

INSTITUTE OF ENGINEERING AND TECHNOLOGY LUCKNOW

(An Autonomous Constituent Institute of Dr. A.P.J. Abdul Kalam Technical University, Lucknow)



Syllabus

For

M.Tech.

(Biotechnology)

[Effective from the Session: 2016-17]

Study and Evaluation Scheme
M.TECH. BIO-TECHNOLOGY
(Effective from the session: 2016-17)

1st Year, 1st Semester

S No.	Subject Code	Name of the Subject	Periods			Credit	Theory			Practical		Subject Total
			L	T	P		CT	TA	ESE	TA	ESE	
1	MTBT101	Applied Biochemistry & Molecular Biology	3	0	0	3	20	10	70	--	--	100
2	MTBT102	Bioprocess Engineering & Technology	3	0	0	3	20	10	70	--	--	100
3	MTBT01?	Departmental Elective - I	3	0	0	3	20	10	70	--	--	100
4	MTBT02?	Departmental Elective - II	3	0	0	3	20	10	70	--	--	100
5		Research Process & Methodology	3	0	0	3	20	10	70	--	--	100
6	MTBT151	Applied Biochemistry & Molecular Biology Lab	--	--	3	2	--	--	--	20	30	50
7	MTBT152	Bioprocess Engineering & Technology Lab	--	--	2	1	--	--	--	20	30	50
		Total				18						600

L: Lecture T: Tutorial P: Practical/Project CT: Class Test TA: Teacher's Assessment, ESE: End Semester Examination

Departmental Elective-I

1. MTBT011: Immunology & Vaccine Technology
2. MTBT012: Quality Control in Biotechnology
3. MTBT013: Applied Clinical Research

Departmental Elective-II

1. MTBT021: Biological Treatment of Waste Water
2. MTBT022: Nano Biotechnology & Toxicology
3. MTBT023: Industrial Biotechnological Products

Study and Evaluation Scheme
M.TECH. BIO-TECHNOLOGY
(Effective from the session: 2016-17)

1st Year, IInd Semester

S No.	Subject Code	Name of the Subject	Periods			Credit	Theory			Practical		Subject Total
			L	T	P		CT	TA	ESE	TA	ESE	
1	MTBT201	Bioinformatics	3	0	0	3	20	10	70	--	--	100
2	MTBT202	Entrepreneurship, IPR & Biosafety	3	0	0	3	20	10	70	--	--	100
3	MTBT03?	Departmental Elective - III	3	0	0	3	20	10	70	--	--	100
4	MTBT04?	Departmental Elective - IV	3	0	0	3	20	10	70	--	--	100
5	MTBT05?	Departmental Elective - V	3	0	0	3	20	10	70	--	--	100
6	MTBT251	Bioinformatics Lab	--	--	3	2	--	--	--	20	30	50
7	MTBT252	Seminar-I	--	--	2	1	--	--	--	50	--	50
		Total				18						600

L: Lecture T: Tutorial P: Practical/Project CT: Class Test TA: Teacher's Assessment, ESE: End Semester Examination

Departmental Elective-III

1. MTBT031: Genetic Engineering
2. MTBT032: Applied Food Biotechnology
3. MTBT033: Molecular Modelling & Industrial Application

Departmental Elective-IV

1. MTBT041: Bioreactor Analysis & Design
2. MTBT041: Enzyme Technology & Industrial Application
3. MTBT043: Applied Bioenergy

Departmental Elective-V

1. MTBT051: Tissue Culture Techniques
2. MTBT052: Diagnostic Techniques in Biotechnology
3. MTBT053: Fundamentals of Stem Cell Technology

Study and Evaluation Scheme
M.TECH. BIO-TECHNOLOGY
(Effective from the session: 2017-18)

2nd Year, IIIrd Semester

S No.	Subject Code	Name of the Subject	Periods			Credit	Theory			Practical		Subject Total
			L	T	P		CT	TA	ESE	TA	ESE	
1	MTBT351	Seminar-II	0	0	6	3	--	--	--	100	--	100
2	MTBT352	Dissertation	0	0	30	15	--	--	--	200	300	500
		Total				18						600

2nd Year, IVth Semester

S No.	Subject Code	Name of the Subject	Periods			Credit	Theory			Practical		Subject Total
			L	T	P		CT	TA	ESE	TA	ESE	
1	MTBT451	Dissertation (Final)	0	0	3	3	--	--	--	200	400	600
		Total				18						600

L: Lecture T: Tutorial P: Practical/Project CT: Class Test TA: Teacher's Assessment, ESE: End Semester Examination

M.Tech. Biotechnology (First Semester)

MTBT101: APPLIED BIOCHEMISTRY & MOLECULAR BIOLOGY

L: T: P

3: 0: 0

UNIT I

Structures and functions of Bio-molecules: Carbohydrates: classification, mono, di, oligo and polysaccharides. Lipids: fatty acids, simple, complex & derived lipids. Protein: Amino Acids Structure and function, Protein Structure Hierarchy. Nucleic acids: nucleosides, nucleotides, DNA & RNA.

UNIT II

Bioenergetics: Overview of principles of bioenergetics (free energy, enthalpy and entropy). Energy relationships between catabolic and anabolic pathways. Phosphoryl group transfers and ATP, Free-energy change for ATP hydrolysis.

UNIT III

Metabolism: Glycolysis, Gluconeogenesis, Respiration and Introduction to the Citric Acid Cycle, Electron Transport, Oxidative phosphorylation, Fatty Acid Catabolism: Fatty acid oxidation, Protein Metabolism: The Urea Cycle

UNIT IV

Gene structure, DNA & RNA as a genetic material, RNA World, packaging of DNA as chromosome, DNA replication- Prokaryotic and eukaryotic DNA replication, Mechanism of replication. Telomeres, telomerase and end replication. Role of telomerase in aging and cancer.

UNIT V

Transcription, genetic code, reverse transcription, mRNA processing. Translation, Gene regulation, operons: Lac operon, Trp operon, transposons.

Text / Reference Books:

1. Biochemistry- L.Stryer , Third Edition
2. Biochemistry- Voet & Voet.
3. Principles of Biochemistry- A.Lehninger , CBS Publishers and Distributors , 1987.
4. Biochemistry- S C Rastogi, Tata Mcgraw- Hill Publishing Com. Ltd., IInd Edition , 2003.
5. Zubay. Biochemistry. 4th ed. William C. Brown Publication, 1998.
6. Watson. J. D, Baker. T. A, Bell. S. P, Gann. A, Levine. M, Losick. R. Molecular Biology of Gene. 6th The Benjamin / Cummings Pub. Co. Inc, 2008.
7. Darnell, Lodish and Baltimore. Molecular Cell Biology, Scientific American Publishing Inc, 2000.
8. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Molecular biology of the Cell. 4th ed. Garland publishing Inc, 2002.
9. Benjamin Lewin. Gene VII. Oxford University Press, Nelson Cox.

MTBT102: BIOPROCESS ENGINEERING & TECHNOLOGY

L	T	P
3	0	0

UNIT I

Historical development of bioprocess technology, An overview of traditional and modern applications of biotechnological processes, General requirements of fermentation processes, Basic design and construction of fermenter and ancillaries, Main parameters for monitoring & control of fermentation processes, Different raw materials used in fermentation industry and their pretreatment, Medium for plant cell culture and animal cell culture, Medium design of commercial media for industrial fermentations-Plackett burman design, response surface methodology, simplex design.

UNIT II

Stoichiometry of Cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients Energetic analysis of microbial growth and product formation, oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth.

UNIT III

Mass transfer includes transport phenomena in bioprocesses, Factors affecting oxygen transfer rate in bioreactors, Techniques for measurement of volumetric oxygen transfer coefficient, Fluid rheology and factors affecting bioreactor processes, Flow Patterns in agitated tanks, Mechanism & Power requirements of mixing, Scale up of mixing systems.

UNIT IV

Different regulatory mechanisms involved in controlling the catabolic and anabolic processes of microbes, Induction, nutritional repression, carbon catabolite repression, Crabtree effect, feedback inhibition and feedback repression, Concept of Overproduction of metabolites, Case studies on production of Lactic acid, Glutamic acid, Penicillin, Microbial Lipase and Protease, Recombinant Insulin, Interferons, Hepatitis Vaccines etc. Case studies should deal with strain improvement, medium designs, process optimization technology.

UNIT V

Unit Operation: Filtration, filter aids, filtration Equipment and filtration theory, Centrifugation process and its equipments, Cell disruption, Aqueous Two-Phase Liquid Extraction. Adsorption process and its operations, Chromatography: Theory and mechanism, Scaling-up chromatography.

Text Books:

1. Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press.
2. Bioprocess Technology - Kinetics & Reactors" by A Moser, Springer-Verlag.
3. Biochemical Engineering and Biotechnology Handbook" by B. Atkinson & F. Mavituna, 2nd Ed. Stockton Press.
4. Bioprocess Engineering Principles" by Pauline M. Doran, Academic Press.
5. Biochemical Engineering- S. Aiba , A.E. Humphray, University of Tokyo Press.
6. Lee J.M, Biochemical Engineering 2nd ed, Prentice Hall, 2000.
7. Principles of Cell Energetics": BIOTOL series, Butterworth - Heinemann.
8. Biotechnology" Vol.4 Meaning Modelling and Control Ed. K.Schuglerl, VCH (1991).

9. Unit operations of Chemical Engineering" 5th ed. by W L McCabe, J C Smith and P. Harriot
Mc Graw-Hill (1993).
10. Diffusion" by E L Cussler, Cambridge University Press (1984).
11. Bioprocess Engineering Principles" by Pauline M.Doran, Academic Press.
12. Biochemical Engineering- S. Aiba , A.E. Humphray, University of Tokyo Press

MTBT011: IMMUNOLOGY & VACCINE TECHNOLOGY

L: T: P

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UNIT I

Fundamental concepts and anatomy of the immune system, Components of innate and acquired immunity, Humoral and Cell mediated immunity, Haematopoiesis, Antigens , immunogens, haptens, Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing.

UNIT II

Immunoglobulins-basic structure, classes and subclasses of immunoglobulins, antigenic determinants, Multigene organization of immunoglobulin genes, Immunological basis of self – non-self discrimination; Kinetics of immune response, memory; B cell maturation, activation and differentiation; Generation of antibody diversity, Antigen processing and presentation- endogenous antigens and exogenous antigens.

UNIT III

A short history of vaccination, Active and passive immunization, General immunization practices, Vaccination of immunocompromised hosts, Vaccination of human immunodeficiency virus-infected persons, Vaccines, 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.

UNIT IV

Licensed vaccines, Viral Vaccine (Poliovirus vaccine-inactivated & Live, Rabies vaccines Hepatitis A & B vaccines), Bacterial Vaccine (Anthrax vaccines, Cholera vaccines, Diphtheria toxoid), Parasitic vaccine (Malaria Vaccine).

UNIT V

The vaccine industry, Vaccine manufacturing, Evolution of adjuvants across the centuries, Vaccine additives and manufacturing residuals, Regulation and testing of vaccines, Regulation of vaccines in developing countries, Vaccine safety and Legal issues.

Text/Reference Books:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999. 4. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.
4. Stanley A. Plotkin & Walter Orenstein & Paul A. Offit, Vaccines, 6th Edition 2013 BMA Medical Book Awards Highly Commended in Public Health! Elsevier Publication.
5. Roitt's Essential Immunology. 11th ed. P. Delves, et al., ed., Blackwell Publishing, 2006.

MTBT012: QUALITY CONTROL IN BIOTECHNOLOGY

L: T: P

3: 0: 0

UNIT I

Concept and evolution of quality control and quality assurance. Total Quality Management, Philosophy of GMP and cGMP. Preparation of audit, Conducting audit, Audit Analysis, Audit Report and Audit follow up Quality control laboratory responsibilities: GLP protocols on non-clinical testing control on animal house, data generation, integration and storage, standard test procedure, retention of sample records. CPCSEA guidelines.

UNIT II

Quality review and batch release document of finished products, annual product quality review and parametric release, Audits, quality audits of manufacturing processes and facilities, audits of quality control.

UNIT III

Good documentation practices, root cause analysis, corrective action preventive action (CAPA), out of specifications (OOS) and out of trend (OOT), Clinical studies- ICH GCP (E6) guidelines, post marketing surveillance, Pharmacovigilance.

UNIT IV

BABE (bioavailability and bioequivalence) studies, Concepts and management of contract manufacturing guidelines, Statistical Tools for Quality Control and Precision, Tools of Problem Solving and Continuous Improvement.

UNIT V

Introduction, scope and importance of IPR, Concept of trade mark, copyright and patents Product registration guidelines – CDSCO, USFDA, Concept of ISO 9001:2008, 14000, OSHAS guidelines, Quality Strategy for Indian Industry, Brief concept of IND, NDA, ANDA, SNDA and PAT.

Text / Reference Books:

1. Sharp J. Good Pharmaceutical Manufacturing Practice: Rationale and Compliance. CRC Press; 2005.
2. Gad SC. Pharmaceutical Manufacturing Handbook: Production and Processes. John Wiley & Sons; 2008.
3. Steinborn L. GMP/ISO Quality Audit Manual for Healthcare Manufacturers and Their Suppliers, Sixth Edition, (Volume 1 - With Checklists and Software Package). Taylor & Francis; 2003.
4. Kolman J, Meng P, Scott G. Good Clinical Practice: Standard Operating Procedures for Clinical Researchers. Wiley; 1998.
5. Waller P. An Introduction to Pharmacovigilance. John Wiley & Sons; 2011.
6. Niazi S. Handbook of Bioequivalence Testing. CRC Press; 2007.
7. Chalmers AA. International Pharmaceutical Registration. Interpharm Press; 2000.
8. Edwards AJ. ISO 14001 Environmental Certification Step-by-Steps: Revised Edition. Butterworth-Heinemann; 2003.
9. Mantus D. FDA Regulatory Affairs: A Guide for Prescription Drugs, Medical Devices, and Biologics. Informa Healthcare USA; 2008.
10. Chalmers AA. International Pharmaceutical Registration. Interpharm Press; 2000.
11. Ganguli P. Intellectual Property Rights. The McGraw Hill Companies; 2008.

UNIT I: Introduction to clinical research

Basic pharmacology and drug development process, clinical research definition, Basic terminology used in clinical research, preclinical studies, Introduction to pharmacoeconomics, Types of clinical trials, single blinding, double blinding, open access, randomized trials and their examples, interventional study, Good Clinical Practices, Types and Scope of Clinical Research.

UNIT II: Clinical trials

New drug discovery process- purpose, main steps involved in new drug discovery process, timelines of each steps, advantages and purposes of each steps, Pre clinical toxicology: General principles, Systemic toxicology (Single dose and repeat dose toxicity studies), Carcinogenicity, Mutagenicity, Teratogenicity, Reproductive toxicity, Local toxicity, Genotoxicity, animal toxicity requirements, Phase-I, II, III, IV trials: Introduction and designing, Various phases of clinical trials, Post Marketing surveillance, methods & Principles of sampling, Inclusion and exclusion criteria, Methods of allocation and randomization, Informed consent process in brief monitoring, treatment outcome, Termination of trial, Safety monitoring in clinical trials

UNIT III: Ethics & Regulations in Clinical research

Ethical Theories and Foundations, Ethics Review Committee and Informed Consent Process, Integrity & Misconduct in Clinical Research, unethical trials, thalidomide tragedy, Conflicts of Interest, Evolution and History of Regulations in Clinical Research, Study of various clinical trials (completed or ongoing), Patents US Regulatory Structure, Clinical Trial Application in India Import & Export of Drug in India, Investigational New Drug application (IND), New Drug Application (NDA), Abbreviated New Drug Application (ANDA), Post Drug Approval Activities, PMS, FDA Audits and Inspections EU Regulatory Affairs, EMEA Organization and Function, INDIAN Regulatory system, Schedule Y- Rules and Regulations.

UNIT IV: Principles of controlled clinical trials

Clinical trial design (observational and interventional) protocol, consent in clinical trials, placebo, bias and methods to prevent bias, ethics in clinical trials, monitoring, problems and solutions of controlled clinical trials. Multicentre clinical trials, Requirements, regulations and feasibility, Designing of Protocol, CRF, e-CRF, IB, ICF, SOP BA/BE Studies Report writing, Publication, Improving patient enrolment and retention in Clinical Trials Other Clinical Studies- Pharmacoepidemiology, ADR monitoring, pharmacokinetic trials, quality of life studies.

UNIT V: Biostatistics and data management

Preparation of a successful clinical study, Study management, Project management Documentation, Monitoring, Audits and Inspections Pharmacovigilance Training in clinical research Budgeting in clinical research, Supplies and vendor management, Importance of statistics in clinical research Statistical considerations at the design, analysis and reporting stage. Data management, Data validation, SAE reconciliation, query management Software considerations.

TEXT BOOKS and REFERENCES:

1. Basic and Clinical Pharmacology, Prentice hall, International, Katzung, B.G.
2. Clinical Pharmacology, Scientific book agency, Laurence, DR and Bennet PN.
3. Clinical pharmacokinetics, Pub. Springer Verlab, Dr. D.R Krishna, V. Klotz
4. Remington Pharmaceutical Sciences, Lippincott, Williams and Wilkins
5. Drug interaction, Kven Stockley. Hamsten
6. Clinical pharmacology and drug therapy Grahame smith and Aronson,
7. Text Book of Therapeutics Drug and Disease Management Hardbound. Richard A Helms,
8. Clinical Pharmacy and therapeutics Herfindal E T and Hirschman JL, Williams and Wilkins,
9. Methodology of Clinical Drug Trials, 2nd Edition. Spriet A., Dupin-Spriet T., Simon P. Publisher: Karger.

MTBT021: BIOLOGICAL TREATMENT OF WASTE WATER

L: T: P

3: 0: 0

UNIT I-ACTIVATED SLUDGE PROCESS-PROCESS ANALYSIS AND SELECTION

Characteristics of Activated Sludge (aerobic and anaerobic); Analysis of Data– Mass Balance Analysis. Reactors used in waste water treatment- Up Flow Anaerobic Sludge Blanket (UASB), Two-stage, Aerobic UNI Tank System (TSU-System, Route Zone Treatment, Submerged Aerobic Fixed Film(SAFF) Reactor, and Fluidized Aerobic Bioreactor (FAB).

UNIT II-AEROBIC FIXED-FILM & ANAEROBIC TREATMENT PROCESSES

Biofilm process considerations; Trickling Filters and Biological Towers; Rotating Biological Contactors; Granular – Media Filters; Fluidized – Bed & Circulating Bed- Biofilm reactors. Hybrid Biofilm/suspended growth processes. Anaerobic Processes: Methanogenesis, process chemistry and microbiology; process kinetics and factors for the design of anaerobic digestors.

UNIT III-ADVANCED WASTE WATER TREATMENT

Technologies used in advanced treatment-Classification of technologies; Removal of Colloids and suspended particles-Depth Filtration, Surface Filtration, Membrane Filtration Absorption, Ion Exchange, Advanced oxidation process, Activated Carbon, Air Stripping, Heavy Metals Removal, Steam Stripping, Chemical Precipitation, and Electrolysis.

UNIT IV-BIOLOGICAL PHOSPHORUS REMOVAL

Nitrification & Denitrification Processes: Biochemistry and Physiology of Nitrifying Bacteria; Common process considerations; One sludge versus two sludge nitrification. Physiology of Denitrifying Bacteria; Tertiary Denitrification; One- sludge denitrification, Normal Phosphorus Uptake into Biomass; Mechanism for Biological Phosphorus Removal; Enhanced Biological Phosphorus Removal by Bacteria and Algae.

UNIT V-ENVIRONMENTAL CONCERNS & RECYCLING OF WASTES

Environmental regulations and technology- Regulatory Concerns, Technology; Laws, regulations and permits, Air, Water, Solid Waste, Environmental Auditing, National Environmental Policy act, Occupational Safety and Health Act (OSHA), Storm Water Regulations; Technology (waste water); Recycling of Industrial wastes: paper, plastics, leather and chemicals.

REFERENCES

1. Wastewater Engineering: Treatment Disposal Reuse by Metcalf & Eddy
2. Environmental Biotechnology : Principles and Applications by Bruce E. Rittmann
3. Waste water Engineering Treatment and Reuse: McGraw Hill, G. Tchobanoglous,FI Biston, 2002.
4. Industrial Waste Water Managemnet Treatment and Disposal by Waste Water McGraw Hill III Edition 2008.
5. Biological Wastewater Treatment”, Second Edition, Marcel Dekker, Inc., New York,
6. Introduction to Waste Water Treatment- R. S. Ramalho, Academic Press.
7. Environmental Biotechnology, B.C. Bhattacharya & Ritu Banerjee, Oxford Press, 2007.

MTBT022: NANO BIOTECHNOLOGY & TOXICOLOGY

L: T: P

3: 0: 0

UNIT-I

Introduction to Nanobiotechnology: Definition of Nanobiotechnology, History, Origin, Fundamental Concepts, Bottom-up versus Top-down approaches, Discussion on Nanofabrication, Current research, Tool and Techniques, Applications and Implications and Nanofabrication.

UNIT-II

Nanomaterials and Nanoparticles: Carbon nanotubes and related structures, Properties, Synthesis, Applications, Bucky balls, Nanoparticles types and their synthesis, Application of Gold, Silver and Zinc oxide nanoparticles, Interaction of nanoparticles with biomembrane and genes.

UNIT-III

Nanocharecterization tool and techniques: UV-visible spectrophotometry, Fourier transform infrared spectroscopy (FTIR), Scanning Electron Microscopy (SEM) , Scanning tunneling microscopy (STM), Transmission electron microscopy (TEM), Atomic force microscopy (AFM), Nanolithography techniques.

UNIT-IV

Nanomedicine and Sensor Technology: Drug delivery, Bioavailability, Nano imaging agents, Protein and peptidal delivery (Cancer and Surgery), Nanocapsule and Nanosensor technology.

UNIT-V

Toxicology: Principles of Toxicology/concept of Toxicology, Environmental Toxicology, Occupational Toxicology , Nanotoxicity studies: Toxicity mechanism studies, Toxicodynamics-Dose vs Toxicity relationships , Toxicokinetics, Toxicity assement – cytotoxicity, genotoxicity, hepatotoxicity, neurotoxicity, nephrotoxicity, bioassays, Biomarkers, Cell culture studies and In vitro studies.

Text / Reference Books

1. Nanomedicine: Biocompatibility- Robert A. Freitas; Landes Biosciences
2. The Nanobiotechnology Hand Book- Yobing Xie, CRC Press.2012
3. Nanobiotechnology: Christof M. Niemeyer, Chad A. Mirkin, John Wiley & Sons, 2004
4. Nancy A. Monteiro-Riviere, C. Lang Tran., 'Nanotoxicology: Characterization, Dosing and Health Effects', Informa Healthcare publishers, 2007.
5. P. Houdy, M. Lahmani, F. Marano, 'Nanoethics and Nanotoxicology', Springer-Verlag Berlin Heidelberg 2011.
6. A Reference handbook of nanotoxicology by M.ZafarNyamadzi 2008.

MTBT023: INDUSTRIAL BIOTECHNOLOGICAL PRODUCTS

L: T: P

3: 0: 0

Unit I

Different types of culture media; Substrates for industrial microbial processes; Industrially important micro-organisms: Isolation, screening, Selection of mutants; Process optimization techniques.

Unit II

Process technology for the production of various Products: Primary metabolite: ethanol, citric acid, vinegar and amino acid; Production of alcoholic beverages: wine and beer; Secondary metabolites: Antibiotics; Process technology for the production of microbial biomass.

Unit III

Introduction and production of secondary metabolites with some case study. Production of bioplastics (PHB, PHA), bioinsecticides, bioherbicides, biopolymers, Biofertilizers and biological weapons with reference to anthrax,

Unit-IV

Production of industrially important enzymes: Solid state fermentation, submerged fermentation, Extraction, Purification and characterization of industrial enzymes, industrial process using enzymes for production of drugs and fine chemicals, Enzyme based biosensors.

Unit V

Technological processes for industrial manufacture of selected foods of commercial importance from plants and animal sources. Process involved in preparation of Yoghurt, acidophilus milk, Koumis, kefir, cheese, bread, alcoholic beverage, vinegar and oriental fermented food. Food packaging, Equipment involved in the commercially important food processing methods.

Text/ References:

1. Industrial Microbiology, Casida Jr. L. E. 1968) new Age International (P) Ltd. New Delhi.
2. Prescott & Dunn's Industrial Microbiology. Ed. E.G. Reed (1987). CBS Publishers, New Delhi.
3. Biotechnology: A Text book of Industrial Microbiology 2nd Edition. Crueger, W. and Cruger, A. (2000) Panima Publishing Corporation, New Delhi.
4. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry, Palmer, T. (2000) Horwood Publishing Colphon.
5. Manual of Industrial Microbiology and Biotechnology 2nd Edition. Ed. Arnold L. Demain and Julian E. Davies (1999) ASM Press Washington D.C.
6. Microbiology, Pelzar Jr. M.J.: Chan E.C.S. and Krieg, N. R. (1993) Tata Mc Graw Hill, New Delhi.

MTBT151: APPLIED BIOCHEMISTRY & MOLECULAR BIOLOGY LAB

L: T: P
0: 0: 3

1. Quantitative estimation of amino acids by ninhydrin reaction.
2. Quantitative estimation of proteins.
3. To separate lipids with the help of thin layer chromatography (TLC).
4. To verify the Lambert Beer's law with the help of UV absorption spectra of proteins.
5. Protein purification by ammonium sulfate precipitation.
6. Isolation of DNA and RNA from animal tissue and plant tissue.
7. Gel electrophoretic analysis of various DNA and their restriction digests
8. Transformation with plasmid and bacteriophage DNA
9. Restriction mapping of plasmid DNA
10. Blotting: northern blotting, southern blotting
11. PCR technique

MTBT152: BIOPROCESS TECHNOLOGY & ENGINEERING LAB

L: T: P
0: 0: 3

1. Determination of kinetic parameters for batch cultivation of yeast under shake flask conditions.
2. Determination of volumetric oxygen transfer coefficient (K_{La})
3. Determination of activation energy (E_a) of microbial strains.
4. Process optimization for enzyme production using specific experimental design.
5. Preparation of immobilized enzymes & cells and evaluation of kinetic parameters.
6. Computational Design of Fermentative Process.
7. Fermenter designing and the study of various parts of fermenter and their function for microbial cell culture.
8. Fermentative production of Penicillin by using *Penicillium chrysogenum*.
9. Microbial production of enzymes Cellulase & Protease.
10. Ethanol production from molasses or starchy raw material.
11. Fermentative production of Wine from grapes.
12. Separation and purification of microorganisms from yogurt and cheese.
13. Fermentative production of alpha amylase under solid & submerged conditions.
14. Protein profiling of fermentation broth through dialysis procedure.
15. To study the Scale-up and Sterilization in Bioreactors.

MTBT201: BIOINFORMATICS

L: T: P

3: 0: 0

UNIT I

Introduction to Bioinformatics, Need for informatics tools and exercises, Bioinformatics resources: NCBI, EBI, ExPASy, RCSB. Significance of databases towards informatics projects. Primary and Secondary Databases. GenBank, DDBJ, EMBL, PIR, Uniprot-KB, SWISS-PROT, TrEMBL. Specialized databases: Pubmed, OMIM, Medical databases, KEGG, EST databases; Genome databases at NCBI, EBI, TIGR, SANGER. Overview of other popular tools for various bioinformatics exercises.

UNIT II

Introduction, The evolutionary basis of sequence alignment, the Modular Nature of proteins, Optional Alignment Methods, Substitution scores, substitution matrices, PAM, BLOSUM, Gap penalties, Statistical significance of Alignments, Pair wise sequence alignment algorithms, Practical Aspect of Multiple Sequence Alignment, Progressive and Iterative Alignment Methods, CLUSTALW, Database similarity searching, FASTA, BLAST, Low-Complexity Regions. PSI-BLAST, PHI-BLAST.

UNIT III

Introduction to Phylogenetic analysis, rooted and unrooted trees, Elements of phylogenetic Models, Phylogenetic Data Analysis: Alignment, Substitution Model Building, Tree Building, and Tree Evaluation, Tree - Building Methods-Distance based and character based methods, Evaluating Trees and Data- Boot strapping (parametric and non parametric), Phylogenetic softwares (CLUSTALW, PHYLIP etc), Conceptual numericals.

UNIT IV

Restriction mapping, Utilities, DNA strider, MacVector and OMIGA, gene construction KIT, Vector NTI, Web based tools (MAP, REBASE); Primer design – need for tools, Primer design programs and software (PRIME3).

UNIT V

Sequencing methods, Bioinformatics tools and automation in Genome Sequencing, analysis of raw genome sequence data, Utility of EST database in sequencing, Bioinformatics in detection of Polymorphisms, SNPs and their relevance, Bioinformatics tools in microarray data analysis. Tools for comparative genomics: BLAST2, AVID, Vista, MUMmer, COG, VOG. Usages of visualization software available in public domain like VMD, Rasmol, Pymol, SpdbViewer, Chime, Cn3D and GRASP. Rotameric Structures of Proteins (Conformational Flexibility), Canonical DNA Forms (DNA Sequence Effects).

Text/ Reference Books:

5. Bioinformatics (Sequence and Genome Analysis)- David W. Mount, Cold Spring Harbor Laboratory Press, 2001.
2. Bioinformatics- Zoe Lacroix, Terence Critchlow, Morgan Kaufmann Publishersm, 2004.
3. Bioinformatics – From Genomics to Drugs, Volume 1; Basic Technoliges, Thomas Lengauer, Wiley- VCH, 2001.
4. Bioinformatics (Practical Approach): Sequence, Structure and Databanks – Des Higgins, OXFORD Univ. Press, 2003.
6. Bioinformatics Computer Skills - Gibas & Jambeck, O' Reilly, 2001, I Ed.
7. Bioinformatics Computing- Bryan Berjeron, Prentice-Hall of India, Private Ltd., 2003.

9. Computational Molecular Biology (An Algorithmic Approach)- Pavel A. Pevzner, Prentice-Hall of India, Private Ltd., 2004.
11. Introduction to bioinformatics- T K Attwood, D J Parry-Smith, Pearson Education, 2004.
15. Sequence Analysis (In A Nutshell)- Scott Market & Darryl Leon, O' Reilly, 1st Edition, 2003.
16. Scolnick. J.; Drug Discovery and Design, Academic Press, London,2001.
17. N. R. Cohen, Editor, Guidebook on Molecular Modeling in Drug Design. Academic Press, San Diego, 1996.

MTBT202: ENTREPRENEURSHIP, IPR & BIOSAFETY

L: T: P

3: 0: 0

Unit I

Accounting and Finance: Taking decision on starting a venture; Assessment of feasibility of a 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.

Unit II

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 Negotiations/Strategy: 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

Unit III

Information Technology: How to use IT for business administration; Use of IT in improving business performance; Available software for better financial management; E-business setup, management. Human Resource Development (HRD): Leadership skills; Managerial skills; Organization structure, pros & cons of different structures; Team building, teamwork; Appraisal; Rewards in small scale set up.

Unit IV

IPR: Introduction to Intellectual Property, Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS, Filing of a patent application

Unit V

Biosafety: an Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Roles of Institutional Biosafety Committee, Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

Text/References:

1. Selected papers from scientific journals.

MTBT031: GENETIC ENGINEERING

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Unit I

DNA Structure and properties; Enzymes used in Genetic Engineering; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques, Hybridization techniques; Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNaseI footprinting; Methyl interference assay

Unit II

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors, Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors; Expression vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors

Unit III

Insertion of Foreign DNA into Host Cells; Transformation; Isolation of mRNA and total RNA; cDNA and genomic libraries and its construction; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression

Unit IV

Primer design; Fidelity of thermostable enzymes; DNA polymerases; Concept of PCR, Types of PCR, Gene specific and degenerate primer design, linkers, adaptors, Fidelity of uDNA polymerase. Application of PCR. Chimeric protein engineering by PCR

Unit V

Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene Therapy; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

Text/References:

2. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
3. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
4. Brown TA, Genomes, 3rd ed. Garland Science 2006
5. Selected papers from scientific journals.
6. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.
7. Ausubel et al (2002). Short Protocols in Molecular Biology. Wiley
8. Robertson et al (1997). Manipulation & Expression of Recombinant DNA. AP

MTBT032: APPLIED FOOD BIOTECHNOLOGY

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Unit I

Food Biotechnology: Introduction & Applications; Methods for the microbiological examination of water and foods; Control of Microbiological quality and safety; Food borne illnesses and diseases; Microbial cultures for food fermentation, their maintenance, strain development

Unit II

Starter cultures–types, designing and development, micro encapsulation and packaging, scopes and challenge; Development and formulation of novel products such as probiotic foods. Nitrogenomics-concept, working, significance and relevance. Biosensors and novel tools and their application in food science & Technology

Unit III

GM foods: Introduction and controversies related to GMOs. Ethical issues concerning GM foods; testing for GMOs; current guidelines for the production, release and movement of GMOs; labelling and traceability; trade related aspects; biosafety; risk assessment and risk management. Public perception of GM foods. IPR. GMO Act–2004. New products and processes in various food commodities including plant and animal products.

Unit IV

Production of organic acids (vinegar, lactic acid), alcoholic beverages (beer, wine, and distilled alcoholic beverages such as whiskey, rum, vodka), glycerol; Propagation of baker's yeasts;

Unit V

Microbial production of vitamins (B2 and B12), antibiotics (penicillin, streptomycin, tetracycline); Enzymatic production of glucose, fructose, starch, SCP and mushrooms

Text/References:

1. Industrial Microbiology Prescott & Dunn, CBS Publishers
2. Modern Food Microbiology by Jay JM, CBS Publishers
3. Comprehensive Biotechnology by Murray & Mooyoung, Academic press
4. Industrial Microbiology by Casida L.R., New Age International Pvt. Ltd.
5. Food Microbiology; Frazier WC; 4th ed, Tata-McGrowhill Pub.
6. Microbiology by Pelczar, Chan, and Krieg, TMH
7. Fermentation Biotechnology, Principles, Processed Products by Ward OP, Open University Press.
8. Lee, B. H. Fundamentals of Food Biotechnology. VCH. 2006

MTBT033: MOLECULAR MODELING & INDUSTRIAL APPLICATION

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Unit I

Molecular Modelling: Introduction; Useful Concepts in Molecular Modelling; The Molecular Modelling Literature; Molecular Modelling software: BIOSUITE; Force Fields

Unit II

Energy Minimisation and Computer Simulation: Minimisation and Related Methods for Exploring the Energy Surface. Non-Derivative method, 1st and 2nd order minimisation methods. Results of a Simulation and Estimating Errors. GROMACS and CNS. Molecular Dynamics & Monte Carlo Simulation;

Unit III

Drugs: An introduction, Overview of drug discovery process, Trends in drug discovery process. Rationale of Drug Discovery: Medical needs, Target identification, Target validation, Receptors and assay development.

Unit IV

Herbal Drugs: Definition, Trade scenario, Phytochemical standardization and fingerprinting, Marker compounds, Polyherbal formulations. Drug Development and Pre-Clinical Studies: Drug receptor interactions; enzyme inhibition and inactivation, In-vitro and in-vivo pharmacodynamic models, Therapeutic index, Pharmacokinetics - Microbial and animal models, In-vitro and insilico toxicological models, Drug formulations.

Unit V

Applications of microbes for designing vaccines: case study.

Text/References:

1. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001.
2. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.
4. Patwardhan B, Drug Discovery and Development-Traditional Medicine and Ethnopharmacology, New India Publishing (2007)
5. Larsen PK, Leljifore T and Medsan U, Text Book of Drug Design and Discovery, CRC Press (2009)
6. Hillisch A and Hilgenfeld R, Modern Methods of Drug Discovery, Birkhauser (2003).

MTBT041: BIOREACTOR ANALYSIS AND DESIGN

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UNIT I

Introduction; General design information; Material and energy balance calculations; Process Flow sheeting, Selection of bioprocess equipment (upstream and downstream); Specifications of bioprocess equipment; Mechanical design of reactors, heat transfer and mass transfer equipment; Design considerations for maintaining sterility of process streams and process equipment; Piping and instrumentation; Materials of construction for bioprocess plants.

UNIT II

Basic aspects of bioreactor designing, Physical, chemical and biological sensors and control, Advanced control strategies viz. PID controllers, Fuzzy logic based controllers and Artificial Neural Network (ANN) based controllers, Basic concepts of computer modelling and optimization in bioprocess applications.

UNIT III

Ideal bioreactors: Batch reactors, Fed-batch reactors, enzyme-catalyzed reaction in CSTRs, CSTR reactors with recycle and wall cell growth, the ideal plug-flow tubular reactor, Reactors with nonideal mixing: Mixing times in agitated tanks, residence time distribution, models for nonideal reactors, Mixing-bioreaction interactions.

UNIT IV

Reactor dynamics and stability, Multiphase bioreactors: conversion of heterogeneous substrates, packed-bed reactors, bubble column bioreactors, fluidized bed bioreactors, trickle-bed reactors, airlift reactor, Immobilized Enzyme reactors, Photo bioreactors, Hollow fiber membrane bioreactors. Scale up and scale down issues: Effect of scale on oxygenation, mixing, sterilization, pH, temperature, inoculum development, nutrient availability and supply; Bioreactor scale-up based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer coefficients.

UNIT V

Facility design aspects; Utility supply aspects; Equipment cleaning aspects; Culture cell banks; cGMP guidelines; Validation; Safety. Process economics; Case studies, Scale up of downstream processes: Adsorption (LUB method); Chromatography (constant resolution etc.); Filtration (constant resistance etc.); Centrifugation (equivalent times etc.); Extractors (geometry based rules).

Text Books:

1. Moser, Anton, Bioprocess Technology: Kinetics and Reactors, Springer Verlag, 1988.
2. Bailey J.E. & Ollis, D.F. Biochemical Engineering Fundamentals, 2nd ed., McGraw Hill, 1986
3. Lee, James M. Biochemical Engineering, PHI, USA.
4. Atkinson, Handbook of Bioreactors, Blanch, H.W. Clark, D.S. Biochemical Engineering, Marcel Decker, 1999
5. Biochemical Engineering fundamentals" 2nd ed. -J E Bailey and D F Ollis, McGraw-Hill (1986) Chapters 8,9&10.
6. Biochemical Engineering" -S Aiba, A E Humphrey and N Millis , 1978, University of Tokyo Press.
7. Biotechnology" Vols. 3 & 4 Eds., S Rehm and G Reed. VCH (1991).
8. Biochemical Engineering and Biotechnology Handbook" 2nd Ed., .Atkinson & F.Mavituna, Stockton Press (1991).
9. Bioreactor Design & Product Yield" , BIOTOL series, Butterworth - Heinemann (1992).
10. Principles of fermentation technology" - F Stanbury and A Whitaker, Pergamon press (1984)

11. Unit operations of Chemical Engineering" 5th ed. by W L McCabe, J C Smith and P. Harriot Mc Graw-Hill (1993).
12. Bioprocess Engineering Principles" by Pauline M.Doran, Academic Press.
13. Feedback and Control systems- Schaum's outline series, McGraw-Hill Book Comp., 1967
14. Unit Operations of Chemical Engineering- Mc Caba Smith, Harriott, Mc Graw – Hill Chemical Engg. Series., V Ed., 1985.

MTBT042: ENZYME TECHNOLOGY & INDUSTRIAL APPLICATION

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UNIT I-ENZYME TECHNOLOGY

Introductions: Enzymes- Michaelis-Menten kinetics. Kinetics and Statistics Inhibition- Effect of pH and temperature- Enzymology- Immobilized enzymes: Methods, Mass transfer considerations and Industrial enzymes.

UNIT II-METABOLISM, STOICHIOMETRY AND MICROBIAL GROWTH KINETICS

Introduction to metabolism- Nutrient transport- Glycolysis - TCA cycle and other pathways - Control of metabolism. Factors affecting microbial growth – Stoichiometry- mass balances and energy balances. Growth kinetics Measurement of growth.

UNIT III-BIOREACTORS, STERILIZATION, SENSORS AND INSTRUMENTATION

Introduction to bioreactors - Batch and Fed-batch bioreactors, Continuous bioreactors, Immobilized cells. Bioreactor operation, Sterilization, Aeration, Sensors. Instrumentation, Culture - specific design aspects: plant/mammalian cell culture reactors.

UNIT IV-PRIMARY & SECONDARY SEPARATION PROCESS

Biomass removal - Biomass disruption – Membrane based techniques. Extraction -solvent, aqueous two phases, super critical, and Adsorption. Chromatography, Precipitation (Ammonium Sulfate, solvent), Electrophoresis (capillary), Crystallization, Drying and Freeze drying.

UNIT V- INDUSTRIAL APPLICATION

White Biotechnology: Few industrial process using enzymes for production of drugs and fine chemicals, Enzyme based biosensors, Enzyme in organic catalysis, Molecular Imprinting. Enzyme engineering, selection of chiral molecules and their enzymatic separation, functional expression of enzymes protein engineering by modification of protein folding invitro and invivo, Case study

REFERENCES

1. Michael Shuler and Fikret Kargi. "Bioprocess Engineering: Basic Concepts", 2nd Edition, Prentice Hall, and Englewood Cliffs, NJ, 2002.
2. Pauline Doran. "Bioprocess engineering principles", Academic Press, 1995.
3. Colin Ratledge, Bjorn Kristiansen, "Basic Biotechnology", 2nd Edition, Cambridge University Press, 2001.
4. Roger Harrison et al., "Bioseparation Science and Engineering", Oxford University Press, 2003.
5. Harrison R.G. Todd P., Rudge S.R. "Bioseparation Science and Engineering", Oxford Press 2003.

MTBT043: APPLIED BIOENERGY

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Unit I

Introduction to applied bioenergy, Types of bioenergy, Energy scenario-role of energy in economic development and social transformation, Commercial and non-commercial forms of energy, Present and future global projections of energy consumptions.

Unit II

Principles of biomass energy conversion processes, biological, chemical and thermo-chemical technologies for biomass conversion and their utilization covering: Biogas, Produces gas, Alcohol and Biodiesel, Second generation biofuel from high efficiency algal-derived biocrude, Biobased fats (Lipids) and oils from biomass for energy production, Biorefinery systems: An Overview.

Unit III

Current bio-energy applications and conversion technologies, Advantages of applied bioenergy over other sources of energy, Advances in bio-energy research: An overview of technological developments, bioenergy value chain, Databases of bioenergy related enzymes, Sustainable farming of bioenergy crops.

Unit IV

Impact of Energy on Economy, Development and Environment, Energy for Sustainable Development, Energy and Environmental policies, Need for use of new and renewable energy sources, Energy Policy Issues: Fossil Fuels, Renewable Energy, Power sector reforms, restructuring of energy supply sector, energy strategy for future, Status of Nuclear and Renewable Energy: Present Status and future promise.

Unit V

Global Energy Issues, National & State Level Energy Issues, National & State Energy Policy, Industrial Energy Policy, Energy Security, Energy Vision, Energy Pricing and Impact of Global Variations, Energy Productivity (National and Sector wise productivity).

References:

1. Anthony San Pietro (1980); Biochemical and Photosynthetic aspects of Energy Production, Academic Press, New York.
2. Berman, ER Geothermal Energy, Noyes Data Corporation, New Jersey
3. Parker, Colin & Roberts, (1985); Energy from Waste- An Evaluation of Conversion Technologies, Elsevier Applied Science London
4. Boyle Godfrey ed. (1996); Renewable Energy: Power for a sustainable future, Oxford, OUP
5. Ralph E.H. Simsed. (2004); Bioenergy options for cleaner environment by World Renewable Energy Network.
6. Ravindranath N.H. and Hall D.O. (1995); Biomass, Energy and Environment, A developing country perspective from India by, Oxford University Press,
7. Brown Robert C. (2003); Biorenewable Resources: Engineering New Products from Agriculture, Iowa State University Press ,USA

MTBT051: TISSUE CULTURE TECHNIQUES

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Unit I

Basic cell culture techniques, Types of cell culture media; Ingredients of media; Physiochemical properties; CO₂ and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics growth supplements;

Unit II

Different tissue culture techniques; Types of primary culture; Chicken embryo fibroblast culture; Chicken liver and kidney culture; Secondary culture; Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organ culture etc.; Behavior of cells in culture conditions: division, growth pattern, metabolism of estimation of cell number; Development of cell lines;

Unit III

Cell cloning and selection; Transfection and transformation of cells; Commercial scale production of animal cells, stem cells and their application; Application of animal cell culture for *in vitro* testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

Unit IV

Fundamentals of plant tissue culture, plant regeneration: organogenesis. Somatic embryogenesis; somaclonal variation, its genetic basis and application in crop improvement. Cell/callus line selection for resistance to herbicide, stress and diseases.: Isolation, culture and plant regeneration, protoplast fusion, identification and characterization of somatic hybrids., Field techniques for propagation of regenerated plants.

Unit V

Explant selection, sterilization and inoculation; Various media preparations; MS, B5, SH PC L-2; Callus and cell suspension culture; Induction and growth parameters; Chromosomal variability in callus culture. Plant regeneration from embryo, meristem and callus culture. Androgenesis: Anther and pollen culture; Isolation and culture of protoplasts.

Texts/References:

1. B. Hafez and E.S.E Hafez, Reproduction in farm animals, 7th Edition, Wiley Blackwell, 2000
2. G.E. Seidel, Jr. and S.M. Seidel, Training manual for embryo transfer in cattle (FAO Animal Production and Health Paper-77), 1st Edition, W.D. Hoard and sons FAO, 1991
3. I. Gordon, Laboratory production of cattle embryos, 2nd edition, CAB International, 2003.
4. Louis-Marie Houdebine, Transgenic Animals: Generation and Use 5th Edition, CRC Press, 1997.

MTBT052: DIAGNOSTIC TECHNIQUES IN BIOTECHNOLOGY

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Unit I

Volumetric analysis, Balancing & Weighing, Concept of solute & solvent, Units of measurement. Specimen Collection & Processing: Specimen collection (Blood, urine, spinal fluid, saliva synovial fluid, Amniotic fluid), Preservation, transportation

Unit II

Clinical Enzymology: Principle of diagnostic enzymology, Digestive enzyme, Miscellaneous enzyme. General Function Tests: Liver function test, Cardiac Function Test, Renal Function Test, Thyroid Function test, Reproductive endocrine function test

Unit III

Immunodiagnosics: Introduction, Antigen-Antibody Reactions, Conjugation Techniques, Antibody Production, Enzymes and Signal Amplification Systems, Separation and Solid-Phase Systems, Studies related to bacterial, viral and parasitic infections.

Unit IV

Product Development: Immunoassay Classification and Commercial Technologies, Assay Development, Evaluation, and Validation, Reagent Formulations and Shelf Life Evaluation, Data Analysis, Documentation, Registration, and Diagnostics Start-Ups.

Unit V

DNA based diagnostics: PCR, RFLP, SSCP, Microarrays, FISH, In-situ hybridization, Studies related to bacterial, viral and parasitic infections, Cell based diagnostics: Antibody markers, CD Markers, FACS, HLA typing, Bioassays.

Text / Reference Books:

1. Tietz Textbook of Clinical Chemistry, Carl A. Burtis, Edward R. Ashwood, Harcourt Brace & Company Aisa Pvt. Ltd.
2. Commercial Biosensors: Graham Ramsay, John Wiley & Son, INC. (1998).
3. Essentials of Diagnostic Microbiology, Lisa Anne Shimeld.
4. Diagnostic Microbiology, Balley & Scott's.
5. Tietz Text book of Clinical Biochemistry, Burtis & Ashwood. 6. The Science of Laboratory Diagnosis, Crocker Burnett.

MTBT053: Fundamentals of Stem Cell Biology

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UNIT – I

Cell Diversification in Early Animal Embryo:

Process of fertilization & stages of development in Eukaryotes, pluripotency & formation of three germ layers, Differentiation, Organogenesis, ICM , cellular mechanism relating to these developments.

UNIT –II

Stem cell differentiation:

The process of stem cell differentiation leading to the formation of epidermal cells, Skeletal muscles. Transformation of stem cell into gametes/ fertilization entity, Spermatogenesis & oogenesis.,Menstrual Cycle .

UNIT-III

Hemopoietic Stem Cells:

Classification and manifestation of Hemopoietic stem cell disorders, plastic hemopoietic stem cell disorders, myelo dysplastic, myelo proliferative disorders, complications involved in gene therapy, blood transfusion & marrow transplantations, preservation & clinical use of blood, hemapheresis & Apheresis procedures,

UNIT-IV

Concept of stem cells & their applications:

Stem cells & their unique properties, Embryonic stem cells, Adult stem cells, induced pluripotent stem cells, epidermal stem cells & their applications hepatic stem cells & their role in liver regeneration, stem cell treatments, ethical issues of stem cell research.

UNIT-V

Stem cell therapy:

Potential of stem cell therapy for various diseases, eg. AIDS/HIV, Alzheimer's disease, Anaemia, Anti-ageing, Multiple sclerosis, Parkinson disease, Rheumatoid Arthritis.

References:

1. Developmental Biology by R.M.Twyman, Viva Books Pvt. Ltd., 2001
2. Hematology, William J. Williams, Ernest Beutler, Allan JU.Erslev, Marshall A. Lichman.
3. Essential Cell Biology, Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Kieth Roberts and Jamnes D. Watson, Garland Science, Taylor and Francis Group, 2nd Edition, 2003.
4. Stem Cell Biology by Marshak, Cold Spring Harbar Symposium Publication, 2001.
5. Molecular Biology of the Cell, Bruce Alberts, Dennis Bray, Alexander Johnson, Julian Lewis, Martin Raff, Kieth Roberts and Peter Walter, Garland Science, Taylor and Francis Group, 4th Edition, 2003.
6. Molecular and Cell Biology- Schaum's Outline of Theory and Problems by Willam D. Stansfield, Jaime S.Colorne and Raul J. Cano. Tata McGraw Hill Publisher, 2004.

MTBT251: BIOINFORMATICS LAB

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1. To find out five similar sequences of any Protein and DNA query sequence.
2. To predict open reading frame of any given gene sequence.
3. To perform pair wise local and global sequence alignment for any two proteins and DNA sequences.
4. To perform multiple sequence alignment for any five sequences and predicts the Phylogenetic relationship among them.
5. To predict secondary structure for any given protein sequence using Chou-Fasman, GOR and Neural network algorithms.
7. To visualize tertiary structure of any given protein sequence using Rasmol/PyMol/PMV.
8. To visualize the genomic map of Human genome and find out the size, number of genes and number of proteins encoded on Chr-Y.
9. To predict the homology model of any protein sequence.
10. To find out the RMSD value from any two protein structure alignment.