



KALASALINGAM UNIVERSITY

Anand Nagar, Krishnankoil - 626 190

DEPARTMENT OF BIOTECHNOLOGY CURRICULUM FOR M.TECH. PHARMACEUTICAL BIOTECHNOLOGY

Semester I

Code No.	Subject	L	T	P	C
PBT5001	Pharmaceutical Microbiology	3	0	0	3
PBT5002	Biochemistry	3	0	0	3
PBT5003	Biochemical Engineering	3	0	0	3
PBT5004	Pharmaceutical Biotechnology – Drug Discovery and Clinical Applications	3	0	0	3
PBT5005	Concepts in Molecular biology	3	0	0	3
PBT****	Elective I	3	0	0	3
PBT5081	Biopharmaceutical Laboratory I	0	0	6	2
	Total	18	0	6	20

Semester II

Code No.	Subject	L	T	P	C
PBT5006	Modern Pharmaceutical Analysis	3	0	0	3
PBT5007	Bioinformatics and Drug Design	3	0	0	3
PBT5008	Bioprocess Engineering	3	0	0	3
PBT5009	Biopharmaceutical Technology - Biopharmaceuticals in Therapy	3	0	0	3
PBT5010	Biopharmaceutics and Pharmacokinetics	3	0	0	3
PBT****	Elective II	3	0	0	3
PBT5082	Biopharmaceutical Laboratory II	0	0	6	2
	Total	18	0	6	20



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M. TECH. PHARMACEUTICAL BIOTECHNOLOGY

Semester III

Code No.	Subject	L	T	P	C
PBT****	Elective III	3	0	0	3
PBT****	Elective IV	3	0	0	3
PBT****	Elective V	3	0	0	3
PBT6098	M.Tech Thesis Part I	0	0	18	6
	Total	9	0	18	15

Semester IV

Code No.	Subject	L	T	P	C
PBT6099	M. Tech Thesis Part II	0	0	36	12
	Total	0	0	36	12

Total Credits - 67



KALASALINGAM UNIVERSITY
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M.TECH. PHARMACEUTICAL BIOTECHNOLOGY

Electives

Code No.	Subject	L	T	P	C
PBT5011	Probability and Statistics	3	0	0	3
PBT5012	Industrial and Formulative Pharmacy	3	0	0	3
PBT5013	Total Quality Management	3	0	0	3
PBT5014	Enzyme Kinetics and technology	3	0	0	3
PBT5015	Microbial Physiology and Genetics	3	0	0	3
PBT5016	Medicinal Plant Biotechnology	3	0	0	3
PBT5017	Clinical Pharmacology	3	0	0	3
PBT5018	Management of Industrial Waste Water	3	0	0	3
PBT6018	Bio-Conjugate Technology	3	0	0	3
PBT6019	Biological Screening of Drugs	3	0	0	3
PBT6020	Intellectual Property Rights in Biotechnology	3	0	0	3
PBT6021	Novel Drug Delivery Systems	3	0	0	3
PBT6022	Herbal Drug Development and Standardization	3	0	0	3
PBT6023	Nanobiotechnology and Applications in Health Care	3	0	0	3
PBT6024	Pharmacogenetics and Pharmacogenomics	3	0	0	3
PBT6025	Biosensors – Principles and Applications	3	0	0	3

SEMESTER I

PBT5001	PHARMACEUTICAL MICROBIOLOGY	L	T	P	C
		3	0	0	3

Biology of Microorganisms

Introduction – Microscopy - Structure and form of the bacterial cell – size, shape and structure of the cell wall and cytoplasmic membrane - Appendages to the bacterial cell - Capsules and slime - Bacterial spore - process of spore formation – Germination of spores – Toxins produced by bacteria – Bacterial Reproduction - binary fission – method of genetic exchange – Transformation, Conjugation and Transduction - Bacterial growth – growth requirements, measurement of bacterial growth; kinetics of growth and generation time - Culture media - Identification of bacteria - selective and diagnostic media, biochemical tests - Quicker methods for detecting bacteria - Yeasts and moulds - Introduction – Structure- Cell wall - Properties of selected fungi - *Saccharomyces cerevisiae*, *Neurospora crassa*, *Penicillium*, *Aspergillus*, *Epidermophyton*, *Microsporum* and *Trichophyton*

Antibiotics and other antimicrobial agents

Antibiotics – definition, sources and types of antibiotics – penicillins, cephalosporins – Lincomycins, Tetracyclines, Rifamycins and Macrolides – Structure- activity relationships – Pharmacokinetic properties – Antifungals - synthetic antimicrobial agents – Mechanism of action – Bacterial resistance to antibiotics – Antivirals – Methisazone, nucleoside analogues – interferons – Clinical uses of antimicrobial agents – host factors, pharmacological factors and drug resistance - Chemical disinfectants, antiseptics and preservatives - Evaluation of non-antibiotic antimicrobial agents - Mode of action of non-antibiotic antibacterial agents - Resistance to non-antibiotic antimicrobial agents

Microbial Aspects of Pharmaceutical Processing

Ecology of microorganisms as it affects the pharmaceutical industry - Microbial spoilage and preservation of pharmaceutical products - Contamination of non-sterile pharmaceuticals in hospitals and community Environments - Principles and practice of sterilization - Sterilization control and sterility assurance - Sterile pharmaceutical products - Factory and hospital hygiene and good manufacturing practice

Infectious Diseases

Introduction - Spread of infection - Common source infections – Principles of microbial pathogenicity and epidemiology - Properties of selected pathogens – *Staphylococcus*, *Streptococcus*, *Neisseria*, *Clostridium*, *Listeria*, *Pseudomonas*, *Vibrio*, *Yersinia*, *Haemophilus*, *Escherichia*, *Salmonella*, *Shigella*, *Proteus*, *Helicobacter*- *Chlamydia*, *Rickettsia*, *Mycobacterium* – *Spirochetes* – *Borrelia*, *Treponema* and *Leptospira*, *Candida* and *Cryptococcus*

Host Defense

Immune system - introduction - Innate and adaptive immunity – Cells involved in immune defense – Humoral and cell-mediated immunity – Antibody – structure and function – antigen – antibody interactions – Complement – MHC and antigen presentation and

processing – Tumor immunity – immune mediated diseases- immunity to infection - Classes of vaccines - Live vaccines, Killed and component vaccines, Routine immunization against pathogens - Objectives of a vaccine / immunization programme - Effectiveness of the vaccine/ immunogen – Safety, Cost and Longevity of the immunity

TEXT BOOK

1. Hugo, W.B. and Russell, A.D. (2004) *Pharmaceutical Microbiology* – Seventh Edition – Blackwell Science Ltd. Oxford

REFERENCES

1. Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby, Kuby Immunology, W.H., Freeman & Co, San Francisco, 6th Rev. Edition, 2006
2. Mims C.A. (1987) *The Pathogenesis of Infectious Disease*, 3rd edn. London: Academic Press.
3. Frank Austen, K., Burakoff, S.J., Fred Rosen, Terry B. Strom, *Therapeutic Immunology*, Blackwell Science, Boston, 3rd Edition, 2006

PBT5002	BIOCHEMISTRY	L	T	P	C
		3	0	0	3

CHEMISTRY AND METABOLISM OF CARBOHYDRATES AND NUCLEIC ACIDS

Structure and reactions of monosaccharides, disaccharides and polysaccharides – Structural polysaccharides - Storage polysaccharides - homopolysaccharides and heteropolysaccharides - Structure of purines, pyrimidine, nucleosides and nucleotides- Stability and formation of phosphodiester bond - Watson and Crick model of DNA - Calculation of T_m for oligonucleotides - Types of RNA- Structure of tRNA.

Glycolysis, gluconeogenesis and citric acid cycle - electron transport chain, pentose phosphate pathway - Calvin cycle - synthesis and catabolism of purines and pyrimidines - *Denovo* and salvage pathways - regulation of nucleotide biosynthesis and catabolism.

BIOCHEMISTRY AND METABOLISM OF LIPIDS

Structure, properties and classification of lipids - fatty acids, waxes, phospholipids, cerebrosides, lipoproteins and gangliosides - Prostaglandins - prostacyclins, leukotrienes, thromboxanes - physiological implications - Steroids and bile acids.

Fatty acid Metabolism – synthesis and β -metabolism and its regulation - phospholipid metabolism, CAT system - cholesterol biosynthesis - regulation of cholesterol biosynthesis and atherosclerosis - Human plasma lipoproteins

PROTEIN CHEMISTRY AND METABOLISM

Structure and characteristics of amino acids - peptide bond stability and formation - Structural organization of proteins – primary, secondary, tertiary, quaternary and subunit structure of proteins - conformation of proteins - globular and fibrous proteins – Ramachandran plot - denaturation and renaturation - nitrogen excretion and urea cycle. creatine and creatinine - general features of biosynthesis of amino acids (acidic, basic and neutral amino acids).

ENZYME AND HORMONE BIOCHEMISTRY

Definition and characteristics of enzymes - coenzyme, holoenzyme, prosthetic groups - Enzyme Kinetics - Substrate, active site, transition state, activation energy, equilibrium constant, K_m , V_{max} , specificity - Michaelis-Menten equation - Enzyme inhibition and its kinetics - Reaction Mechanism: Acid-base catalysis and covalent catalysis. Allosteric enzymes: MWC Model - Hormones: Introduction, classification and mechanism of action - Hormonal control of metabolism

CHEMISTRY OF NATURAL PRODUCTS

Alkaloids - general introduction and classification - isolation and purification methods, general methods employed for determining the structure of alkaloids - constitution of morphine - reserpine and quinine - steroids- general introduction - stereochemistry, nomenclature and structure elucidation of sterols (cholesterol) - sapogenin (diosgenin) and cardiac glycosides - flavonoids - detailed chemical description of rutin and quercetin - triterpenoids - coumarins - general methods of isolation, purification and structure determination of xanthotoxin and psoralene - steroidal hormones - steroid receptor - natural hormones and currently used synthetic derivatives - SAR - comparison of activity - transformation of phytosterols into steroidal drugs

TEXT BOOK

1. Stryer, L. Biochemistry 6th Edition, WH Freeman & Co., 2006

REFERENCES

1. Williams, D.A., Lemke, T.L., Foye's Principles of Medicinal Chemistry, Lippincott Williams & Wilkins, London, 6th edition 2007
2. Voet and Voet, Biochemistry 2nd Edition, John Wiley & Sons, New York, 1995
3. Lehninger's Principles of Biochemistry by David L. Nelson and Michael M. Cox, Macmillan Worth Publisher.
4. Murray, R.K., Granner, B.K. Mayes, P.A., Rodwell, V.W., Harper's Biochemistry, Prentice Hall International

PBT5003	BIOCHEMICAL ENGINEERING	L	T	P	C
		3	0	0	3

OVERVIEW OF FERMENTATION PROCESSES

An overview of industrial biochemical processes with typical examples, comparison of chemical and biochemical processes - Industrially important microbial strains, their classification, structure, cellular genetics and typical examples of microbial synthesis of biologicals - Isolation, screening and application of industrially important microbes – primary and secondary screening, maintenance of stock cultures and strain improvement for increased yield.

MEDIA REQUIREMENTS AND PRODUCTION OF MICROBIAL METABOLITES

Fermentation industry - general requirements of fermentation processes - basic configuration of fermentor and ancillaries - main parameters to be monitored and controlled in fermentation processes - criteria for a good medium - medium requirements for fermentation processes – nutrient requirements - oxygen requirements - medium formulation for optimal growth and product formation - examples of simple and complex media - design of various commercial media for industrial fermentations - medium optimization methods

Microbial production of organic solvents – organic acids – antibiotics – vitamins – amino acids – nucleotides – other pharmaceutically important microbial metabolites – microbial transformations

METABOLIC STOICHIOMETRY AND ENERGETICS

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 and energetics of microbial growth and product formation - oxygen consumption and heat evolution in aerobic cultures - thermodynamic efficiency of growth.

KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION

Typical characteristics of microbial cells; factors affecting growth; Monod model; modeling of batch and continuous cell growth; immobilized whole cells and their characteristics; Transport in cells - Modes of operation - batch, fed batch and continuous cultivation - product formation kinetics – Leudeking - Piret models - substrate and product inhibition of cell growth and product formation

ENZYME AND ENZYME KINETICS

Enzymes used in industry, medicine and food, their classification with typical examples of industrially important enzymes; mechanism of enzymatic reactions; Michaelis menten kinetics; enzyme inhibition; Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions - formulation of dimensionless groups and calculation of effectiveness factors ; factors affecting reaction rates; industrial production , purification and immobilization; enzyme reactors with typical examples.

TEXT BOOKS

1. Doran, P.M., Bioprocess Engineering Principles, Academic Press(An Imprint Of Elsevier), New Delhi, 2nd Edition, 2005
2. Bailey, J.E., Ollis, D.F., Biochemical Engineering Fundamentals, McGraw Hill Publishers, New Delhi, 2nd Edition, 1986

REFERENCES

1. Shuler, M.L., Fikret Kargi, Bioprocess Engineering-Basic Concepts, Prentice Hall Pvt. Ltd., New Delhi, 2nd Edition, 2004
2. Peter, F., Stanbury, Stephen, J., Hall and A. Whitaker., Principles of Fermentation Technology, Elsevier, Science and Technology Books, New Delhi, 2nd Edition, 2005
3. James Lee, M., Biochemical Engineering, PHI, USA, e-Book Version 2.1,2002
4. Blanch H. W., Clarke, D. S., Biochemical Engineering, Marcel Dekker Inc., 2002

PBT5004	PHARMACEUTICAL BIOTECHNOLOGY – DRUG DISCOVERY AND CLINICAL APPLICATIONS	L	T	P	C
		3	0	0	3

CONCEPTS AND TECHNOLOGIES IN PHARMACEUTICAL BIOTECHNOLOGY

Pharmaceutical biotechnology – Introduction, Industrial Applications, Prokaryotic and Eucaryotic Cells as biofactories - Biopharmaceuticals Expressed in Plants

RECOMBINANT DNA TECHNOLOGY

The uses of recombinant DNA - gel electrophoresis - nucleic acid hybridization assays - DNA structure and complementary base pairing - DNA renaturation, annealing and hybridization - the polymerase chain reaction – templates – primers - DNA polymerase - the PCR amplification process - applications of PCR - constructing recombinant DNA molecules - vectors and host cells for recombinant DNA – transformants - expression of foreign genes - site directed mutagenesis - cloning of human somatostatin in *E. coli* - engineering bacteria for industrial production of small valuable organics - Characterization and Bioanalytical Aspects of Recombinant Proteins as Pharmaceutical Drugs

MONOCLONAL ANTIBODIES AND VACCINES

Monoclonal antibodies - applications of monoclonal antibodies - diagnosis - therapy - generation of monoclonal antibodies – immunization, cell fusion, screening and assays – cloning - cell line characterization - antibody characterization - recombinant antibodies - humanization and deimmunization - antibody fragments and constructs - transgenic mice - production methods - *in vivo* production - mammalian cell culture - pharmaceutical regulation – Vaccines - Ideal Vaccine - types of modern vaccines - attenuated live vaccines - killed inactivated vaccines - conjugated vaccines - subunit vaccines - protein vaccines - DNA vaccines - lipid and carbohydrate antigen vaccines - recombinant live carriers - vaccine adjuvants - Scientific, Technical and Economic Aspects of Vaccine Research and Development

NUCLEIC ACID THERAPEUTICS

Gene therapy - basic approach to gene therapy - vectors used in gene therapy – adeno and retroviral vectors, additional viral-based vectors – manufacturing of viral vectors - non-viral vectors - gene therapy and genetic disease - gene therapy and cancer - gene therapy and AIDS - anti-sense technology - anti-sense oligonucleotides – advantages and disadvantages of ‘oligos’ - delivery and cellular uptake of oligonucleotides - synthesis of oligonucleotides - anti-gene sequences and ribozymes - membrane modifying agents - Electroporation

BIOTECHNOLOGY IN THE 21ST CENTURY AND BEYOND

Monoclonal antibodies as therapeutic agents – Rituximab, Advanced biotechnology products in clinical development - Somatic Gene Therapy- Nonviral Gene Transfer Systems – Xeno transplanation in Pharmaceutical Biotechnology - Tissue Engineering

TEXT BOOK

1. Groves, J.M., Pharmaceutical Biotechnology, Taylor and Francis, London, 2nd edition, 2006.

REFERENCES

1. Klefenz, H., Industrial Pharmaceutical Biotechnology, Wiley-Vch Verlag GmbH, Weinheim, 2nd edition, 2002.
2. Rodney, J.Y., Gibaldi, M, Biotechnology and Biopharmaceuticals, John Wiley, New Jersey, 2nd edition, 2003.
3. *Pharmaceutical Biotechnology, Drug Discovery and Clinical Applications*. Edited by O.Kayser and R.H.Müller (2006) Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim.
4. Walsh, G., Biopharmaceuticals: Biochemistry and Biotechnology, John Wiley, New Jersey, 2nd edition, 2003.

PBT5005	CONCEPTS IN MOLECULAR BIOLOGY	L	T	P	C
		3	0	0	3

CHEMISTRY OF NUCLEIC ACIDS

Chemistry of nucleic acids – Alternative forms of DNA, RNA – types and functions -. DNA topology - DNA synthesis – structure and mechanism of DNA polymerase - Replication structures, Eukaryotic DNA replication - Meselsson and Stahl experiment. Cot curves - Laws of DNA constancy and C-value paradox.

ORGANIZATION OF CHROMOSOMES

Organization of eukaryotic chromosome- duplication and segregation of chromosomes - Nucleosome, higher-order chromatin structure, regulation of chromatin structure - Satellite DNA

GENE EXPRESSION AND ITS REGULATION

The genetic code - mechanism of transcription and translation in prokaryotes and eukaryotes, Post-transcriptional processing - methods for measuring nucleic acid and protein interactions

- Promoters and Enhancers - Operons-*lac* and *trp* operon - Bacteriophage lambda-lysogeny and lytic cycle - M13 and its molecular biology - Environmental regulation of gene expression - Capping, polyadenylation – Splicing mechanism.

MUTATION AND REPAIR

Mutation – fluctuation test, ames test - Molecular basis of spontaneous and induced mutation and their role in evolution- site directed mutagenesis - DNA-methylation - Repair and SOS response. Recombination - Transposons and retrotransposons

TECHNIQUES IN MOLECULAR BIOLOGY

Electrophoresis – PCR, RT-PCR, LCR, Real time quantitative PCR - Blotting and hybridization techniques, autoradiography - RNA interference - DNA finger printing, Foot printing – Microarray and SAGE- Gene sequencing- Antisense technology

TEXT BOOK

1. Watson, J. D. , Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, Molecular Biology of the Gene, Benjamin Cummings, London, 3rd Edition, 2003

REFERENCES

1. Weaver, R.F., Hedrick, P.W., Molecular Biology, William C. Brown, Illinois, 5th Edition, 2003
2. Malacinski G.M., Freifelder D., Essentials of Molecular Biology, Jones & Bartlett Pub, Boston, 4th Edition, 2006

PBT5081	BIOPHARMACEUTICAL LABORATORY I	L	T	P	C
		0	0	6	2

1. Isolation and characterization of bacteria, actinomycetes and fungi.
2. Methods of preservation of cultures
3. Screening of *Streptomyces* for antibiotic production
4. Estimation of microbial load in pharmaceutical excipients and raw materials as per official pharmacopoeia.
5. Determination of growth kinetics of bacteria
6. Induction of mutation and isolation of antibiotic resistant and auxotrophic mutants - adopting replica plating technique.
7. Qualitative and quantitative analysis of antimicrobial agents by ditch – plate and extinction methods
8. Standardization of inoculum and estimation of MIC by serial dilution and gradient – plate technique
9. Fermentation of antibiotics.
10. Down stream processing methods like cell disruption, isolation process for antibiotics, purification by chromatographic techniques
11. Preparation and maintenance of primary cell culture and cell lines

12. Proliferation and migration studies using human cell lines and lymphocytes
13. Determination of cytotoxicity and screening for anti-viral activity of some natural and synthetic products
14. Animal immunization, bleeding; antigen- antibody reactions precipitation, agglutination, haem-aggulutination inhibition
15. Study of Enzyme kinetics and optimization of enzyme activity
16. Scanning Electron Microscopy

SEMESTER II

PBT5006	MODERN PHARMACEUTICAL ANALYSIS	L	T	P	C
		3	0	0	3

SPECTROSCOPIC METHODS

Principle - instrumentation and applications in pharmacy of UV-visible, infra-red, nuclear magnetic resonance (NMR) and fluorescence spectroscopy - flame emission spectroscopy - atomic absorption spectroscopy - mass spectroscopy

CHROMATOGRAPHIC TECHNIQUES

Principles of chromatography – Classification of Chromatographic Methods – Paper, Thin-layer and column chromatography - Separation based on mechanism - Ion-exchange chromatography – Adsorption Chromatography – Gel-filtration Chromatography – Hydrophobic Interaction Chromatography – Affinity Chromatography

Principles – Instrumentation – Applications of i) High Performance Liquid Chromatography – Elution Modes – Column Parameters – Detection based on UV-Visible Absorption and Refractive Index - Reversed-phase HPLC – LC-MS - ii) Gas-liquid Chromatography – Column Parameters – Elution Modes – Types of Detectors

MOLECULAR BIOLOGICAL TECHNIQUES

Electrophoresis - Principle – Theory – Instrumentation - Applications of – i) Moving Boundary Electrophoresis – ii) Zone Electrophoresis – iii) Gel Electrophoresis; Principles – Applications of Isoelectric Focusing – Western Blotting; PCR - Principle – Instrumentation – Procedures – Applications

IMMUNOASSAYS

Introduction – Principle – Theory of immunoassays - Procedures for Radio-immuno assay – ELISA, Flow cytometry - Applications

X-RAY DIFFRACTION METHODS

Introduction – Generation of X-rays – Bragg's Law – X-ray Powder Diffraction – Interpretation of Diffraction Patterns - Applications

TEXTBOOKS

1. Munson, J.W, Pharmaceutical Analysis – Modern Methods – Part A, Part B, Marcel Decker, New York, 5rd edition, 2001.
2. Douglas A. Skoog, James, J. Leary, Instrumental Analysis Principles, Pacific Grove, London, 6th Edition, 2007.

REFERENCES

1. Willard, H.H, Instrumental Methods of Analysis, Van Nostrand, New York, 7th Edition, 2000
2. Chromatographic Analysis of Pharmaceuticals, John A. Adamovics, 2nd Edition.
3. William Kemp, Organic Spectroscopy, W.H. Freeman & Company, London, 3rd Edition, 1991.

PBT5007	BIOINFORMATICS AND DRUG DESIGN	L	T	P	C
		3	0	0	3

INTRODUCTION

Bioinformatics Databases - sequence, structure, mapping, non-redundancy - sequence alignment – pair-wise and multiple – phylogenetics - Structure prediction methods. Hidden Markov models - neural networks

MOLECULAR SIMULATION and DYNAMICS METHODS

Monte Carlo simulation - Methods for the integration of dynamical equations - molecular dynamics of rigid non-linear polyatomic molecules in other ensembles - structural information from M.D

MOLECULAR MECHANICS

Energy minimization - intra molecular interactions - physicochemical parameters in drug design - ionization constants – chelation - solubility and partition Co-efficient - overview of molecular descriptors

DRUG DESIGN

Rational basis of drug designing - criteria for synthesizing drugs - drug designing approaches - QSAR and molecular docking in drug design - De novo design – pharmacophore-based mapping - virtual screening - comparative protein modeling - current research in drug designing- a case study.

BIOINFORMATICS TOOLS

BLAST – FASTA – ClustalW - PROSITE -EMBOSS– ORF Finder- MMDB - AMBER, CHARMM, and X-PLOR - Ludi, Ludi/CAP, Autodock, GRAMM, - NAMD.

TEXTBOOKS

1. Leach, A.R., Molecular Modelling: Principles and application, Princeton Hall, London, 2nd Edition, 2001
2. Krogsgaard, L., Povl Madsen, Text Book of Drug Design and Discovery, CRC, London, 3rd Edition, 2002
3. A.D.Baxevanis & B.F.F.Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Wiley Interscience, New York, 3rd Edition, 2004

REFERENCES

1. Walsh, G., Biopharmaceuticals-Biochemistry and Biotechnology, Wiley, London, 4th Edition, 2003
2. Cohen, N. R., Guidebook on Molecular Modeling in Drug Design. Academic Press, San Diego, 3rd Edition, 1996

PBT5008	BIOPROCESS ENGINEERING	L	T	P	C
		3	0	0	3

TRANSPORT IN MICROBIAL SYSTEMS

Newtonian and Non-Newtonian behaviour of broths; agitation and mixing; power consumption; gas / liquid transport in cells; transfer resistances; mass transfer coefficients and their role in scaleup of equipments; enhancement of O₂ transfer rates; heat transfer in biological systems – their correlations; sterilization cycles and typical examples of heat addition and heat production during biological production.

ANALYSIS OF BIOREACTORS

Bioreactors – Batch and continuous type; immobilized, whole cell, and enzyme reactors; high performance bioreactors; sterile and non-sterile operations; reactors in series with and without recycle; design and scaleup of bioreactors - Stirred tank reactor - non-ideality, RTD and stability analysis - tanks in series and dispersion models – Packed-bed reactor, airlift reactor, fluidized bed reactor and bubble column reactors

BIOREACTOR SCALEUP

Regime analysis of bioreactor processes, oxygen mass transfer in bioreactor – microbial oxygen demand; methods for the determination of mass transfer coefficients; mass transfer correlations. oxygen mass transfer in bioreactors - - scale up criteria for bioreactors based on oxygen transfer - power consumption and impeller tip speed

MODELING AND SIMULATION OF BIOPROCESSES

Study of structured models for analysis of various bioprocesses – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism.

DOWNSTREAM PROCESSING

Different unit operations in downstreaming – sonication, filtration, centrifugation; Membrane separation operations – ultrafiltration and microfiltration, extractive fermentation; Chromatographic methods, Electrophoretic separations, Product finishing and formulation.

TEXT BOOKS

1. Bailey, J.E., Ollis, D.F., Biochemical Engineering Fundamentals, McGraw Hill Publishers, New Delhi, 2nd Edition, 1986
2. Shuler, M.L., Fikret Kargi, Bioprocess Engineering-Basic Concepts, Prentice Hall Pvt. Ltd., New Delhi, 2nd Edition, 2004

REFERENCES

1. Doran, P.M., Bioprocess Engineering Principles, Academic Press(An Imprint Of Elsevier), New Delhi, 2nd Edition, 2005
2. Peter, F., Stanbury, Stephen, J., Hall and A. Whitaker., Principles of Fermentation Technology, Elsevier, Science and Technology Books, New Delhi, 2nd Edition, 2005
3. James Lee, M., Biochemical Engineering, PHI, USA, e-Book Version 2.1,2002
4. Blanch H. W., Clarke, D. S., Biochemical Engineering, Marcel Dekker Inc., 2002

PBT5009	PHARMACEUTICAL BIOTECHNOLOGY - BIOPHARMACEUTICALS IN THERAPY	L	T	P	C
		3	0	0	3

CYTOKINES

Cytokines and cytokine receptors - interferons - biochemistry – role in signal transduction - interferon receptors - JAK–STAT pathway - effects of interferons - production and applications of interferons - interferon toxicity - interleukins - interleukin-1, 2, 4, 5, 6, 11 and 12 - biological activities; role in immune system regulation and infectious diseases; production and therapeutic potential of ILs - safety issues - tumour necrosis factors (TNFs) - biochemistry – role in immunity and inflammation - TNF receptors

GROWTH FACTORS

Haemopoietic growth factors - granulocyte colony stimulating factor (G-CSF), macrophage colony-stimulating factor (M-CSF), granulocyte-macrophage colony stimulating factor (GM-CSF) - clinical application of CSFs - leukaemia inhibitory factor (LIF) - erythropoietin (EPO) - EPO receptor and signal transduction - regulation of EPO production - therapeutic applications of EPO - epidermal growth factor (EGF) - EGF receptor - platelet-derived growth factor (PDGF) - PDGF receptor and signal transduction - PDGF and wound healing - fibroblast growth factors (FGFs) - transforming growth factors (TGFs) - TGF- α - TGF- β

HORMONES OF THERAPEUTIC INTEREST

Insulin - insulin receptor and signal transduction - production and enzymatic conversion of porcine insulin – recombinant insulin - formulation of insulin products – glucagon - human growth hormone (hGH) - growth hormone releasing factor (GHRF) and inhibitory factor (GHRIF) - GH receptor - biological effects and uses of GH - recombinant hGH (rhGH) and

pituitary dwarfism - gonadotrophins - follicle stimulating hormone (FSH), luteinizing hormone (LH) - human chorionic gonadotrophin (hCG) - regulation of gonadotrophin production - sources and medical uses of FSH, LH and hCG - recombinant gonadotrophins

BLOOD PRODUCTS AND THERAPEUTIC ENZYMES

Disease transmission by blood products - whole blood - platelets and red blood cells - blood substitutes – dextrans, albumin, gelatin - oxygen-carrying blood substitutes - haemostasis - coagulation pathway - clotting disorders - factor VIII and haemophilia - production of factor VIII - factors IX, VIIa and XIII - anticoagulants – heparin, vitamin K, hirudin - antithrombin - thrombolytic agents - tissue plasminogen activator (tPA) - first-generation tPA – recombinant tPA – enzymes of therapeutic value - streptokinase, urokinase, staphylokinase and nattokinase - asparaginase - glucocerebrosidase - α -galactosidase and urate oxidase - superoxide dismutase – anti-trypsin - digestive aids – lactose

PROTEINS AS DRUG DELIVERY SYSTEMS

Collagen - gelatin - T - phase relationships of gelatin systems - preparation of gelatin particles - emulsification processes - precipitation processes - submicron diameter gelatin particles - gelatin precipitation - optimization of gelatin nanoparticle production - toxicity of gelatin - sterilization of gelatin products - tissue targeting with gelatin microparticles - albumin microparticles - albumin microparticles - emulsification processes - atomization processes

TEXT BOOKS

1. Rodney, J.Y., Gibaldi, M, Biotechnology and Biopharmaceuticals, John Wiley, New Jersey, 2nd edition, 2004.
2. Groves, J.M., Pharmaceutical Biotechnology, Taylor and Francis, London, 2nd edition, 2006.

REFERENCES

1. Klefenz, H., Industrial Pharmaceutical Biotechnology, Wiley-Vch Verlag GmbH, Weinheim, 2nd edition, 2002.
2. Walsh, G., Biopharmaceuticals: Biochemistry, John Wiley, New Jersey, 2nd edition, 2003.

PBT5010	BIOPHARMACEUTICS AND PHARMACOKINETICS	L	T	P	C
		3	0	0	3

ABSORPTION OF DRUGS

Definition, Structure of cell membrane and composition, Gastrointestinal absorption – Mechanism, Factors affecting drug absorption: Biological, Physiological, Physico-Chemical and Pharmaceutical dosage form factors; Methods of determining absorption: Invitro and Invivo methods; Absorption of drugs from non-oral route.

DISTRIBUTION AND BIOTRANSFORMATION OF DRUGS

Definition, Distribution in blood and other fluids: cellular distribution, drug penetration to CNS, placental transfer of drugs and blood flow; volume of distribution, Plasma protein binding: Drug distribution and drug effects, Drug binding in tissues - biotransformation - Definition - Phase I and Phase II reactions and Factors affecting biotransformation - excretion of drugs, renal and non-renal excretion

PHARMACOKINETICS

Definitions, basic considerations - zero order and first order kinetics - open one compartment model and open two compartment model - non-compartmental methods - Area under first movement curve (AUMC) - drug clearance, apparent volume of distribution, mean residence time (MRT) and its significance - concept of clearance- organ clearance, total clearance - hepatic clearance - and renal clearance

BIOAVAILABILITY AND DOSAGE REGIMEN

Definition, estimating absorption rate of drugs - preabsorptive hydrolysis and metabolism - presystemic metabolism -hepatic metabolism and gut wall metabolism - measurement of bioavailability- pharmacokinetic methods and pharmacodynamic methods - methods of enhancing bioavailability of drugs – prodrugs - enhancement of dissolution characteristics - inclusion of bioavailability enhancers - dosage regimen - multiple dosing with respect to IV and oral route, concept of loading dose, maintenance dose and accumulation index

BIOEQUIVALENCE AND PHARMACOKINETIC VARIABILITY

Bioequivalence - chemical equivalence - therapeutic equivalence - pharmaceutical equivalence - testing of bioequivalence of dosage forms - pharmacodynamic variability - body weight, age, sex, genetic factors, pharmacokinetic variabilities in disease, states of renal, liver, cardiovascular, thyroid and dosage adjustment in the above conditions.

TEXTBOOKS

1. Gibaldi, M., Biopharmaceutics and clinical pharmacokinetics, Lea & Febiger, Philadelphia, 5th edition, 2003.
2. Notari, R.E., Biopharmaceutics and clinical pharmacokinetics, Marcel Decker, New York, 4th Edition, 1987.

REFERENCES

1. Remington, J.P, Gennaro, A.R., Remington's Pharmaceutical Sciences, Mack Publishers, Easton, 17th edition, 1985.
2. Taylor, J.B., Biopharmaceutics, Pergamon Press, Oxford, 2nd Edition, 1990.

BPT5082	BIOPHARMACEUTICAL LABORATORY II	L	T	P	C
		0	0	6	2

1. Estimation of some microbial enzymes and protein estimation.
2. Production of extra-cellular enzymes from microbial sources, and downstream processing using Ammonium sulphate precipitation, Dialysis, Size exclusion chromatography, Affinity chromatography.
3. Isolation of Plasmid DNA and estimation of DNA; agarose electrophoretic analysis.
4. Transformation of bacterial cells using plasmid DNA
5. Isolation of RNA from microbial sources and its estimation
6. Cloning with different expression vectors
7. Southern blotting with radioactive and non-radioactive probes.
8. Northern blotting technique.
9. Qualitative analysis of proteins & Estimation of molecular weight of proteins by PAGE techniques.
10. Enzyme-linked immunosorbant assay and western blotting techniques.
11. Hybridoma techniques: Fusion; screening methods and production and purification of monoclonal antibodies.
12. Development of suitable delivery system for anti-tumour agents, newer vaccines and therapeutic proteins and peptides for site-specific delivery.

SYLLABUS FOR ELECTIVES

PBT5011	PROBABILITY AND STATISTICS	L	T	P	C
		3	0	0	3

PROBABILITY AND RANDOM VARIABLES

Probability concepts, random variables, moment, moment generating function, binomial, Poisson, geometric, negative binomial, exponential, gamma, weibull distributions, functions of random variable, chebychev inequality.

TWO-DIMENSIONAL RANDOM VARIABLES

Marginal and conditional distributions, covariance, correlation and regression, transformation of random variables, central limit theorem.

RANDOM PROCESS

Classification, stationary and markov processes, Poisson process, pure birth process, birth and death process, markov chains, markovian queueing models.

RELIABILITY ENGINEERING

Concepts of reliability, hazard function, series and parallel systems, reliability and availability of markovian systems, maintainability, preventive maintenance

DESIGN OF EXPERIMENTS AND QUALITY CONTROL

Completely randomised design, randomised block design, latin square design, process control, control charts of measurements and attributes, tolerance limits.

TEXT BOOKS

1. Mille I.R., Freund J.E., Probability and Statistics for Engineers, Prentice-Hall, 1995
2. Kapur J.N., Saxena H.C., Mathematical Statistics, S Chand and Company Ltd., New Delhi, 1997.

REFERENCES

1. Balagurusamy E., Reliability Engineering, Tata McGraw-Hill Publishers, New Delhi, 1993.
2. Bhat U.N., Elements Of Applied Stochastic Processes, Wiley Series In Probability And Mathematical Statistics, New York, 2002.

PBT5012	INDUSTRIAL AND FORMULATIVE PHARMACY	L	T	P	C
		3	0	0	3

PREFORMULATION

Principle - organoleptic properties – purity - particle size – shape - and surface area – solubilisation - surfactants and importance – temperature – pH - co-solvency; -Techniques for the study of crystal properties and polymorphism - physicochemical characteristics of new drug molecules with respect to different dosage forms

COMPACTION AND COMPRESSION

Compaction of powders with particular reference to distribution and measurement of forces within the powder mass undergoing compression including- physics of tablet compression - effect of particle size - moisture content - lubrication etc on strength of tablets.

PILOT PLANT SCALE-UP TECHNIQUES AND MANUFACTURING PROCESS

Significance of pilot plant scale up study and large scale manufacturing techniques (formula – equipment – process - stability and quality control) of some important dosage forms such as tablets – capsules – injections - liquid orals – semisolids - ophthalmic products - dry syrups - emulsions including multiple emulsions - multivitamin products

STERILITY AND STABILITY OF DOSAGE FORMS

Principle - advantages, disadvantages, applications of different sterilization methods – equipments - sterility testing – principle - general procedure - control tests - sterility testing of some preparations like parenterals and ophthalmic preparation - surgical sutures and ligatures - surgical dressings – ampoules – vials - transfusion bottles - vaccine bottles - syringes and needles - physicochemical and biological factors affecting stability of drugs - methods to find out degradation pathways - determination of shelf-life by accelerated stability testing - overages and ICH guidelines.

PACKAGING OF PHARMACEUTICALS AND INDUSTRIAL SAFETY

Desirable features and a detailed study of different types of pharmaceutical containers and closures (glass, plastics and rubber), including their merits and demerits; selection and evaluation of pharmaceutical packaging materials - industrial hazards due to fire accidents - mechanical and electrical equipments - chemicals and pharmaceuticals - monitoring and preventive systems (Safety measures)

TEXT BOOKS

1. Lachmann, L., Libermann, H.A., Kanig, J.L, Theory and Practice of Industrial Pharmacy, Lea & Febiger, London, 3rd edition, 1999.
2. Remington, J.P, Gennaro, A.R., Remington's Pharmaceutical Sciences, Mack Publishers, Easton, 18th edition, 1990.
3. Kenneth, E.A., Lachmann, L., Libermann, H.A., Pharmaceutical dosage forms: Tablets Vol. 1-3, Marcel Decker, New York, 4th edition, 1993.

REFERENCES

1. Martin, A, Physical Pharmacy, Wiley Publishers, New York, 5th Edition, 1999.
2. Banker, G.S., Rhodes, C.T., Modern Pharmaceutics, Marcel Decker, New York, 4th edition, 2002.
3. Remington, J.P, Gennaro, A.R., Remington's Pharmaceutical Sciences, Mack Publishers, Easton, 19th edition, 2004.

PBT5013	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

INTRODUCTION

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

TQM PRINCIPLES

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

STATISTICAL PROCESS CONTROL (SPC)

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

TQM TOOLS

Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA.

QUALITY SYSTEMS

Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits.

TEXT BOOKS

1. Dale H. Besterfield, et al., “Total Quality Management”, Pearson Education Asia, 1999. (Indian reprint 2006).
2. James R.E., William M.L., The Management and Control of Quality, South-Western (Thomson Learning), London, 6th Edition, 2007.

REFERENCE

1. Feigenbaum.A.V. Total Quality Management, McGraw-Hill, New York, 4th Edition, 1999.

PBT5014	ENZYME KINETICS AND TECHNOLOGY	L	T	P	C
		3	0	0	3

CLASSIFICATION AND NOMENCLATURE OF ENZYMES

Hydrolases and transferases - peptidases - esterases – kinases – ATPases – oxidoreductases - Lyases and some examples of isomerization, rearrangement and condensation reactions - role of metal ions and cofactors like pyridoxal phosphate - thiamine -pyrophosphate, folate – biotin – flavin - nicotinamide nucleotides and lipoate in enzyme catalytic mechanisms

CONCEPTS OF RATE PROCESSES IN BIOLOGICAL SYSTEMS

Factors contributing to enzyme catalytic rates - single and multi-substrate system - regulatory enzymes - steady-state kinetics - initial velocity, product inhibition enzyme activation analysis - effect of pH and temperature on enzyme rates - isotope effects and their application to transition state structure

STRUCTURAL ENZYMOLOGY

Active site characterization - methods of active site group assignment - chemical modifications and site directed mutagenesis - integration of kinetic, chemical, and structural data towards enzyme mechanisms - immobilization techniques and methods - influence of immobilization on enzyme activity - frontiers in enzyme technology

STABILITY OF ENZYMES

Strain selection, (thermophilic, halophilic, alkalophilic producer strain) - cloning stable enzyme in mesophile - protein engineering to improve enzyme stability

ENZYME APPLICATIONS

Industrial, medical and analytical applications of enzymes - enzyme reactions in non-aqueous medium - synthesis with hydrolase enzymes - chemical modification of enzyme to improve physico-chemical properties

TEXT BOOKS

1. Fersht, A.R., Enzyme Structure and Mechanism, W.H. Freeman & Co, New York, 5th Edition, 2000
2. Segel, I.H., Enzyme Kinetics: Behavior and Analysis of Rapid Equilibrium and Steady-State Enzyme Systems, Wiley Interscience, New York, 6th Edition, 1994

REFERENCES

1. Plowman, K.M., Enzyme Kinetics, McGraw-Hill & Co, London, 4th Edition, 1972.
2. Walsh, C.S., Enzymatic Reaction Mechanisms, W.H. Freeman & Co, New York, 4th Edition, 1979
3. Trevan, M.D., Immobilized Enzymes, John Wiley & Sons, New York, 3rd Edition, 1980

PBT5015	MICROBIAL PHYSIOLOGY & GENETICS	L	T	P	C
		3	0	0	3

MICROBIAL CELL STRUCTURE

Introduction - overview of Prokaryotic Phylogeny and Taxonomy; Microbial cell structure with special reference to cell walls and their components; role of the cytoplasmic membrane and its components; transport systems in the cytoplasmic membrane; role, types and characteristics; Lipoproteins, Bacterial polysaccharides: LPS and teichoic acids; Exopolysaccharides and capsules; Peptidoglycan biosynthesis; Bacterial appendages: pili and flagella

GROWTH AND NUTRITION

Bacterial growth and nutrition - Batch culture; Quantifying growth; Factors affecting growth rate. Continuous culture. Chemostat cultures, some quantitative analysis of properties of microbes during growth. Limiting nutrients, maintenance energy, etc. characteristics and techniques used to study this; cell vs population growth.

BIOCHEMICAL METABOLISM

The biochemical basis of nutritional versatility; Diversity of bacterial metabolism; Metabolism of carbohydrates: main pathways and examples of bacterial sugars; aerobic and anaerobic metabolism; examples of fermentations; methanogenesis; C1 and C2 metabolism; growth on inorganic energy sources, NADH and ATP as metabolic “currencies”; Regulation

and assembly of metabolic pathways; Nutrition requirement - assimilation as well as dissimilation;

BIOENERGETICS

Introduction to bioenergetics – Photosynthesis; Redox, electron transport chains and respiratory inhibitors; microbial fuel cells and nanowires

GENETICS AND GENOMICS

Microbial Genetics overview; Gene transfer in bacteria – transformation, conjugation and transduction; reproductive cycle of bacteriophage T4 and lambda; Genomics and metagenomics; Microbial genome sequencing: its implications for physiological/biochemical studies; genomic islands, pathogenicity islands and examples of virulence factors in micro organisms.

TEXT BOOK

1. Brock, T. D., Madigan, M. T., Martinko, J. M., Parker, J., 2003. Biology of Microorganisms, Prentice Hall, New Jersey, 11th Edition, 2006.

REFERENCES

1. Larry Barton, Structural and Functional Relationships in Prokaryotes, Springer, New York, 4th Edition, 2005.
2. Caldwell, D. R., Microbial Physiology and Metabolism, Star Publishing Company. Belmont, CA, 3rd Edition, 2000.
3. Nicholls, D. G., Ferguson, S.J., Bioenergetics, Academic Press. Boston, MA, 2nd Edition, 2002.
4. Stryer, L., Biochemistry, W. H. Freeman and Company, New York, 6th Edition, 2006.

PBT5016	MEDICINAL PLANT BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

INTRODUCTION

Historical perspective and prospects for development of medicinal plant biotechnology - Applications in pharmacy and allied fields

PLANT TISSUE CULTURE

Types, techniques, nutritional requirements and growth of plant tissue cultures - Secondary metabolism in tissue cultures with emphasis on production of medicinal agents and its impact in pharmacy - cellular totipotency, Embryogenesis & Organogenesis - Somaclonal variation and genetic instability in plant cell cultures - Micropropagation - Advantages, disadvantages & factors influencing micropropagation Different methods of micropropagation and stages involved in micropropagation - Protoplast culture - Isolation and purification of protoplasts -methods of protoplast fusion & protoplast culture

IMMOBILISED PLANT CELL CULTURE SYSTEMS

Immobilization techniques and advantages of immobilization techniques - Effect of immobilization on secondary metabolism- bioreactors for pilot and large-scale cultivation of plant cells

PRODUCTION OF PLANT BIOMEDICINALS

Effect of Culture methods, Precursors and Elicitors on production of biomedicinals - Biotransformation and its applications in Pharmacy - Cryopreservation- Different methods of cryopreservation and its impact on production of biomedicinals – Hairy-root culture - Method of establishment and its applications

TRANSGENIC PLANTS AND CELL LINES

Cloning of plant cells - Different methods of cloning and its applications, advantages and disadvantages of plant cell cloning - transgenic plants - Plant fingerprint analysis Methods used in gene identification, localization and sequencing of genes - application of PCR to plant genome analysis - Screening and selection of high yielding cell lines - ELISA methods used to certify pathogen in plants

TEXTBOOKS

1. Murray, D.R., Advanced Methods in Plant Breeding and Biotechnology, CAB Publications, New York, 6th Edition, 2000
2. Jeffrey W. P, Walker, J.M., Plant Cell and Tissue Culture, Humana Press, New Jersey, 3rd Edition, 1990.

REFERENCES

1. Walker, J. M., Rapley, R., Molecular Biology and Biotechnology, Royal Society of Chemistry, Cambridge, 4th Edition, 2000.
2. Shargool , P.D., Ngo, T.T., Biotechnological applications of Plant Cultures, CRC Press, 2nd Edition, 1994.
3. Russel, G. E., Biotechnology of higher plants, Wimborne, Dorset, 2nd Edition, 1994.

PBT5017	CLINICAL PHARMACOLOGY	L	T	P	C
		3	0	0	3

DRUG DEVELOPMENT PROGRAM

Basic principles involved in the development of a drug - Pre human requirements before starting a clinical trial - Pre requisites of clinical trials - Different phases of clinical trials

CLINICAL RESEARCH/ TRIAL CO-ORDINATION

Clinical research organizations and clinical research associates and their function - ICH Good Clinical Practice guidelines: introduction, objectives and its functions - Documentation involved in clinical trials

CLINICAL PHARMACOKINETICS

One compartment open model - Multicompartmental models - Bioavailability and bioequivalence – clearance - Application of pharmacokinetics in clinical situations, dosage adjustment in renal and hepatic failure

TOXICOLOGY

Principles of toxicology - Abnormal action of drugs such as tolerance, addiction - habituation - idiosyncrasy, allergy, hypersensitivity, antagonism, synergism, potentiation and Tachyphylaxis - Adverse drug reactions and their monitoring - Heavy metal poisoning

DRUG INTERACTIONS & RATIONALE FOR DRUG COMBINATIONS:

Drug interactions - implications and possible means to avoid them - Drug – Drug interactions - involving antibiotics, cardiovascular drugs, antihistaminic drugs and analgesic, anti-inflammatory agents. Various mechanisms of drug interaction, drug-food interaction and drug - drug interaction

TEXTBOOKS

1. Bertram G K., Basic and Clinical Pharmacology, McGraw Hill, New York, 11th Edition, 2007.
2. Gibaldi, M., Biopharmaceutics and clinical pharmacokinetics, Lea & Febiger, Philadelphia, 5th edition, 1995.

REFERENCES

1. Dipiro, J.T., Pharmacotherapy, A Pathophysiologic Approach, McGraw Hill, New York, 6th Edition 2005.
2. Shargel, L., Andrew, B.C., Wu-Pong, S., Applied Biopharmaceutics & Pharmacokinetics, McGraw Hill, London, 5th Edition 2004.
3. Ellenhorn, M.J., Text book of Toxicology", 2nd edition, Williams and Wilkins Publications, New York, 2001.

PBT5018	MANAGEMENT OF INDUSTRIAL WASTEWATER	L	T	P	C
		3	0	0	3

INTRODUCTION

Industrial scenario in India– Industrial activity and Environment with reference to pharmaceutical industry – Sources and types of industrial wastewater – Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater

WATER ANALYSIS AND INDUSTRIAL POLLUTION PREVENTION

Physical, chemical and biological parameters - Standard methods of water analyses - Prediction of water demand and wastewater generation - Water and wastewater quality-Prevention Vs Control of Industrial Pollution – Benefits and Barriers – Source reduction techniques – Waste Audit – Evaluation of Pollution prevention options – Environmental statement as a tool for pollution prevention – Waste minimization Circles

INDUSTRIAL WASTEWATER TREATMENT

Various methods employed for waste water treatment – equalization, neutralization, oil separation, flotation, precipitation - Heavy metal Removal – Refractory organics separation by adsorption – Aerobic and anaerobic biological treatment – Sequencing batch reactors – High Rate reactors - Chemical oxidation – Ozonation – Photocatalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies – Nutrient removal - Design and Operation of Physical and Biological Wastewater Treatment Systems

TREATMENT OF PHARMACEUTICAL WASTE WATER

Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing – Petroleum Refining – Pharmaceuticals – Sugar and Distilleries – Food Processing – fertilizers – Thermal Power Plants and Industrial Estates.

WASTEWATER REUSE AND RESIDUAL MANAGEMENT

Individual and Common Effluent Treatment Plants – Joint treatment of industrial wastewater - Zero effluent discharge systems - Quality requirements for Wastewater reuse – Industrial reuse – Disposal on water and land – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – Thickening, digestion, conditioning, dewatering and disposal of sludge – Management of RO rejects.

TEXTBOOKS

1. Tchobanoglous, G., Metcalf & Eddy, Burton, Stensel, D.H. Waste water Engineering Treatment and Disposal and Reuse, McGraw-Hill Companies, New York, 4th Edition, 2002
2. Lepathak, Water Pollution Management Hand Book, Blackwell Publishing, San Diego, 4th Edition, 2000

REFERENCES

1. Arceivala, Waste Water treatment for pollution control, MGH, New York, 2nd Edition, 1998
2. Tchobanoglous, G., Burton, F. L., Stensel, H.D., Wastewater engineering: Treatment and reuse, TMH, London, 4th Edition, 2003
3. Mattock, G., Ellis Horwood, New Processes of Waste water treatment and recovery, Ellis Horward, New York, 4th Edition, 2000
4. Jogdand, Environmental Biotechnology, Himalaya Publishing House, New Delhi, 3rd Edition, 1995
5. Paul L. Bishop Pollution Prevention: - Fundamentals and Practice, McGraw-Hill International, 2000.

PBT6018	BIOCONJUGATE TECHNIQUES	L	T	P	C
		3	0	0	3

FUNCTIONAL TARGETS

Modification of Amino acids, peptides and proteins – Modification of sugars, polysaccharides and glycoconjugates – modification of nucleic acids and oligonucleotides

CHEMISTRY OF ACTIVE GROUPS

Amine reactive chemical reactions – Thiol reactive chemical reactions – carboxylate reactive chemical reactions – hydroxyl-reactive chemical reactions – aldehyde and ketone reactive chemical reactions – Photoreactive chemical reactions

BIOCONJUGATE REAGENTS

Zero-length cross linkers – Homobifunctional cross linkers – Heterobifunctional cross linkers – Trifunctional cross linkers – Cleavable reagent systems – tags and probes

ENZYME AND NUCLEIC ACID MODIFICATION AND CONJUGATION

Properties of common enzymes – Activated enzymes for conjugation – biotinylated enzymes – chemical modification of nucleic acids – biotin labeling of DNA- enzyme conjugation to DNA – Fluorescence of DNA.

BIOCONJUGATE APPLICATIONS

Preparation of Hapten-carrier Immunogen conjugates - antibody modification and conjugation – immunotoxin conjugation techniques – liposome conjugates and derivatives- Colloidal – gold-labeled proteins – modification with synthetic polymers.

TEXT BOOK

1. Hermanson, G.T., Bioconjugate Techniques, Academic Press, San Diego, 4th Edition, 2008.

REFERENCE

1. Meares, C.F., Perspectives in Bioconjugate Chemistry, ACS Publications, Washington DC, 2nd Edition, 1993.

PBT6019	BIOLOGICAL SCREENING OF DRUGS	L	T	P	C
		3	0	0	3

PRE-CLINICAL EVALUATION

Natural drug screening and its importance - CPCSEA and OECD guidelines to conduct experiments - Design and general facilities to maintain animals - Common lab animal- Description, handling and applications - Transgenic animals: Production, maintenance and applications

SCREENING PROCEDURES FOR HERBAL DRUGS

Screening methods for Anti-hypertensive - Antioxidant - Antipyretic & anti-inflammatory, Antiepileptic – Antidepressant, Antidiabetic, Anticancer - Anti-fertility, Anti-ulcer, Antiviral, antibacterial and antifungal, Antihepatotoxic, Immunomodulatory, Osteoporosis and Nephroprotective

CLINICAL TRIALS

ICH & ICMR guidelines to conduct clinical trials - Fundamentals of clinical trials: Protocols, volunteers, informed consent - ethical committee, design (single blind, double blind, cross over and randomization – placebos and controlled studies

PHASED TRIALS

Objectives, methods and execution of phase I, Phase II, Phase III & Phase IV trials

HIGH THROUGHPUT SCREENING OF NATURAL PRODUCTS

Introduction – methods used, and applications of high throughput screening

TEXTBOOKS

1. Remington, J.P, Gennaro, A.R., Remington's Pharmaceutical Sciences, Mack Publishers, Easton, 17th edition, 1985.
2. Laurence, D.R., Bacharach, A. L., Evaluation of drug activities Pharmacometrics Vol 1 and 2, Academic Press, London, 2nd Edition, 1969.

REFERENCES

1. Novel approaches to plant drug discovery based on high throughput pharmacological screening and genetic manipulation, Littleton, J., Rogers, T., Falcone, D., Springer, Life Sciences, 2005 Dec 22; 78(5): 467-75.
2. Atkins, P.W., Julio D. P., Physical Chemistry, W.H. Freeman & Co, New York, 8th Edition, 2006
3. Fleiss, J.L., The design and analysis of Clinical Trials, Wiley, New York, 3rd Edition, 2004.

PBT6020	INTELLECTUAL PROPERTY RIGHTS IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

INTRODUCTION TO IPR

Invention and creativity - Intellectual Property (IP), importance - Protection of IPR - Basic types of property (movable property, immovable property and intellectual property)

PATENTS IN IPR

Patents - Copyrights and related rights - Trademarks and rights arising from Trademark registration - Definitions - Industrial designs and integrated circuits - Protection of geographical indications at national and international levels - Application procedures, PBR. IPR for bioprocess and bioproducts

INTERNATIONAL CONVENTION RELATING TO INTELLECTUAL PROPERTY

Establishment of WIPO - Mission and activities - History - General agreement on Trade and tariff (GATT) - WIPO copyright treaty (WCT)

INDIAN POSITION VS WTO AND STRATEGIES

Indian IPR legislations - Commitments to WTO - Patent ordinance and the bill - draft of a national intellectual property policy – Protection against unfair competition

IPR TRANSACTIONS AND TECHNOLOGY TRANSFER CONTRACT

Various types of contracts - Assignment, lease and license - conditionality, drafting of technology transfer contract and global sharing of technology - Confidentiality and proper use, further innovation and invention - Ever-greening chain

TEXT BOOKS

1. Carlos, C., Trade Related aspects of IPR, a Commentary on TRIPS agreement, Oxford University Press, USA, 1st Edition, 2007
2. Cornish, W.R., Intellectual Property- Patent, Copyright Trademarks and Allied rights, Sweet and Maxwell, USA, 5th Revised Edition, 2005

REFERENCES

1. Intellectual Property Today: [www.iptoday.com].
2. Eli Whitney, United States Patent Number: 72X, Cotton Gin, March 14, 1794.
3. Oakland, J.S., Total Quality Management, Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 1989.
4. Narayana V., Sreenivasan, N.S., Quality Management – Concepts and Tasks, New Age International, New Delhi, 2nd Edition, 1996.
5. Zeiri., Total Quality Management for Engineers, Wood Head Publishers, 1993.

PBT6021	NOVEL DRUG DELIVERY SYSTEMS	L	T	P	C
		3	0	0	3

SUSTAINED RELEASE DRUG DELIVERY SYSTEMS (SRDDS)

Introduction - rationale of SRDDS - advantages and disadvantages of SRDDS - factors influencing the design and performances of SRDDS – physicochemical properties of a drug influencing design and performance - biological factors influencing design and performance of SRDDS - routes of drug administration of SRDDS - micro encapsulation - different micro-encapsulation processes, - advantages - disadvantages and applications - polymers used in SRDDS – classification and applications in formulation - system design for rate-controlled drug delivery - feedback - regulated drug delivery systems, *in vitro* and *in vivo* evaluation of controlled released drug delivery

PARENTERAL CONTROLLED RELEASE DRUG DELIVERY SYSTEMS

Approaches for injectable controlled release formulations - development of injectable controlled - release formulations – long-acting penicillin preparations – long-acting Insulin

preparations - long acting steroid preparations and long-acting contraceptive preparations - approaches and applications of implantable drug delivery systems

ORAL CONTROLLED RELEASE SYSTEMS

Design and development of oral controlled-release drug administration - dissolution controlled – diffusion-controlled - membrane permeation controlled - osmotic pressure controlled - gel diffusion-controlled - pH controlled - ion - exchange controlled delivery systems - prolongation of GI retention of oral drug delivery system

TRANSDERMAL AND MUCOADHESIVE DRUG DELIVERY SYSTEMS

Permeation through skin, factors affecting permeation, basic components of TDDS, formulation approaches used in development of TDDS and their evaluation, permeation enhancers - buccal drug delivery system - structure of oral mucosa - trans-mucosal permeability - mucosal membrane modules - permeability enhancers – *in vitro* and *in vivo* methods for buccal absorption - buccal strips - nasal drug delivery systems - physiology of nose - fundamentals of nasal absorption - distribution of drug in the nasal cavity - enhancement of absorption – *in vitro* and *in vivo* methods for determination of nasal absorption - applications of nasal drug delivery systems - pulmonary drug delivery system and its applications

OCULAR AND TARGETED DRUG DELIVERY SYSTEM

Preparation and evaluation of ocular controlled drug delivery systems - ophthalmic inserts and insitu gels – targeted drug delivery systems – concepts - targeting of drugs through nanoparticles, liposome - resealed erythrocytes – microspheres - magnetic microspheres and monoclonal antibodies - brief study of colon targeting

TEXTBOOK

1. Mathiowitz, E., Encyclopedia of Controlled Delivery, John Wiley, New York, 3rd edition, 2007.
2. Jain, N.K, Controlled and Novel Drug Delivery, CBS, New Delhi, First edition, 1997 (reprint in 2001).

REFERENCES

1. Vyas, S.P., Khar, R.K., Controlled Drug Delivery - Concepts and Advances, Vallabh Prakashan, New Delhi, First edition, 2002.
2. Remington, J.P, Gennaro, A.R., Remington's Pharmaceutical Sciences, Mack Publishers, Easton, 17th edition, 1985.
3. Robinson, J.R., Lee, V.H.L, Controlled Drug Delivery - Fundamentals and Applications, Marcel Decker, 2nd edition, 1987.

PBT6022	HERBAL DRUG DEVELOPMENT AND STANDARDIZATION	L	T	P	C
		3	0	0	3

GENERAL METHODS OF PROCESSING OF HERBS

Definition, sources, identification and authentication of herbs - Different methods of processing of herbs like collection, harvesting and garbling - packing and storage conditions - Methods of drying – Natural and artificial drying methods, with their merits and demerits.

METHODS OF PREPARATION OF EXTRACTS

Principles of extraction and selection of suitable extraction method - Different methods of extraction including maceration, percolation, hot continuous extraction, pilot-scale extraction and supercritical fluid extraction with their merits and demerits - Purification and recovery of solvents

STANDARDIZATION OF HERBAL RAW MATERIALS AND EXTRACTS

Standardization of herbal raw materials, including pharmacognostical, physical, chemical and biological methods with examples - Standardization of herbal extracts, physical, chemical and spectral analysis - Qualitative and Quantitative estimation of active principles from standardized extracts by HPTLC - Biological standardization -Pharmacological screening of herbal extracts and Microbiological evaluation of herbal extracts - Toxicity studies of herbal extracts.

ISOLATION AND ESTIMATION OF PHYTOCONSTITUENTS

Different methods (including industrial) for isolation and estimation of phytoconstituents from the following drugs (with special emphasis on HPLC and HPTLC) - Hypericin / Hyperforin from Hypericum species - Forskoline from Coleus forskoli - Catechins from Green tea - L-hydroxy citric acid from Garcinia combogia - L-Dopa from Mucuna pruriens.

Andrographolides from Andrographis paniculata - Alicin from Garlic - Piperine from Piper nigrum / Piper longum - Bacosides from Bacopa monnieri - Berberine from Berberis aristata

HERBAL FORMULATION DEVELOPMENT

Selection of herbal ingredients - Different dosage forms of herbal drugs - Evaluation of different dosage forms - Stability studies of herbal formulations.

TEXTBOOKS

1. Choudhary,, R.D., Herbal Drug Industry, Eastern publisher, New Delhi, 1st Edition, 2004
2. Mukarjee, P.K., Quality Control of Herbal Drugs, Business horizons Pharmaceutical publisher, 1st Edition New Delhi, 2002.

REFERENCES

1. Wagner, H., Bladt, S., Plant Drug Analysis, Springer, New York, 2nd Edition, 1996.
2. Barn, J.N., Biological Standardization, Oxford University Press, London, 2nd Edition, 1950.

3. Kokate, C.K., Purohit, Gokhlae, Text Book of Pharmacognosy, Nirali Prakashan, New Delhi, 4th edition, 1996.

PBT 6023	NANOBIOTECHNOLOGY AND APPLICATIONS IN HEALTH CARE	L	T	P	C
		3	0	0	3

NANOTECHNOLOGY IN PHARMACEUTICAL APPLICATIONS

Human anatomy – Form, function and physiology – Developmental prolog - principle of development – Neurophysiology – sensory physiology and muscle physiology - Trends in nanobiotechnology - Protein- and peptide-based compounds for cancer, diabetes, infectious diseases and organ transplant- therapeutic classes- focused pharmaceutical delivery systems

IMMUNOASSAY TECHNIQUES

Understanding of antibody-based diagnostic techniques (immunoassay) - micro- and nano-immunosensors- Bio-Barcode Assay- use of magnets, gold, DNA and antibodies- therapies and diagnostics for cancer and central nervous system disorders

IMPROVED MEDICAL DIAGNOSTICS

Improved diagnostic products and techniques- *in vivo* imaging capabilities by enabling detection of tumors, plaques, genetic defects and other disease states-ability to control or manipulate on the atomic scale- Nanobot medical devices- logic and intelligence embedded into medical devices- standalone sensing and computing devices.

Methods for diagnosis

Animation of the PCR - DNA Profiling - Cantilever Sensors - Targeted Drug Delivery - Magnetic Nanoparticles - Cancer cell targeting - Stem Cell Scaffolds - Electrochemical Impedance Spectroscopy (EIS) - Tethered Lipid Membranes

PROSTHETIC AND MEDICAL IMPLANTS

New generations of prosthetic and medical implants- artificial organs and implants- artificial scaffolds or biosynthetic coatings- biocompatibility and reduced rejection ratio- retinal, cochlear, and neural implants, repair of damaged nerve cells, and replacement of damaged skin, tissue, or bone.

BIOMIMICRY

Principles of biomimicry and biologically inspired design, Biomimetic materials, Biologically inspired guidance/sensing and movement systems, System design and optimization, Green technologies

TEXT BOOK

Chemical Sensors and Biosensors; Brian, R Eggins; Wiley; New York, 2002

REFERENCES

1. Biosensors and modern biospecific analytical techniques, Wilson & Wilson's Comprehensive Analytical Chemistry; Ed. L Gorton; Elsevier, Amsterdam, London; 2005.
2. The Immunoassay Handbook; Ed. David Wild; 3rd ed.; Amsterdam: Elsevier; 2005.
3. Electrochemical Methods: Fundamentals and Applications; Allen J Bard and Larry R Faulkner; Wiley, New York, Chichester : 3rd ed.; 2006.
4. Ultrathin Electrochemical Chemo- and Biosensors: Technology and Performance in Springer Series on Chemical Sensors and Biosensors; Volume Two; Ed. Vladimir M. Mirsky; Springer, Berlin; 2004

PBT6024	PHARMACOGENETICS AND PHARMACOGENOMICS	L	T	P	C
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PHARMACOGENETICS: LINKAGE AND ASSOCIATION ANALYSIS

Classic examples of pharmacogenetics – pedigrees - recessive traits - positional cloning of drug-induced arrhythmia gene (Long QT) - genetic polymorphisms and maps - association analysis - beta receptor polymorphism - criteria for successful association analysis (power analysis, choice of cases and controls, Hardy - Weinberg equilibrium), application to pharmacogenetics - candidate gene versus whole genome association studies - haplotypes versus individual markers

PHARMACOGENETICS HEALTHCARE: ETHICS AND CLINICAL STUDY DESIGN

Cost of pharmacogenetic testing to process and to costs, types of clinical protocols, consent forms, the Committee on Human Research, ethical implications of pharmacogenetic studies

MODEL ORGANISMS IN PHARMACOGENETIC STUDIES

Use of yeast, *C. elegans*, zebrafish and mice in pharmacogenetic studies

PHARMACOGENOMICS

Expression arrays to study drug response - SNP genotyping methods and technology - Pharmacokinetics and pharmacodynamic factors involved in drug response, gender and ethnic differences in drug response, molecular mechanisms for alterations in drug response - drug metabolizing enzymes - Thiopurine methyltransferase deficiencies, pedigree analysis, autosomal recessive traits, CYP 2D6 polymorphisms, genetic basis of polymorphisms, effects on drug response - Drug transporters - MDR1 studies in knockout mice, human polymorphisms, effects on drug response, haplotypes, other transporter polymorphisms – transcription factors - nuclear receptors, PXR, FXR, CAR

THE HUMAN GENOME

Organization and structure of genomes - genetic data and the internet - nNavigating the National Center for Biotechnology Information (NCBI) - navigating the Pharmacogenetics and Pharmacogenomics Knowledge Base (PharmGKB) - genome evolution mechanisms of

gene duplication and development of gene families - paralogs versus orthologs - genomes – diversity - size and structure genomic technologies - microarrays and quantitative PCR

TEXT BOOK

1. Elliot, S.V., Pharmacogenetics and Pharmacogenomics: Recent Conceptual and Technical Advances, Karger, Paris, 1st edition, 2001.

REFERENCES

1. Federico, I., Pharmacogenomics: Methods and protocols, Humana Press, New Jersey, 1st edition, 2005.
2. Selected review/research articles from International Journals

PBT6025	BIOSENSORS – PRINCIPLES AND APPLICATIONS	L	T	P	C
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INTRODUCTION

Historical perspective - Signal transduction - Physico-chemical and biological transducers - Sensor types and technologies - Main technical definitions - calibration, selectivity, sensitivity, reproducibility, detection limits, response time; Problems and trade-offs.

TRANSDUCERS

Electrochemical transducers (amperometric, potentiometric, conductimetric); Semiconductor transducers (ISFET, ENFET); Optical transducers (absorption, fluorescence, bio/chemiluminescence, SPR) - Thermal transducers - Piezoelectric and acoustic-wave transducers - Limitations & problems to be addressed; An Overview of Performance and Applications

BIORECOGNITION SYSTEMS

Enzymes - oligonucleotides and Nucleic Acids - Lipids (Langmuir-Blodgett bilayers, Phospholipids, Liposomes) - Membrane receptors and transporters – Immunoreceptors – Chemoreceptors - Immobilization of enzymes, peptides, antibodies, oligonucleotides and Nucleic Acids – Immobilization of cells

TYPES OF BIOSENSORS AND FABRICATION

Catalytic biosensors: mono-enzyme electrodes - bi-enzyme electrodes: enzyme sequence electrodes and enzyme competition electrodes - Affinity-based biosensors - Inhibition based biosensors – Cell based biosensors - Biochips and biosensor arrays

Methods for biosensors fabrication - self-assembled monolayers, screen printing, photolithography, micro contact printing, MEMS – nano materials for biosensors

APPLICATIONS OF BIOSENSORS

Clinical chemistry - Test-strips for glucose monitoring, Urea determination - Implantable sensors for long-term monitoring - Drug development and detection – Pathogen detection -

Environmental monitoring - Technological process control - Food quality control - Forensic science benefits

TEXT BOOKS

1. Brian Eggins, Chemical Sensors and Biosensors, John Willey & Sons, 2002
2. Kumar, C.S.S.R. (Ed.) Nanomaterials for Biosensors, John Wiley & Sons, 2007

REFERENCES

1. Jiri Janata, Principles of Chemical Sensors, Plenum Press, 1989.
2. Frontiers in Biosensors, Edited by: F. Schellr, F. Schubert, J. Fedrowitz, Birkhauser Verlag, 1995.
3. Optical Biosensors. Present & Future. Editors: F. Ligler, C. Rowe Taitt, Elsevier, 2002.
4. Alice Cunningham, Introduction to Bioanalytical Sensors, John Wiley& Sons, 1998.
5. Commercial Biosensors, Graham Ramsay Editor, John Wiley& Sons, 1998.