

IK GUJRAL PUNJAB TECHNICAL UNIVERSITY
Study Scheme and Syllabus of
M. Tech. Biotechnology Batch 2018 onwards

First Semester

Course Code	Course Title	Load Distribution			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
MTBT101-18	Microbial biotechnology	4	-	-	40	60	150	4
MTBT102-18	Biomolecules & Biotechnology	4	-	-	40	60	150	4
MTBT103-18	Bioprocess Engineering & Technology	4	-	-	40	60	150	4
MTBT XXX	Elective-I	4	-	-	40	60	150	4
MTBT YYY	Elective-II	4	-	-	40	60	150	4
MTBT104-18	LAB-I (Biomolecules And Microbial Biotechnology Lab)	-	-	4	60	40	100	2
TOTAL		20	0	4	260	340	600	22

TOTAL LOAD: 26 Hrs.

Elective-I

MTBT 105-18 Stem cell technology

MTBT 106-18 Bioanalytical techniques

MTBT 107-18 Industrial Enzyme Technology

MTBT 108-18 Pharmaceutical Biotechnology

Elective-II

MTBT 109-18 Environmental Engineering & waste management

MTBT 110-18 Intellectual property rights, bioethics and biosafety

MTBT 111-18 Food processing technology

Second Semester

Course Code	Course Title	Load Distribution			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
MTBT201-18	Applied Immunology	4			40	60	100	4
MTBT202-18	Applied Biotechnology	4	-		40	60	100	4
MTBT203-18	Fermentation Technology	4	-		40	60	100	4
MTBT XXX	Elective-III	4			40	60	100	4
MTBT YYY	Open Elective-I	4			40	60	100	4
MTBT204-18	LAB-II (Applied Biotechnology & Immunology Lab)			4	60	40	100	2
TOTAL		20	0	4	260	340	600	22

Contact Hours: 25

Elective-III

MTBT 205-18 Cell & Tissue culture
 MTBT 206-18 Plant molecular farming

Open Elective-I

MTBT 207-18 Research Methodology/ Statistical Techniques
 MTBT 208-18 Human Resource Management

3rd Semester

Course Code	Course Title	Load Distribution			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
MTBT -YYY	Open Elective-II	4	-	-	40	60	100	4
MTBT-XXX	Elective-IV	4	-	-	40	60	100	4
MTBT301-18	Major Project & Dissertation	-	-	4	60	40	100	4
MTBT302-18	Seminar	-	-	2	40	60	100	2
Total		8	-	6	180	220	400	14

Contact Hours: 26

Elective-IV

MTBT 303-18 Advanced Bioinformatics
MTBT 304-18 Drug designing & Development

Open Elective-II

MTBT 305-18 Computational Biology
MTBT 306-18 Nanobiotechnology

4TH SEMESTER

Course Code	Course Title	Load Allocation				Marks Distribution			Credits
		L	T	P	Total	Int.	Ext.	Total	
MTBT401-18	Thesis / Dissertation	0	0	20	20	-	-	S / US	20

* 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.

MTBT 101/18 MICROBIAL BIOTECHNOLOGY

- **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 α - keto glutaric acid),
 - **Vitamins** (Vitamin B₁₂, 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.**

Suggested books:

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 6TH 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

- **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

Suggested Books:

1. Principles of Biochemistry by A. Lehninger revised by Nelson and Cox, 2008.
2. Biochemistry by Mathews, Van Holde and Ahern. IIIrd 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 Biotechnolgy-the genetic manipulation of plants, 2nd Edition by A Slater, N.W. Scott M.R. Fowler, Oxford Univ Press (2008)

- **Microbial Growth Kinetics**
Factors affecting Microbial Growth; Mass Balances; Energy Balances; Growth Kinetics; Batch Culture , Continuous Culture , Fed Batch Culture, Feedback culture.
- **Fermentation Kinetics:** 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 ; pervaporation; Perstraction
- **Chromatography:** Adsorption, Size Exclusion, HPLC, Electrophoresis, Drying and Crystallization

Suggested Books:

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.

MTBT – 104/18

BIOMOLECULES AND MICROBIAL BIOTECHNOLOGY LAB

- 1.** Isolation of industrially important microorganisms for microbial processes.
- 2.** Determination of phenol coefficient.
- 3.** Strain Improvement Techniques
- 4.** Microbial production of antibiotics (Penicillin)
- 5.** Degradation of toxic compounds by microbes
- 6.** Determination of protein concentration by various methods: Lowry's, Bradford etc.
- 7.** Extraction of protein by different methods: salt precipitation, solvent precipitation etc.
- 8.** Separation and purification of proteins by gel filtration chromatography.
- 9.** Assay of enzyme activity such as protease, amylase and lipase.
- 10.** Separation of amino acids by TLC.

- **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

Suggested Books:

1. Developmental Biology (8th Edition) by *Scott F. Gilbert* (2006) Sinauer Associated, Inc. Publishers
2. Hematology (4th 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 (4th 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

- **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

Suggested Books:

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 (1st Edition) by *P. Carmona, R. Navarro* (1997) Kluwer Academic Publishers.

Course Objective: The objective of the course is to inform the students about basic principles for optimization, modelling *etc* in which both, free and immobilized enzymes play a role. Students will be able to implement both biochemical and engineering knowledge in order to design new and improve current enzymatic processes.

- **Introduction and Scope:** Enzymes-Historical Resume, Nomenclature and Classification, Biological Roles, Enzyme activity, Specific activity and turn over number, Isozymes, Marker enzymes, K_m and V_{max} of Enzymes and their significance, 3D- Structure of Enzymes, Active Site, Modifiers of Enzyme Activity, Enzyme Activators, Enzyme Inhibitors.
- **Production of Enzymes:** Sources of industrial enzymes (natural & recombinant), Screening for new and improved enzymes, different methods of extraction, isolation and purification of commercially important enzymes, large-scale industrial enzyme production and downstream processing.
- **Techniques of Enzyme Immobilization:** Immobilization- Definition, Advantages & Disadvantages, Types of Immobilization Techniques- Physical and chemical - adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding with examples; Advantages and disadvantages of different immobilization techniques; Overview of applications of immobilized enzyme systems, Design of enzyme electrodes and their application as biosensors in industry, health care, and environment.
- **Kinetics of Immobilized Enzymes:** Analysis of mass transfer effects of kinetics of immobilized enzyme reactions, Analysis of Film and Pore Diffusion Effects on Kinetics of immobilized enzyme reactions, calculation of effectiveness factors of immobilized enzyme systems, Bioconversion studies with immobilized enzyme packed-bed reactors, mass transfer in enzyme reactors, Steady state analysis of mass transfer and biochemical reaction in enzyme reactors.
- **Applications:** Applications of Enzymes, Industrial, Analytical and Diagnostic purposes, commercial applications of enzymes in food, pharmaceutical and other industries, enzymes for diagnostic applications, Case studies on application – chiral conversion, esterification etc.

Suggested Books:

1. Tripathi G, Enzyme Biotechnology, ABD Publishers (2009)
2. Aehle W, Enzyme in Industry: Production and Applications, Wiley-VCH (2007).
3. Bisswanger H, Enzyme Kinetics: Principles and Methods, Wiley-VCH (2008).
4. Dixon M and Webb MC, Enzymes, Longmans (1980).

- **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)

Suggested Books:

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)

ENVIRONMENTAL ENGINEERING AND WASTE MANAGEMENT

- **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

Suggested Books:

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

INTELLECTUAL PROPERTY RIGHTS, BIOETHICS AND BIOSAFETY

- **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

Suggested Books:

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

Course Objective:

This course aims to impart a strong basic knowledge on processing criteria of foods (both traditional and emerging technologies) concepts applied in food processing industries, delivery of finished food products. Microbial safety, regulations in practice, traceability methods and state-of-the art analytical techniques used for assessing contamination of food.

- **Introduction:** Overview of food processing with special emphasis to fruit and vegetable processing technology, consumer trends in processed foods
- **Food Handling and Storage:** Food refrigeration and cold storage, Construction of cold storage; Different types of freezers including plate contact freezer, air blast freezer, cryogenic freezing and refrigerated vans. Hygienic handling of food when developing safe and appealing products, preparation and storage of food.
- **Analysis:** Food products of animal origin, Plantation products and spices technology, Food additives, Aroma and flavour compounds in food
- **Food Processing:** Radiation and thermal preservation and processing of food products, Hurdle concept, Enzymes in food processing,
- **Processed Products:** Protein chemistry and technology, Food chemistry, engineering properties of foods
- **Process time calculations;** Sterilizers and accessories used in canning industries; Engineering aspects of pasteurizer; homogenizer, evaporators (basic principle and single-effect evaporator) and concentrators used in food industries, Heat exchangers (including paraflow HEs);
- Emerging technologies in food processing, Food dehydration technology, Food process management and control.

Suggested Books:

1. Heldman DR, Food Preservation and Process Design, Academic press (2011).
2. Das H, Food Processing Operations Analysis. Asian Books Pvt Ltd (2005).
3. The Fundamentals of Food Engineering; Charm SE; 1963, AVI Pub.
4. Bakery Technology & Engineering; Matz SA; 1960, AVI Pub.
5. Engineering Properties of Foods; Rao MA & Rizvi SSH; 1986, Marcel Dekker Inc. Fundamentals of Food Process Engineering; Toledo RT; 2nd ed, 2000, CBS Publishers.

MTBT201/18 (APPLIED IMMUNOLOGY)

Unit-I: Introduction to organization of Immune system, structure & function of Immune cells and organs.

Unit-II

Kinetics of Immune Response; B cell maturation, activation and differentiation; B- cell receptor, Generation of antibody diversity; T-cell maturation, activation and differentiation; T- cell receptors; 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; Complement system

Unit-III: 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, CMI techniques, Cell Cytotoxicity assays.

Unit-IV: 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.

Unit-V: Clinical Immunology

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, Secondary immunodeficiencies.

Suggested Books:

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 (4th edition). *F C Hay* (2002) OMR Westwood

MTBT202/18 (APPLIED BIOTECHNOLOGY)

Unit-I: Gene Cloning Techniques

Restriction enzymes: their types and uses; 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, λ and M13 based vectors; Cosmids; Artificial chromosomes: YAC, BAC, HAC, PAC

Unit-II: 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

Unit-III: 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

Unit-IV: 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

Suggested Books:

1. Principles of Gene Manipulation, (6th 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 (2nd Edition) by *J W Dale, M von Schantz* (2007) John Wiley & Sons Ltd.
4. Gene cloning and DNA analysis (5th 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 (2nd Edition) by *Bernard R. Glick and Jack J. Pasternack* (1998) ASM Press.

MTBT203/18 FERMENTATION TECHNOLOGY

Unit -I 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

Unit II Isolation of Industrially Important Strains: Strain improvement Techniques; Storage of strains; Culture collection centers

Unit III 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**

Unit IV Application of Fermentation Technology: Primary metabolites: Ethanol, beer, wine, whisky; Secondary metabolites: Penicillin, streptomycin, tetracycline; Biomass production: SCP, yeast (*Sacharomyces*); Cheese production

Suggested Books:

1. Principles of Fermentation Technology, (2nd Edition) by *P F Stanbury, S. Hall, A. Whitaker* (2003) Butterworth-Heinemann Publisher
2. Fermentation Microbiology and Biotechnology, (3rd 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 (2nd Edition) by *William Andrew* (1997) William Andrew Publishing

MTBT204/18 LAB-II (Applied Biotechnology and Immunology Lab)

1. Isolation of genomic DNA from bacteria
2. Preparation of plasmid DNA from E.coli DH5 and gel electrophoresis
3. Restriction digestion of vector (gel analysis) and insert using restriction endonucleases
4. PCR amplification of DNA and analysis by agarose gel electrophoresis
5. Purification of protein by affinity or Ion-exchange chromatography
6. Chromatographic Techniques (TLC, GC, HPLC, Column and Paper)
7. Antibody titre by ELISA method
8. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion
9. Isolation and purification of IgG from serum or IgY from chicken egg
10. Blood smear identification of leucocytes by Giemsa stain
11. Separation of leucocytes by dextran method
12. Separation of mononuclear cells by Ficoll-Hypaque
13. Immunodiagnosics using commercial kits

Elective-III MTBT205/18 (Cell and Tissue Culture)

Unit I 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. Organ Culture: Methods, behavior of organ explants and utility of organ culture, whole embryo culture. 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.

Unit II 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. 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.

Unit III Chloroplast Genetic Engineering: Methodology, applications in herbicide resistance, production of biopharmaceuticals, edible vaccines, foreign gene expression. Molecular and biochemical basis of plant disease resistance, signalling pathways, protein kinases, virus induced gene silencing. Molecular basis of plant resistance to various abiotic stresses like drought, salinity, heavy metals etc.

Unit IV 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. Molecular farming: Use of plants and animals for production of nutraceuticals, edible vaccines and other desired products

Suggested Readings:

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)

Elective-III MTBT206/18 (Plant Molecular Farming)

Unit I – Introduction: Definition, common perception and the milestones of plant molecular farming; Transgenic plants as bioreactors-an attractive alternative to current forms of manufacture of various compounds, Relevance and advantages of plant-based molecular farming

Unit II – Plant Transformation Techniques: Advantages of various strategies for genetic transformation of plants-stable nuclear and plastid transformation, plant cell-suspension cultures, introduction to transient expression systems. Factors Affecting Transgene Expression: Limitations and optimization of plant production systems-choice of suitable host plants, optimizing expression and stability of recombinant proteins, glycosylation aspects, downstream processing of the plant-derived products

Unit III – Case Studies: Strategic details of various molecular farming techniques, production of carbohydrates, amylose-free starch, high-amylose starch, cyclodextrins, fructans, trehalose, production of lipids, medium-chain, saturated & mono-unsaturated fatty acids, improvement of plant oils, production of rare fatty acids, production of biodegradable plastics in plants.

Unit IV – Commercially Useful Products-I: Genetically engineered plants as protein factories: Enzymes for industrial and agricultural uses, plantibodies and subunit vaccines. Commercially Useful Products-II: The oleosin system: hirudin and insulin production, production of biopharmaceuticals in plants; Chloroplast: a clean high-level expression system for molecular farming based on single or multiple transgenes. Social and Ethical Concerns: Critical evaluation of various case studies on molecular farming and their future prospects; Economic and regulatory considerations of plant molecular farming

Suggested Readings / Books:

1. Plant Biotechnology by Slater, A., Scott, N.W., and Fowler, M.R., Second Edition, Oxford University Press (2008).
2. Principles of Gene Manipulation and Genomics by Primrose, S.B. and Twyman, R.M., Seventh Edition, Blackwell Publishing (2006).
3. Biotechnology by Satyanarayana, U., Books and Allied (P) Ltd. (2005).
4. Biotechnology-an Introduction by Barnum, S.R., Thompson Brooks/Cole (2007).
5. Molecular Biotechnology by Primrose, S.B., Second Edition, Panima Publishing Corporation (2001)

(Open Elective -I) MTBT207/18 Research Methodology/Statistical Techniques

Unit I- introduction to Education Research: Concept, types-basic, applied and action, Need for educational reach, Reviewing Literature: Need, Sources-Primary and Secondary, Purposes of Review, Scope of Review, Steps in conducting review. Identifying and defining research problem: Locating. Analyzing stating and evaluating problem, generating different types of hypotheses and evaluating them. Method of Research: Descriptive research design-survey, case study, content analysis, Ex-post Facto Research, Correlational and Experimental Research.

Unit II- Sampling Techniques: Concept of population and sample' sampling techniques-simple random sampling, stratified random sampling, systematic sampling and cluster sampling, snow ball sampling, purposive sampling, quota sampling techniques determining size of sample. Design and development of measuring instruments, Tests, questionnaires, checklists, observation schedules, evaluating research instruments, selecting a standardized test. Procedure of data collection: Aspects of data collection, coding data for analysis.

Unit III- Statistical Methods of Analysis: Descriptive statistics: Meaning, graphical representations, mean, range and standard deviation, characteristics and uses of normal curve. Inferential statistics: t-test. Chi-square tests. Correlation (rank difference and product moment), ANOVA (oneway)

Unit IV - Procedure for writing a research proposal; Purpose, types and components of research proposal. Procedure for writing a research report: Audiences and types of research reports, Format of Research report and journal Strategies for evaluating, research, disseminating and utilizing research- An Overview.

Suggested Readings:

- Borg, W and Gall, M. Educational Research: An Introduction, New York, Longman, 2003
- Cohen, L. Educational Research in class rooms and schools! A Manual of Materials and Methods NY:nHarper and Row Publishers, 2000
- CPSC: Developing Skills in Technican Education Research Modules 1 to 11 Singapore, Colombo Plan Staff College for Technician Education
- Garrett, HE and Woodworth, RS Statistics in Psychology and Education, Educational Research, Bombay: Vakils Fetter and Simons Ltd. 2003
- Gay, LR, Educational Research, Ohio: Charles E. Merril Publishing Company 2000 Wiersma
- William Research Methods in Education- An Introduction London, Allyn and Bacon, Inc. 2000

(Open Elective -I) MTBT/208/18 – Human Resource Management

UNIT I - Human resource management: functions, scope and models, HRM environment and environmental scanning, human resource planning, job analysis and job designing, recruitment, selection, induction and placement, training and development, job evaluation.

UNIT II -Managing performance, potential management, fringe benefits and incentives: compensation management, promotion, demotion, transfer, separation and right sizing.

UNIT III -Team management, empowerment management, creativity and decision-making management, organizational learning and knowledge management, culture management, change management, managing ethical issues in human resource management, HRD audit.

UNIT IV-E-HRM/HRIS; measuring intellectual capital, impact of HRM practices on organizational performance, implications for HRD, contemporary issues in human resource management, global HR practices.

Suggested Readings:

- Aswathappa, K., Human Resource Management, Tata McGraw-Hill.
- Bratton, J. and Gold, J., Human Resource Management: Theory and Practice, Palgrave.
- Dessler, G., Human Resource Management, Prentice-Hall.
- Flipppo, E., Human Resource Management, McGraw Hill.
- Gomez-Mejia, L., Managing Human Resources, Pearson Education.
- Ivantsevich, J., Human Resource Management, Tata McGraw-Hill.
- Kandula, S. R., Human resource Management in Practice, Prentice Hall of India Pvt Ltd.

MTBT 303/18 ADVANCED BIOINFORMATICS

LTP [310]

UNIT 1 Sequence Alignment and Phylogenetics

10 Hrs.

Introduction to Bioinformatics, Sequence databases, Scoring matrices; Pairwise and Multiple sequence alignment; BLAST; Molecular evolution and phylogenetics, Phylogenetic trees, Molecular clock theory, Maximum Parsimony, Distance based methods: UPGMA, Maximum likelihood method, Bayesian statistical analysis, Pattern Analysis in Sequences Motif Representation: consensus, regular expressions; PSSMs; Markov models; Hidden Markov models (HMM) and its applications.

UNIT 2 Structural Bioinformatics

10 Hrs.

Structure databases (PDB, SCOP, CATH etc.); Representation of molecular structures (DNA, mRNA, protein), secondary structures and its prediction, domains and motifs; Visualization software (Pymol, Rasmol etc.); 3D structure and its prediction; Molecular docking; Protein-Protein interactions; Protein-Ligand interactions

UNIT 3 Genomics and Proteomics

10 Hrs.

Transcriptomic related databases; Microarray and NGS data analysis; Real Time PCR; SAGE; Proteomics: 2D gel electrophoresis; Mass Spectrometry data analysis; Protein arrays; CHIP Analysis.

UNIT 4 System Biology

10 Hrs.

Objectives and Applications of Systems Biology, Strategies relating to in-silico modelling of biological processes, Metabolic Networks, Signal Transduction Pathways; Cytoscape; Markup language (SMBL); E-cell and V-cell Simulations and Applications

References:

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

MTBT 304/18 Drug Design and Development

[LTP 310]

Unit I Drug Discovery

08 hrs

Target Identification and Validation; Targets: Membrane Proteins, DNA, RNA and Enzymes; Lead Identification and Modification, Biological Assays: Lead Identification and High Throughput Screening

Unit II Computer-Aided Drug Design

12 Hrs

Molecular Modelling (geometry optimisation, molecular dynamics simulation and conformational searching); Ligand-based Drug Design (quantitative structure-activity relationship (QSAR) and pharmacophore determination); Structure Determination (3-dimensional structure of the receptor viz protein, nucleic acid and protein-nucleic acid complex); Structure based drug design.

Unit III Drug Development

12 Hrs

General Principles (Bioavailability, barriers to drug action, application of pharmacokinetics and pharmacodynamics in drug delivery and Lipinski's rule); Pre-Clinical and Clinical testing

Unit IV Drug Regulatory Operations

08 Hrs

Drug Regulatory Operations, Role of Regulatory Authorities, US Food and Drug Administration, Regulatory applications viz. Investigational new drug (IND), New drug application (NDA), Abbreviated New Drug Application (ANDA).

Suggested Readings/ Books

- Drug Discovery and Development; Technology in Transition. HP Rang. Elsevier Ltd 1st edition 2006.
- Pharmacology in Drug Discovery. T. P. Kenakin. Elsevier, 1st Edition 2012.
- An introduction to medicinal chemistry. G. L. Patrick. 5th Edition Oxford UK, Oxford University Press, 2013.
- Textbook of Drug Design. Krogsgaard-Larsen, Liljefors and Madsen (Editors), Taylor and Francis, London UK, 2002.
- Drug Discovery Handbook S.C. Gad (Editor) Wiley-Interscience Hoboken USA, 2005.

MTBT 305/18 Computational Biology (Open Elective)

[LTP 310]

Unit -I Algorithm

10 Hrs

Problem solving Technique: Algorithm design; Complexity, Complexity theory; Flowchart, Compiling, Testing and Debugging; Documentation – Data structures – Array, Stack, Queue, Linked, List concepts.

Unit-II Pattern Matching and Genetic Algorithms

10 Hrs

Hash Tables, Repeat Finding, Exact Pattern Matching; Genetic Algorithm: Basic Concepts, Reproduction, Cross over, Mutation, Fitness Value; Optimization using GA; Applications of GA in bioinformatics.

Unit- III Hidden Markov Model and Machine Learning

10 Hrs

Introduction of Markov Chain and Hidden Markov models: Forward-backward algorithm, Viterbi and Baum-Welch algorithms, Application of Hidden Markov models in Bioinformatics. Introduction to Machine learning: SVM and ANN; Recent machine algorithms and their application in solving biological problem

Unit IV Perl for Bioinformatics

10 Hrs

Variables, Data types, control flow constructs, Pattern Matching, String manipulation, arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation Laboratory Demonstrations for Biological Databases, Programs in PERL. BioPERL.

Suggested Readings/ Books

- Benson G. and Page R. D.M. (2003). Algorithms in Bioinformatics. Springer.
- Norvig P. (2003). Artificial Intelligence: A Modern Approach. Prentice Hall
- Cathy H. Wu and Malarty J. W. (2001). Neural Networks and Genome Informatics. Elsevier Science.
- Michael Waterman, Chapwan& Hall/CRC, (2000). Introduction to Computational Biology-Maps, sequences and genomes.
- Pavel A.Pevzner (2000), Computational Molecular Biology- An Algorithmic Approach, MIT Press
- Chopra, S.C.Numerical methods for engineers.
- James T (2001) Beginning Perl for Bioinformatics O'Reilly Media, Inc.
- Jamison DC (2003) Perl Programming for Biologists John Wiley & Son

UNIT 1 Introduction to Nanobiotechnology

08 Hrs

Basic concept; Historical perspective; Recent Advances and Scope of nanobiotechnology; Nanofabrication Techniques; Nanostructured Surface and Cellular Behavior: Surface functionalization of nanoparticles, cellular response to the nanostructured surfaces

UNIT 2 Synthesis and Characterization of Nanomaterials

12 Hrs.

Physical, Chemical and Biological methods; Mechanical milling, laser ablation, sputtering and microwave plasma. Chemical reduction and oxidation, hydrothermal, photolysis, radiolysis, and metallo-organic chemical vapor deposition; Biological synthesis of nanomaterials; Structural Characterization - XRD, SAXS, SEM, TEM, SPM/AFM; Chemical Characterization – Optical spectroscopy, Electron spectroscopy, Ionic spectrometry; Physical properties – Melting point, Lattice constant, Electrical and magnetic characterization; Mechanical properties – nanoindentation, nanotribology; Size and shape dependent optical, emission, electronic, transport, photonic, refractive index, dielectric, mechanical, magnetic, non-linear optical properties.

UNIT 3 DNA and Protein Based Nanostructures

10 Hrs.

Nanoparticles, carbon nanotubes, fullerenes, nanofibres, quantum dots and buckyballs interface with biological macromolecules; Biological perspectives of nanomaterials – impact of nanomaterials in biological processes, tolerance by immune systems and toxicity; Nucleic acid engineering - modifications of DNA for nanotechnological applications, nanostructured assembly using DNA. DNA based nanowires and network – fabrication and their applications, self assembled DNA nanostructures and nanodevices, DNA programmed organization of nanostructures, Protein based self-assembly nanostructures -layers, nanopores.

UNIT 4 Nanotechnology in Therapeutics and Diagnostics

10 Hrs.

Biosensors; Theranostics; Surface plasmon resonance based nanosensors, nanowires, SERS active nanoparticles; Quantum dots; nanoparticles as contrast agents for MRI Nanodiamonds; carbon nanotubes; virus-based nanoparticles; dendrimers, graphene, buckyballs and their applications. Overview of smart devices for medical field, miniaturised devices for drug delivery, advantages of miniaturised devices – lab on chip concept; Epipen, intelligent pill, wobbling gels.

Recommended Books

1. Nanobiotechnology: Concepts, Applications and Perspectives. Edited by: Niemeyer, C.M. and Mirkin, C.A. WILEY-VCH, Verlag GmbH & Co, 2004, 1st edition.
2. Nanobiotechnology- II, More Concepts and Applications. Edited by: Mirkin, C. A. and Niemeyer, C.M. WILEY-VCH, Verlag GmbH & Co, 2007, 1st edition.
3. The Nanobiotechnology Handbook. Edited by: Xie, Y. CRC Press, Taylor & Francis Group, 2013, 1st Edition
4. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications, Edited by: Vo-Dinh, T. CRC Press, Taylor & Francis Group, 2007, 1st edition.