, PAC
- **Polymerase Chain Reaction:** PCR reaction conditions, RT-PCR, Real time PCR, Anchored PCR, Inverse PCR; Applications of PCR in cloning and diagnostics and Bio-medical sequencing; DNA fingerprinting; EMSA; DNA footprinting.
- **Genomic and cDNA libraries:** Screening of libraries by nucleic acid hybridization, immuno-screening, screening by function, phage display, two hybrid screening
- **Production and Purification of Proteins:** Expression in *E.coli*, Expression in yeast, Expression in insect cells, Expression in eukaryotic cells; Purification by tagging: His tag, GST tag, MBP tag, TAP tagging
- **DNA Sequencing:** Methods used in gene analysis and its applications in medical science
- **Gene Therapy:** *in vivo* and *ex vivo* gene therapy; Gene knockout analysis, Antisense RNA, micro RNA and RNA interference
- Molecular approaches to generate transgenic organisms and their applications: BT cotton, Golden rice, Cloned animals
- Microarray technology

## References

1. Principles of Gene Manipulation, (6<sup>th</sup> Edition) by *S.B. Primrose, R.M. Twyman and R.W.Old* (2001) S. B. University Press
2. Molecular Cloning: A Laboratory Manual, Vol:1-3 by *J. Sambrook and D.W. Russel* (2001) CSHL
3. From Genes to Genomes: Concepts and Applications of DNA Technology (2<sup>nd</sup> Edition) by *J W Dale, M von Schantz* (2007) John Wiley & Sons Ltd.
4. Gene cloning and DNA analysis (5<sup>th</sup> Edition) by *T. A. Brown* (2006) Blackwell Publishing.
5. Analysis of genes and genomes by *Richard Reece* (2004) John Wiley & Sons Ltd.
6. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2<sup>nd</sup> Edition) by *Bernard R. Glick and Jack J. Pasternack* (1998) ASM Press.

- **Bioreactor:** Introduction; Importance; Composition: Its accessories
- **Kinetics of Bioreactor:** Types of bioreactors: Air Lift, Bubble Column, Plug flow, CSTR, Fluidized, Packed Bed reactor; Sterilization of Bioreactors: Batch and Continuous Bioreactor
- **Isolation of Industrially Important Strains:** Strain improvement Techniques; Storage of strains; Culture collection centers
- **Fermentation Media:** Carbon and Nitrogen sources; Inducers, Inhibitors, Precursors; Antifoaming agents; Importance of synthetic, semi-synthetic and complex media
- **Inoculum preparation for industrial fermentations**
- **Hygiene and Safety in Fermentation lab**
- **Application of Fermentation Technology:** Primary metabolites: Ethanol, beer, wine, whisky; Secondary metabolites: Penicillin, streptomycin, tetracycline; Biomass production: SCP, yeast (*Sacharomyces*); Cheese production

**References:**

1. Principles of Fermentation Technology, (2<sup>nd</sup> Edition) by *P F Stanbury, S. Hall, A. Whitaker* (2003) Butterworth-Heinemann Publisher
2. Fermentation Microbiology and Biotechnology, (3<sup>rd</sup> Edition) by *E. M. T. El-Mansi* (1999) Taylor & Francis
3. Practical Fermentation Technology by *Brian McNeil* (2008) John Wiley & sons Ltd.
4. Industrial Microbiology: An Introduction by *Michael J. Waites, Neil Morgan, Rockey* (2001) Blackwell Science Ltd.
5. Fermentation and Biochemical Engineering Handbook: Principles, Process Design and Equipment (2<sup>nd</sup> Edition) by *William Andrew* (1997) William Andrew Publishing

- **Spectrophotometry (UV and Visible):** Principle, Single beam and Double beam Spectrophotometer, Factors influencing the absorption spectra, overview of empirical rules, Solvent Perturbation method and differential spectroscopy; various biotechnological applications of absorption spectroscopy.
- **Infrared and Raman Spectroscopy:** Principle, Factors affecting the spectra, Instrumentation, Overview of different class of compounds and their IR spectra.
- **Nuclear Magnetic Resonance:** Phenomena of resonance, Instrumentation, Diamagnetic Shielding, Anisotropy, Chemical Shift, Free Induction Decay (FID), Population Distribution of nuclei, and prediction of NMR spectra on the basis of (n+1) rule for basic class of compounds. Overview of electron spins resonance spectroscopy (ESR) and magnetic resonance imaging (MRI).
- **Mass Spectroscopic Techniques:** Introduction to mass-spectroscopy, significance, instrumentation details of a mass-spectrometer, ionization techniques, single and double focusing, alternate mass separation techniques- time of flight and quadrupole. Interface of mass-spectra with liquid and gas chromatography (LC-MS and GC-MS)
- **Spectro-fluorimetry:** Principle, significance and various details related to instrumentation.
- **Atomic Absorption Spectrophotometry:** Principle, instrumentation details, various interferences in atomic absorption spectroscopy and applications.
- **Electron Microscopy:** Transmission and Scanning Electron Microscopy, significance of vacuum, basic instrumentation for TEM and SEM, sample preparation for electron microscopy.
- **Crystallography and X-ray diffraction:** Introduction to x-ray and general theory and instrumentation, Bragg's law, various techniques to determine crystal structure.
- **Radioisotope Techniques:** Radiotracers, units of radioactivity measurement, proportional and scintillation counters, introduction to autoradiography and nuclear medicine.
- **Centrifugation:** Principle, Types and their applications; Ultracentrifugation and its applications

**References:**

1. Principles and Techniques of Practical Biochemistry (5th Edition) by *Keith Wilson, John Walker* (2000) Cambridge University Press.
2. Organic Spectroscopy (3rd edition) by *William Kemp*. English Language Book Society & the Macmillan Press Ltd.
3. Physical Biochemistry (2nd edition) by David Friefelder. Freeman & Co. New York.
4. Spectroscopy of Biological Molecules: Modern trends (1<sup>st</sup> Edition) by *P. Carmona, R. Navarro* (1997) Kluwer Academic Publishers.

- **Stem Cell Concept:** Properties of stem cell; Types of stem cell: Embryonic stem cell, Adult stem cells; Stem Cells in the epithelium of the small intestine and colon.
- **Stem cell biology:** Cell Cycle Control and its Check Points with special reference to markers and telomerase activity and separation techniques of stem cells.
- **Embryonic Stem Cells:** Embryonal Carcinoma Cells as Embryonic Stem Cells, Trophoblast Stem Cells
- Culture sub-cloning, spontaneous and controlled differentiation of human embryonic stem cells
- Transcriptome profiling of embryonic stem cells
- **Hematopoietic stem cells:** Repopulating patterns of primitive hematopoietic stem cells and their differentiation in various cell lineages and plasticity
- **Mesenchymal stem cells** of human adult bone marrow
- **Stem Cells and Neurogenesis:** Differentiation of stem cells into neurons and their biomedical applications in disease treatment.
- Scope of stem cell research in nuclear reprogramming for treatment of diseases such as neural disorder, liver and skin diseases and burns.
- Epigenesis in pluripotent cells
- Stem cells and translational medicine, ethics, laws and policies in the use of stem cell technology

**References:**

1. Developmental Biology (8th Edition) by *Scott F. Gilbert* (2006) Sinauer Associated, Inc. Publishers
2. Hematology (4<sup>th</sup> edition) by *W.J. Williams, E. Beutler, A.J.U. Erslev, M.A. Lichtman* (1990) Mc Graw Hill Publishers
3. Molecular Biology of the Cell (4<sup>th</sup> Edition) by *Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P* (2002) Garland Science, New York
4. Stem Cell Biology by *Marshak* (2001) Cold Spring Harbour Symposium Publications
5. Stem Cells by *Ariff Bongso and Eng Hin Lee* (2005) World Scientific Publications Co. Pvt. Ltd



- **Objectives of Intellectual Property Rights:** Origin and evolution of IPR; tangible and intangible property
- **Classification of Intellectual Property:** Copyrights and related rights, Patent, Industrial Design, Trademarks and Geographical indications, Rights of traditional Knowledge and Protection of plant varieties
- **IPR:** National and international perspective; TRIPS; WIPO
- **Patent:** Basic criterion for patentability; patentable subjects; patentable inventions; patent acquisition; infringement of patent; discovery vs. invention; product patenting vs. process patenting; special issue in biotechnology patent; patenting laws in Indian and International perspective; Case study: Basmati case, Neem controversy, Turmeric case
- **Biosafety:** Definition and requirement; Biosafety in relation to human health, environment; Transgenic research and applications; Biosafety laws, guidelines and conventions; Biosafety regulation: principles and practices in microbial and biomedical labs, guidelines for research involving DNA molecule; Regulation bodies at National and International level
- Legal and socioeconomic impact of the products and techniques in Biotechnology; Bioethics in plant, animal and microbial genetic engineering; Ethical issues in healthcare, Biopiracy and ethical conflicts

**References:**

1. Coyle's Information Highway Handbook: A Practical File on the New Information Order (2000) American Library Association
2. Practical Approach To Intellectual Property Rights by *Rachna Singh Puri, Arvind Viswanathan* (2009) I. K. International Pvt Ltd

- Isolation of genomic DNA from bacteria
- Preparation of plasmid DNA from *E.coli* DH5 $\alpha$  and gel electrophoresis
- Restriction digestion of vector (gel analysis) and insert using restriction endonucleases
- Vector and Insert ligation
- Transformation of plasmid DNA in *E.coli* DH5 $\alpha$
- PCR amplification of DNA and analysis by agarose gel electrophoresis
- Purification of protein by affinity or Ion-exchange chromatography
- Separation of proteins by native and SDS- page.
- DNA estimation by UV Spectrophotometer.
- RNA estimation by UV Spectrophotometer
- Sample preparation and data analysis by NMR, IR and Mass Spectroscopy
- Chromatographic Techniques (TLC, GC, HPLC, Column and Paper)

- Selection of animals, Preparation of antigens, Immunization and methods of bleeding, Serum separation, Storage
- Antibody titre by ELISA method
- Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion
- Complement fixation test
- Isolation and purification of IgG from serum or IgY from chicken egg
- SDS-PAGE, Immunoblotting, Dot blot assays
- Blood smear identification of leucocytes by Giemsa stain
- Separation of leucocytes by dextran method
- Demonstration of Phagocytosis by NBT assay
- Separation of mononuclear cells by Ficoll-Hypaque
- Lymphoproliferation by mitogen / antigen induced
- Hybridoma technology and monoclonal antibody production
- Immunodiagnosics using commercial kits
- Purification of immunoglobulins

**References:**

1. Using Antibodies: A Laboratory Manual (1998) by *Harlow & Lane*, Cold Spring Harbor Lab Press.
2. Immunological Techniques Made Easy (1998) by *Cochet et al.*, Wiley Publishers, Canada.

**Scheme and Syllabus  
of  
M.Tech. Biotechnology 3<sup>rd</sup> sem**

**CELL AND TISSUE CULTURE (MTBT – 201)**

1. **General Tissue Culture Techniques:** Types of tissue cultures, methods of disaggregating primary cultures, primary tissue explantation technique, reactor systems for large-scale production using animal cells.
2. **Organ Culture:** Methods, behavior of organ explants and utility of organ culture, whole embryo culture.
3. **Methods in Cell Culture:** Micro and macro carrier culture, cell immobilization, animal cell bioreactor, large scale cell cultures for biotechnology, somatic cell fusion, flow cytometry, transfection.
4. **Applications of Animal Cell Culture:** Use in gene therapy, cloning from short-term cultured cells, cloning from long-term cultured cells, cloning for production of transgenic animals, cloning for conservation. Application of animal cell culture for *in vitro* testing of drugs; Testing of toxicity of environmental pollutants in cell culture.
5. **Hybridoma technology:** Production of monoclonal and polyclonal antibodies with different types of antigens, antigen preparation and modification, adjuvants dose and route of antigen administration, collection of sera, purification of antibodies, production and applications of monoclonal antibodies for diagnosis and therapy.
6. **Chloroplast genetic engineering:** Methodology, applications in herbicide resistance, production of biopharmaceuticals, edible vaccines, foreign gene expression
7. Molecular and biochemical basis of plant disease resistance, signalling pathways, protein kinases, virus induced gene silencing
8. Molecular basis of plant resistance to various abiotic stresses like drought, salinity, heavy metals etc.
9. **Molecular breeding:** Concept and methodology of different types of molecular markers. Role of molecular markers in crop and farm animal improvement, conservation of biodiversity; Marker assisted selection; QTL mapping
10. **Molecular farming:** Use of plants and animals for production of nutraceuticals, edible vaccines and other desired products

**Books Recommended:**

1. Freshney R. Ian, "*Culture of animal cells: A manual of Basic Technique*", Willey-Liss Publisher, 5th edition (2005).
2. Minuth W.W., Strehl R., Schumacher K., "*Tissue Engineering: Essential for Daily Laboratory Works*", Willey Publisher (2005).
3. Plant Biotechnology by H. S. Chawla, Oxford and IBH, 2009

4. Plants, Genes and Crop Biotechnology 2nd Edition by Chrispeels, M.J. & Sadava D.E. American Society of Plant Biologists, Jones and Bartlett Publishers, USA (2003).
5. Plant Biotechnology by B D Singh. Kalyani publisher, 2003
6. Agricultural Biotechnology by Arie Altman. Marcel Dekker, Inc. (2001).
7. Biochemistry and Molecular Biology of Plants: Edited by Buchanan B.B., Grissem W, and Jones RL (2000)
8. Jenkins N, ed., "*Animal Cell Biotechnology: Methods and Protocol*", Humana Press (1999).
9. Butler, M "*Mammalian Cell Biotechnology- A Practical Approach*," IRL Oxford University Press (1991)

## ADVANCED BIOINFORMATICS (MTBT – 203)

- ***Sequence-alignment related problems.***

Sequence databases; Similarity matrices; Pairwise alignment; BLAST; Statistical significance of alignment; Sequence assembly; Multiple sequence alignment; Clustal; Phylogenetics: distance based approaches, maximum parsimony.

- ***Pattern analysis in sequences***

Motif representation: consensus, regular expressions; PSSMs; Markov models; Gene finding: composition based finding, sequence motif-based finding.

- ***Structure-related problems***

Representation of molecular structures (DNA, mRNA, protein), secondary structures, domains and motifs; Structure classification (SCOP, CATH); Visualization software (Pymol, Rasmol etc.); Protein structure prediction by comparative modelling approaches (homology modelling); Computer-aided drug design (pharmacophore identification); Protein-ligand docking; QSAR; Protein-Protein interactions

- ***System-wide analyses***

Transcriptomics: Microarray technology, expression profiles, data analysis; SAGE; Proteomics: 2D gel electrophoresis; Mass Spectrometry; Protein arrays; Metabolomics: <sup>13</sup>C NMR based metabolic flux analysis; Real Time PCR; CHIP Analysis; CHIP on CHIP

### References

1. David W. Mount. Bioinformatics: Sequence and Genome Analysis 2nd Edition, CSHL Press, 2004.
2. Baxevanis and F. B. F. Ouellette, Bioinformatics: a practical guide to the analysis of genes and proteins, 2<sup>nd</sup> Edition, John Wiley, 2001.
3. Jonathan Pevsner, Bioinformatics and Functional Genomics, 1st Edition, Wiley-Liss, 2003.
4. P. E. Bourne and H. Weissig. Structural Bioinformatics. Wiley. 2003.
5. Branden and J. Tooze, Introduction to Protein Structure, 2nd Edition, Garland Publishing, 1999.

## **CELL AND TISSUE CULTURE LAB (MTBT – 205)**

1. Cell culture in static phase (T-flask),
2. Culture and maintenance of monolayer culture, quantification of cell growth,
3. Determination of critical shear stress, micro carrier and perfusion culture
4. Isolation of genomic DNA from plants
5. PCR amplification
6. Analysis on agarose gel electrophoresis
7. Genetic transformation in plants
8. Molecular markers

## **ADVANCED BIOINFORMATICS LAB (MTBT – 207)**

1. Introduction and getting used to biological databases, data type and data retrieval.
2. Sequence alignment
3. Phylogenetic trees.
4. Protein structure visualization
5. Protein structure prediction, Secondary structure prediction, Structural prediction through homology modeling.
6. Analysis of Microarray data
7. Gene optimization
8. Drug design