

ANNA UNIVERSITY TIRUCHIRAPPALLI

Tiruchirappalli – 620 024

Regulations 2008

Curriculum

M.TECH. BIOTECHNOLOGY

SEMESTER I

S.No.	Subject Code	Subject	L	T	P	C
Theory						
1	BT5101	Bridge Course*	4	0	0	4
2	BT5102	Biochemical Engineering	4	0	0	4
3	BT5103	Recombinant DNA Technology	3	1	0	4
4	MA5151	Applied Numerical Methods and Statistical Analysis	3	1	0	4
Practical						
5	BT5104	Biochemical Engineering Laboratory	0	0	6	3
6	BT5105	Microbiology and Recombinant DNA Technology Laboratory	0	0	6	3
Total						22

SEMESTER II

S.No.	Subject Code	Subject	L	T	P	C
Theory						
1	BT5151	Immunotechnology	4	0	0	4
2	BT5152	Advanced Bioprocess Engineering	4	0	0	4
3	BT5153	Industrial Management and Bioethics	4	0	0	4
4	E1****	Elective I	3	0	0	3
5	E2****	Elective II	3	0	0	3
Practical						
6	BT5154	Immunotechnology Laboratory	0	0	6	3
Total						21

SEMESTER III

S.No.	Subject Code	Subject	L	T	P	C
Theory						
1	BT5201	Cancer Biology	4	0	0	4
2	BT5202	Separation Process in Biotechnology	4	0	0	4
3	BT5203	Enzyme and Protein Engineering	4	0	0	4
Practical						
4	BT5204	Project Phase I (Institutional / Industrial)	0	0	12	6
Total						18

SEMESTER IV

S.No.	Subject Code	Subject	L	T	P	C
Practical						
1	BT5251	Project Phase II (Institutional / Industrial)	0	0	24	12
Total						12

* Microbiology and Molecular Biology for students with B.E. / B.Tech. Degree,
Principles of Chemical Engineering for students with M.Sc. Degree

Total Credits to be Earned for the Award of the Degree = 73

LIST OF ELECTIVES

ELECTIVE I

S.No.	Subject Code	Subject	L	T	P	C
Theory						
1	BT5051	Biopharmaceuticals	3	0	0	3
2	BT5052	Animal Biotechnology	3	0	0	3
3	BT5053	Nanobiotechnology	3	0	0	3

ELECTIVE II

S.No.	Subject Code	Subject	L	T	P	C
Theory						
1	BT5054	Environmental Biotechnology	3	0	0	3
2	BT5055	Plant Biotechnology	3	0	0	3
3	BT5056	Genomics and Proteomics	3	0	0	3

ANNA UNIVERSITY TIRUCHIRAPPALLI

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Regulations 2007

Syllabus

M.TECH. BIOTECHNOLOGY

SEMESTER I

MICROBIOLOGY AND MOLECULAR BIOLOGY

Bridge Course – I (for B.E./B/Tech students)

L	T	P	C
4	0	0	4

UNIT I INTRODUCTION TO MICROBIOLOGY 9

Development – History and modern microbiology, structure of microbes – Taxonomy – Microscopy – Culturing of microorganisms – Characterization and identification.

UNIT II MICROBIAL GROWTH AND METABOLISM 7

Nutritional requirements, nutrient transport – Physical and gaseous requirements – Growth and control of growth – Energy and metabolism – Metabolic pathway.

UNIT III CONTROL OF MICROORGANISMS AND ENVIRONMENTAL APPLICATIONS 9

Drugs – Chemotherapy, antimicrobial agents and disinfectants – Diseases caused by microorganisms and control – Recycling of waste biomass – Production of biogas – Leaching of ores by microorganism – Application of biofertilizers and bio-pesticides – Bioremediation.

UNIT IV TRANSCRIPTION, TRANSLATION AND GENE REGULATION 11

Genetic material – Mechanism of replication – Different types in prokaryotes and eukaryotes – Mechanism of transcription in prokaryotes and eukaryotes – RNAs, RNA-polymerase, splicing, transcriptional factors and transcriptional inhibitors. Translation – Factors involved in translation, prokaryotic and eukaryotic translation machinery, co and post-translational modifications – Operon concept, types of operons.

UNIT V MOLECULAR DIAGNOSTICS AND THERAPEUTICS 9

Monoclonal antibodies – DNA diagnostic systems, molecular diagnostic of genetic diseases – RNAi – Cancer therapy – Gene silencing.

Total: 45

REFERENCES

1. Benjamin L., “Genes – VIII”, Oxford University Press, 2006.
2. Gregory J.H., “RNAi - A guide to Gene Silencing”, Cold Spring Harbour Laboratory Press, 2002.
3. Daniel L., “Microbiology”, Second Edition, WCB-McGraw – Hill, 2001.
4. <http://biowww.net/browse-1.html>

PRINCIPLES OF CHEMICAL ENGINEERING

Bridge Course – I (For M. Sc. Students)

L	T	P	C
4	0	0	4

UNIT I INTRODUCTION

5

Role of chemical engineering sciences in design and analysis of chemical processes – Overview of unit operations and processes in the chemical industry – Units and conversion factor – Introduction to dimensional analysis.

UNIT II MATERIAL AND ENERGY BALANCES

13

Overall and component material balances – Material balances without chemical reactions – Chemical reactions – Stoichiometry – Conversion and yield – Material balance calculations with chemical reactions – Combustion calculations – Recycle operations – Energy balances – Entropy – Latent heat – Chemical reactions – Combustion – Concepts of chemical thermodynamics, the relation to VLE, solution thermodynamics and reaction thermodynamics.

UNIT III FLUID MECHANICS

9

Properties of fluids – Fluid static forces at fluid surfaces – Pressure and measurement of pressure differences – Fluid flow concepts and basic equations of fluid flow continuity equation and Bernoulli's equation – Shear stress relationship and viscous effects in fluid flow – Non-Newtonian fluids, significance of dimensionless groups in fluid flow operations.

UNIT IV TRANSPORTATION OF FLUIDS

9

Different types of pumps, compressors and valves – Measurement of fluid flow using hydrodynamic methods, direct displacement method – Types of agitators, flow patterns in agitated vessels, calculation of power consumption – Applications in bioreactor design.

UNIT V HEAT TRANSFER

9

Nature of heat flow – Conduction, convection, radiation – Steady state conduction – Principles of heat flow in fluids – Heat transfer by forced convection in laminar and turbulent flow – Heat exchange equipments – Principles and design.

Total: 45

REFERENCES

1. McCabe W.L., Smith J.C. and Harriott P., "Unit Operations in Chemical Engineering", Seventh Edition, Tata McGraw-Hill, 2004
2. Geankoplis C.J., "Transport Processes and Unit Operations", Third Edition, Prentice Hall India, 2003.
3. <http://www.cbu.edu/~rprice/lectures>

BT5102 – BIOCHEMICAL ENGINEERING

L	T	P	C
4	0	0	4

UNIT I INTRODUCTION TO BIOSCIENCE 7

Types of Microorganisms – Structure and function of microbial cells – Fundamentals of microbial growth, batch and continuous culture – Isolation and purification of enzymes from cell – Assay of enzymes.

UNIT II FUNCTIONING OF CELLS AND FUNDAMENTAL MOLECULAR BIOLOGY 11

Metabolism and bio-energetics – Photosynthesis, carbon metabolism, EMP pathway, Tricarboxylic acid cycle and electron transport chain, aerobic and anaerobic metabolic pathways – Synthesis and regulation of biomolecules – Fundamentals of microbial genetics, role of DNA and RNA.

UNIT III ENZYME TECHNOLOGY AND KINETICS 9

Applied enzyme catalysis – Applications of enzymes in industry and medicine – Immobilization of enzymes – Kinetics of enzyme catalytic reactions involving isolated enzyme – Reversible inhibition.

UNIT IV REACTIONS CATALYZED BY ENZYMES, REACTORS, ANALYSIS 9

Reactor design and analysis for soluble enzyme systems – Cofactor regeneration – Membrane reactor – Effect of mass transfer in immobilized enzyme particle systems – Reactors for immobilized enzyme systems.

UNIT V BIO REACTORS, EFFECT OF TRANSPORT PROCESSES 9

Introduction to bioreactor design – Continuously stirred aerated tank bioreactors – Mixing power correlation – Determination of volumetric mass transfer rate of oxygen from air bubbles and effect of mechanical mixing and aeration on oxygen transfer rate, heat transfer and power consumption – Multiphase bioreactors and their applications – Downstream processing and product recovery in bioprocesses.

Total: 45

REFERENCES

1. Najafpour G., “Biochemical Engineering and Biotechnology”, Elsevier B.V., 2007.
2. Shuler M. L. and Kargi. F., “Bioprocess Engineering: Basic concepts”, Second Edition, Prentice Hall, 2001
3. Doran, P.M., “Bioprocess Engineering Principles”, Academic Press, 2000
4. http://www.engr.sjsu.edu/ckomives/Courses/Introduction%20to%20Biochemical%20Engineering_lecture_notes.htm

BT5103 – RECOMBINANT DNA TECHNOLOGY

L	T	P	C
3	1	0	4

UNIT I CLONING AND EXPRESSION OF GENES 10

Cloning vehicles – Restriction enzymes, restriction modification, linkers, adaptors, homopolymeric tailing, restriction mapping – Expression and purification of recombinant proteins – Prokaryotic and eukaryotic expression vectors – *In vivo* homologous recombination – Large scale expression and purification of proteins.

UNIT II LIBRARY CONSTRUCTION 8

cDNA and genomic DNA library construction and screening – Preparation of DNA, RNA probes – Immunoscreening and blotting techniques.

UNIT III SEQUENCING 10

Methodology – Chemical and enzymatic methods, automated sequence, genome sequencing methods – Top down approach, bottom up approach.

UNIT IV PCR AND MUTAGENESIS 7

PCR principle, applications, different types of PCR – Mutagenesis and chimeric protein engineering by PCR – RACE – Kunkel's method of mutagenesis.

UNIT V GENE TRANSFER AND GENE THERAPY 10

Introduction of foreign genes into plant and animal cells – Creation of transgenic plants and animal knockouts – Gene therapy, types and vectors.

L: 45 T: 15 Total: 60

REFERENCES

1. Primrose S.B., Twyman R.H. and Old R. W., "Principles of Gene Manipulation and Genomics", Seventh Edition, Blackwell Science, 2006
2. Winnacker E.L., "From Genes to Clones: Introduction to Gene Technology", Panima, 2003
3. Glick B.R. and Pasternak J.J., "Molecular Biotechnology: Principles and Applications of Recombinant DNA", Third Edition, ASM Press, 2003.
4. <http://homepages.strath.ac.uk/~dfs99109/BB211/BB211RDTLectMat.html>

MA5151 – APPLIED NUMERICAL METHODS AND STATISTICAL ANALYSIS

L	T	P	C
3	1	0	4

UNIT I TREATMENT AND ANALYSIS OF ENGINEERING DATA 9

Empirical law and curve fitting – Graphical representation – Method of group averages – The principle of least squares – Methods of moments – Numerical Integration (Trapezoidal and Simpson’s rule) and differentiation (Newton’s forward and backward difference formula).

UNIT II MATHEMATICAL BASIS OF MANAGERIAL DECISIONS 9

Solution of Numerical algebraic and transcendental equations (Bisection, Iterative, Regula-Falsi and Newton’s method) – Solutions of simultaneous linear algebraic equations – Gauss elimination. Gauss Jordan method, Crout’s method, Gauss jacobi, Gauss seidal – Ordinary differential equation (Tailor’s, Euler’s and Runge kutta method).

UNIT III STATISTICAL ANALYSIS 9

Definition of random variables, Binomial distribution, Poisson distribution, Normal distribution – Application to business situation – Application of SPSS techniques using 10.0 version.

UNIT IV THEORY OF SAMPLING AND SAMPLING METHODS 9

Simple random sampling – Stratified random sampling, Systematic sampling, Cluster sampling – Testing of hypothesis and theory of inference – Type I and II errors – Concept of sampling distribution – Test of significance for means, proportions and standard deviations of large samples.

UNIT V THEORY OF CORRELATION AND REGRESSION 9

Meaning of correlation and regression, Principles of least squares – Simple linear regression – Simple correlation – Co-efficient rank correlation.

L: 45 T: 15 Total: 60

REFERENCES

1. Gupta S.C. and Kapoor V.K., “Fundamentals of Applied Statistics”, Sultan Chand & Sons, 2002.
2. Rao S.S., “Applied Numerical Methods for Engineers and Scientists”, First Edition, 2002.
3. http://www.pp.rhul.ac.uk/~cowan/stat_course.html

BT5104 – BIOCHEMICAL ENGINEERING LABORATORY

L	T	P	C
0	0	6	3

LIST OF EXPERIMENTS

1. Cell fractionation based on density gradient
2. Cheese production from milk
3. Enzymes in laundry detergents
4. Cellulose degradation
5. Cell immobilization with calcium alginate
6. Batch heat sterilization and thermal death kinetics
7. Beer fermentation (recipes)
8. Yogurt fermentation with lactobacillus cultures
9. Batch submerged fermentation of baker yeast in a shaker flask
10. Continuous immobilized enzyme reactor
11. Study of rheology of fermentation broth and power determination
12. CNBr immobilization procedure
13. Enzyme kinetics of invertase via initial rate determination
14. Starch hydrolysis by amylase
15. Enzyme purification by isoelectric precipitation

Total: 45

**BT5105 – MICROBIOLOGY AND RECOMBINANT DNA TECHNOLOGY
LABORATORY**

L T P C
0 0 6 3

LIST OF EXPERIMENTS

1. Sterilization techniques
2. Different methods of isolation of microorganisms
3. Isolation and identification of microorganisms from environmental samples
4. Isolation and identification of microorganisms from biological materials
5. Autotrophic mutant selection
6. Genomic DNA isolation and purification
7. Plasmid DNA isolation and purification
8. Electrophoresis
9. Sodium-dodecyl polyacrylamide gel electrophoresis (SDS-PAGE)
10. Polymerase chain reaction (PCR)
11. Transformation of *E. coli* competent cells
12. Selection of recombinants by restriction mapping
13. Blotting techniques (Southern, Northern, Western).

Total: 45

SEMESTER II

BT5151 – IMMUNOTECHNOLOGY

L	T	P	C
4	0	0	4

UNIT I INTRODUCTION 12

Cells of the immune system and their development – Primary and secondary lymphoid organs – Humoral immune response – Cell mediated immune responses – Complement.

UNIT II ANTIBODIES 10

Monoclonal antibodies and their use in diagnostics – ELISA – Agglutination tests – Antigen detection assay – Plaque forming cell assay.

UNIT III CELLULAR IMMUNOLOGY 12

PBMC separation from the blood – Identification of lymphocytes based on CD markers – FACS – Lymphoproliferation assay – Mixed lymphocyte reaction – Cr5I release assay – Macrophage cultures – Cytokine bioassays, IL2, IFN γ , TNF α ; HLA typing.

UNIT IV VACCINE TECHNOLOGY 6

Basic principles of vaccine development – Protein based vaccines – DNA vaccines – Plant based vaccines – Recombinant antigens as vaccines – Reverse vaccinology.

UNIT V DEVELOPMENT OF IMMUNOTHERAPEUTICS 5

Engineered antibodies – Catalytic antibodies, idiotypic antibodies – Combinatorial libraries for antibody isolation.

Total: 45

REFERENCES

1. Goldsby R.A., Kindt T. J., Kuby J. and Osborne B. A., “Immunology”, Fifth Edition, W H Freeman, 2003.
2. Roitt I., Brostoff J. and Male K.D., “Immunology”, Sixth Edition, Mosby, 2001.
3. <http://www.cehs.siu.edu/fix/medmicro/genimm.htm>

BT5152 – ADVANCED BIOPROCESS ENGINEERING

L	T	P	C
4	0	0	4

UNIT I CULTIVATION AND PRODUCT DEVELOPMENT 8

Culture phases, Monod kinetics, Michaelis-Menten kinetics – Modifications, cell and product recovery and purification techniques – Micro and macro scale production – Fermentation of ethanol – Antibiotics – Biofertilizer – Biosurfactants – Industrial enzymes – Interleukins – Interferon – Lymphokines.

UNIT II PROCESS CONTROL AND APPLICATIONS 8

Biologically important set points and their importance – Process parameters – Controllable parameters – Types of controls, monitoring, control-loops, feed back and feed forward, self adapting controllers, expert system approach.

UNIT III BIOPROCESSES OPTIMIZATION AND DESIGN AND OPERATION OF BIOREACTORS 8

Identification of process parameters, quantification and correlation development, statistical optimization, operation research, process economics – Design and analysis of packed bed and membrane bioreactors – Design and operation of novel bioreactors, air lift loop reactors, fluidized bed and trickle bed bioreactors.

UNIT IV BIOPROCESS CONSIDERATIONS IN ANIMAL AND PLANT CELL CULTURE 8

Animal cell cultures – Methods used for the cultivation of animal cells, bioreactor consideration and products. Plant cell cultures – Comparison to microbes, bioreactor considerations – Economics of tissue culture.

UNIT V ADVANCED BIOPROCESS IN GENETIC ENGINEERING 8

Genetically engineered organism, guidelines for choosing host, vector systems, process constraints, genetic instability – Medical applications – Tissue engineering – Gene therapy using viral vectors – Bioreactors.

L: 40 T: 5 Total: 45

REFERENCES

1. Shuler M. L. and Kargi. F., “Bioprocess Engineering: Basic concepts”, Second Edition, Prentice Hall, 2001
2. Ward O.P., “Fermentation Biotechnology”, Open University Press, 2002.
3. Atkinson. P. and Mavitona F., “Biochemical Engineering and Biotechnological Hand Book”, McGraw Hill, UK, 2000.
4. <http://www.staff.ncl.ac.uk/jarka.glassey/biotech2.htm>

UNIT I STRATEGIC MANAGEMENT 9

Scientific organizations under government of India – PASTER program aimed at technological self-reliance – Management strategy – Operational strategy – Strategic Vs tactical planning – globalization – Open-economy – Strategic alliances – Enterprise resource planning – Mission statement – Environmental appraisal – Opportunities and threats – Organizational appraisal – Generic strategy alternatives – Stability expansion – Modernization / diversification / merger, take-over and liquidation strategies – Strategy evaluation and correction – Strategy implementation – Knowledge management.

UNIT II TECHNOLOGY ACQUISITION AND MARKETING 9

Technological indicators – Make Vs buy decisions – Techno market survey – Assessment and evaluation of technology – Case studies – Methodology of technology assessment – Technology evaluation parameters – Identification of core competence – Technology absorption and diffusion – Constraints in technology absorption – Management of technology absorption – Importance of diffusion – Knowledge management – New product development strategies.

UNIT III TECHNOLOGY MANAGEMENT 9

Models of technology transfer – Technology search strategy – Dimensions of technology transfer – Features of technology package – Routes of technology transfer – Technology absorption capabilities of recipient enterprise – Competence of know-how supplier – Pricing of technology – Technology transfer agreements – Code of conduct for technology transfer – Government initiative and technology transfer and defense experiences and models.

UNIT IV BIOETHICS AND BIOSAFETY 9

Ethics in Biotechnology – Business ethics – Positive and negative effects, biosafety regulations national and international guidelines – rDNA Guidelines – IBSC guidelines and its scope – Biosafety levels, biosafety guidelines – Risk and assessment – Characterization of the organisms – Effects of pathogenicity, toxigenicity, allergenicity etc – Substantial equivalence – Effects related to gene transfer and marker genes – Ecological effects – Field testing of genetically modified organism, field trials and risk communication.

UNIT V INTELLECTUAL PROPERTY RIGHTS 9

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry, Types of patents – Patent Requirements – Application preparation, filing and prosecution – Patentable subject matter – TRIPS agreement. The requirements of TRIPS – Implementation in developing countries.

Total: 45**REFERENCES**

1. Stanley S.A., “Bioethics”, Wisdom educational service, 2008.
2. Taylor F.W., “The Principles of Scientific Management “, Kessinger Publishing, 2006.
3. <http://ocw.mit.edu/OcwWeb/Sloan-School-of-Management/15-568ASpring-2005/LectureNotes/>

BT5154 – IMMUNOTECHNOLOGY LABORATORY

L	T	P	C
0	0	6	3

1. Maintenance of laboratory animals
2. Collection of blood from various laboratory animals
3. Different immunodiffusion methods – Ouchterlony double immunodiffusion
4. Mancini single radial immunodiffusion
5. Immunoelectrophoresis – serum proteins
6. Rocket immunoelectrophoresis
7. NBT assay for macrophages
8. Immunization techniques – Preparation of soluble and particulate/cellular antigens
9. Haemagglutination and haemolysin titration assay
10. Separation and preservation of serum complements
11. Isolation and purification of antibodies

Total: 45

III SEMESTER

BT5201 – CANCER BIOLOGY

L	T	P	C
4	0	0	4

UNIT I CELL CYCLE AND CANCER 9

Cancer: Definition, causes, properties, classification, clonal nature – Cell cycle-phases, cyclins and CDKs, check points – Apoptosis – Extrinsic and intrinsic pathways, apoptosome and caspases – Relevance of apoptotic and anti-apoptotic factors in cancer.

UNIT II MECHANISM OF CARCINOGENESIS 9

Mechanism of carcinogenesis – Initiation, promotion and progression – Risk factors – Oncogenes-types, c-Myc, Ras, Bcl-2 family – Tumor suppressor genes – p53/TP53, INK4A/ARF, Rb protein pathways – Chemicals, radiation, environmental factors and viruses (HPV, EBV etc).

UNIT III TUMOR GROWTH 9

Metastasis, steps involved – Angiogenesis – Vascular growth and differentiation factors, EPH/EPHRIN signaling, NOTCH signaling, role of inhibitors – Tumor immunity - Tumor antigens and immunosurveillance.

UNIT IV SUSCEPTIBILITY TO CANCER 9

Genes conferring susceptibility to cancer, genetic instability – Types, sensing and repairing DNA damage, telomere attrition, aneuploidy – Telomeres and senescence – Cell-Matrix adhesion, cell-cell interaction, cell-cell signaling, malignancy – Role of cadherin, integrin, metalloproteinases and cell invasion.

UNIT V DIAGNOSIS AND TREATMENT 9

Diagnosis: Disease staging, tumor markers, FISH, Karyotyping, DNA microarrays, SNPs, CGH, proteomics tools (2D-gels, LC-MS, MALDI-TOF) and imaging techniques.

Treatment: Chemotherapy – Classification of cytotoxic drugs, alkylating agents and platinum drugs – Topoisomerase inhibitors – Radiotherapy – Gene therapy – Immuno therapy – Antigen specific and Adaptive therapy – Stem cell therapy.

Total: 45

REFERENCES

1. Ruddon R.W., “Cancer Biology”, Oxford University Press, Second Edition, 2007.
2. Weinberg R.A., “The Biology of Cancer”, Taylor & Francis, Garland Science, 2007.
3. Pelengaris S. and Khan M., “The Molecular Biology of Cancer”, Blackwell Publishing, 2006.
4. <http://employees.oneonta.edu/bachman/cancer/index.html>

BT5202 – SEPARATION PROCESS IN BIOTECHNOLOGY

L	T	P	C
4	0	0	4

UNIT I BIOPRODUCTS AND BIOSEPARATION – OVERVIEW 9

Broad classification of bioproducts – Small biomolecules – Macromolecules – Overview of bioseparations – Stages of downstream processing, basic principles of engineering analysis, process and product quality, criteria for process development – Cell lysis – Osmotic, chemical and mechanical methods of lysis – Flocculation – The electrical double layer, polymer flocculants.

UNIT II FILTRATION AND SEDIMENTATION 9

Filtration – Conventional and cross flow filtration, filter media and equipment, membrane fouling – Sedimentation – Principles, methods and coefficients, production centrifuges, ultracentrifugation, flocculation and sedimentation.

UNIT III EXTRACTION AND ADSORPTION 9

Extraction – Liquid-liquid extraction, solvent extraction principles, extraction process, operating modes of extraction, centrifugal extractors, aqueous two-phase extraction process and its application – Adsorption – Equilibrium and isotherms – Adsorption column dynamics – Fixed bed adsorption and agitated-bed adsorption.

UNIT IV CHROMATOGRAPHIC SEPARATIONS 9

Classification of chromatographic techniques – Chromatographic terms and parameters – Column chromatography – HPLC – Gel filtration chromatography – Ion exchange chromatography – Hydrophobic interaction chromatography – Reverse phase chromatography – Affinity chromatography.

UNIT V PRECIPITATION, CRYSTALLIZATION AND DRYING 9

Precipitation of proteins, methods, selective denaturation of unwanted proteins – Crystallization principles, batch crystallizers, crystallization of proteins, drying principles, dryer description and operation.

Total: 45

REFERENCES

1. Harrison R.G., Todd P.W., Rudge S. R. and Petrides D., “Bioseparations Science and Engineering “, Oxford University Press, 2003.
2. Ladisch M.R., “Bioseparations Engineering: Principles, Practice & Economics”, Wiley Interscience Publication, 2001.
3. Sivasankar B., “Bioseparations – Principles and Techniques”, Prentice-Hall of India, 2005.
4. <http://chemistry.ewu.edu/jcorkill/chrom/46600.htm>

BT5203 – ENZYME AND PROTEIN ENGINEERING

L	T	P	C
4	0	0	4

UNIT I **STRUCTURAL COMPONENTS OF ENZYMES** **9**

Amino acids – Properties of amino acids side chains, aminoacids as acid and bases, cation and metal binding, anion and polyanion binding, covalent bond formation – Peptide bond – Amino acid sequence or primary structure – Secondary structure – Tertiary structure – Subunits and quaternary structure – Cofactors in enzymes.

UNIT II **PROTEIN LIGAND BINDING EQUILIBRIA** **9**

Equilibrium dissociation constant – Kinetic approach to equilibrium – Binding measurements at equilibrium – Derivation of Langmuir isotherm, multiple binding sites – Graphic analysis of equilibrium ligand binding data – Equilibrium binding with ligand depletion (Tight binding interactions) – Competition among ligands for common binding site.

UNIT III **PROTEINS AND STRUCTURE DETERMINATION** **9**

Membrane proteins – Bacteriorhodopsin, photosynthetic centers – Fibrous proteins – Collagen, spider silk, actin and myosin – Serine proteases, ribonuclease and lysozyme – Methods of protein structure determination – X-ray diffraction, NMR and IR.

UNIT IV **ENGINEERING AND DESIGN OF PROTEIN STRUCTURES** **9**

Protein engineering to increase protein stability – Disulfide bridges, positive effects of glycine and proline, stabilizing the dipoles of α helices – Combinatorial methods, phage display, optimization of proteinase inhibitors by affinity and specificity – Structural scaffolds, random peptide libraries (EPO receptor) – DNA shuffling – β -structure conversion to α structure.

UNIT V **PROTEIN DATABASE ANALYSIS AND ENZYME BIOSENSORS** **9**

Protein database analysis – Enzyme biosensors – Design of enzyme electrodes and their application as biosensors in industry, healthcare and environment.

Total: 45

REFERENCES

1. Copeland R.A., “Enzymes – A Practical Introduction to Structure, Mechanism and Data analysis”, Second Edition, Wiley-VCH, 2000.
2. Branden C. and Tooze J., “Introduction to Protein Structure”, Second Edition, Garland Publishing, 1999.
3. Alberghina L., “Protein Engineering in Industrial Biotechnology”, Harwood Academic Publishers, 2000.
4. <http://www.bio.mtu.edu/campbell/401sch1.html>

ELECTIVE I

BT5051 – BIOPHARMACEUTICALS

L	T	P	C
3	0	0	3

UNIT I PHARMACEUTICALS OF BIOLOGICAL ORIGIN 9

Current status and future prospects of biopharmaceuticals – Pharmaceuticals of animal origin, plant origin and microbial origin – Sources of biopharmaceuticals.

UNIT II DRUG DEVELOPMENT PROCESS 9

Drug discovery – Gene chips, Proteomics, Structural Genomics, Pharmacogenetics – Plant as a source of drugs, microbial drugs – Pre-clinical trial – Pharmacokinetics and pharmacodynamics – Toxicity studies – Clinical trial, clinical trial design, trial size and study population – Randomized control studies.

UNIT III GROWTH FACTORS AND HORMONES 9

Haemopoietic growth factors – Granulocyte and macrophage colony stimulating factor – Insulin like growth factors – Epidermal growth factor – Platelet growth factor – Neurotrophic factors – Hormones of therapeutic interest – Insulin, glucagon – Human growth hormones – Gonadotrophins.

UNIT IV BLOOD PRODUCTS AND THERAPEUTIC ENZYMES 9

Disease transmission – Whole blood, platelets and red blood cells – Blood substitutes – Haemostasis – Antithrombin – Thrombolytic agents – Enzymes of therapeutic value.

UNIT V ANTIBODIES, VACCINES, ADJUVANTS AND ANTI-SENSE TECHNOLOGY 9

Polyclonal antibody – Monoclonal antibodies – Tumour immunology – Vaccine technology, Adjuvant technology – Anti-sense oligonucleotides, uses, advantages and disadvantages of ‘oligos’, vitravene, an approved antisense agent – Antigene sequences and ribozymes.

Total: 45

REFERENCES

1. Dutton R. and Scharer J., “Advanced Technologies in Biopharmaceutical processing”, Blackwell Publishing, 2007.
2. Gary W., “Biopharmaceuticals: Biochemistry and Biotechnology”, Second Edition, John Wiley, 2003.
3. <http://ocw.kyoto-u.ac.jp/en/pharmaceutical/course01/lecturenote.htm>

BT5052 – ANIMAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION 8

Scope of animal biotechnology – Structure and organization of Animal cells – Culture media, role of carbon dioxide, serum, growth factors in cell culture – Serum and protein free media and their applications – Application of animal cell culture.

UNIT II CELL CULTURE TECHNIQUE 10

Types of cell culture – Primary cells and cell line, organ culture, tissue culture, three dimensional culture and tissue engineering, feeder layers, cell synchronization, cryopreservation – Biology and characterization of cultured cells – Tissue typing, cell-cell interaction, apoptosis and its determination – Engineered cell culture as source of valuable products and protein production.

UNIT III MOLECULAR TECHNIQUES IN CELL CULTURE 9

Transformation – Physical, chemical and biological methods – Viral gene delivery systems – Manipulation of genes – Cell cloning, hybridoma technology and its applications – Cell fusion methods - Gene mapping, vaccine production, gene therapy, targeting, silencing and knockout technique.

UNIT IV ANIMAL CELL BIOREACTOR 8

Scaling up of animal cell culture – Various bio-reactors used for animal cell culture – Roller bottle culture – Bioreactor process control – Stirred animal cell culture – Air lift fermentor – Chemostat – Turbidostat.

UNIT V EMBRYOLOGY 10

Collection and preservation of embryos – Culturing of embryos – Embryo transfer technology – *In vitro* fertilization – Transgenesis methods of transferring genes into animal oocytes – Artificial insemination and embryo transfer – Embryonic stem cell and their applications – Biopharming transgenic animals (Mice, cows, pigs, sheep, goat, buds arid insects) – Transgenic animals as models for human diseases – Ethical issues in animal biotechnology.

Total: 45

REFERENCES

1. Freshney. R.I., “Culture of Animal Cells: A Manual of Basic Technique”, Fourth Edition, John Wiley & Sons Inc., 2000.
2. Mather J.P. and Barnes D., “Methods in Cell Biology – Animal Cell Culture Methods” Volume 57, Academic Press, 1998.
3. Butler M., “Mammalian cell biotechnology: A Practical Approach”, Oxford University Press, 1991.
4. <http://vein.library.usyd.edu.au/links/genetherapy.html>

BT5053 – NANOBIO TECHNOLOGY

L	T	P	C
3	0	0	3

UNIT I PROSPECT OF NANOMEDICINE 9

Nanomedicine and molecular nanotechnology – Nanomedicine history of the idea – Biological tradition – Mechanical tradition biotechnology and molecular nanotechnology.

UNIT II MICROFLUIDICS MEETS NANO: LAB-ON-A-CHIP DEVICES AND THEIR POTENTIAL FOR NANOBIO TECHNOLOGY 9

Concepts and advantages of microfluidic devices – Fluid transport – Stacking and sealing – Materials and methods for the manufacture of microfluidic component, fluidic structures, surface modifications.

UNIT III PROTEIN-BASED NANOSTRUCTURES 9

S-Layers – Engineered nanopores – Microbial nanoparticle production – Magnetosomes – Nanoscale magnetic iron minerals in bacteria – Nanoparticle-biomaterial hybrid systems.

UNIT IV DNA-BASED NANOSTRUCTURES 9

DNA-Protein nanostructures – Biomimetic fabrication of DNA-based metallic nanowires and networks – DNA-Gold nanoparticle conjugates – Nanoparticles as non-viral transfection agents.

UNIT V NANOANALYTICS AND CONTEMPORARY TOPICS 9

Common techniques available for the measurement of nanoparticles – Biochemical computers – Biomechanical computers – Organic and bioelectronic computers.

Total: 45

REFERENCES

1. Niemeyer C.M., and Mirkin C.A., “Nanobiotechnology: Concepts, applications, and perspectives”, Wiley-VCH Verlag GmbH and Co.KGaA.2004
2. Freitas Jr. R.A., “Nanomedicine”, First Edition, Volume IIA, Landes Biosciences, 2004.
3. http://www.chem.latech.edu/~ramu/msnt505/lec_notes/Ji/MSNT505_Ji_notes.html

ELECTIVE II

BT5054 – ENVIRONMENTAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

UNIT I BIOGEOCHEMISTRY 9

Microbial flora of soil – Interactions among soil microorganisms – Nitrogen cycle – Carbon cycle – Sulfur cycle – Phosphorous cycle – Nitrogen fixation by photosynthetic bacteria, cyanobacteria and methanogenic bacteria – Biotechnology in the reduction of carbon dioxide emission.

UNIT II BIODEGRADATION AND BIOREMEDIATION 9

Aerobic degradation of aliphatic and aromatic compounds – Co-metabolic degradation of organopollutants – Anaerobic degradation of aromatic compounds, halogenated organics and sulfonates – Biodegradation of herbicides and pesticides – Remediation technologies – Bioventing, biosparging and bioslurping, phytoremediation – Biodesulphurization of coal and oil – Microbial transformation of heavy metals, bioleaching, bioaccumulation, biosorption, and bioprecipitation of heavy metals.

UNIT III ECO-FRIENDLY BIOPRODUCTS FROM RENEWABLE SOURCES 9

Fundamentals of composting process – Composting technologies, composting systems, compost quality – Biofertilizers – Biopesticides – Scientific aspects and prospects of biofuel production – Bioethanol, biohydrogen, biodiesel – Bioplastics and biopolymers.

UNIT IV BIOLOGICAL TREATMENT OF WASTEWATER 9

Physico-chemical characteristics of wastewater – Activated sludge process – Trickling Filter – Rotating biological contactors – Fluidized bed reactor – Up-flow anaerobic sludge blanket reactor (UASB) – High-rate anaerobic wastewater treatment – Comparison between aerobic and anaerobic treatment processes – Algal photosynthesis in wastewater treatment.

UNIT V STOICHIOMETRY, KINETICS AND BIOREACTORS DESIGN 9

Basic mass balance – Oxidation-reduction reactions – Degree of reduction and mass balance – Design kinetics, mass balance and application of kinetics – Design of activated sludge process and anaerobic digestion system.

Total: 45

REFERENCES

1. Bhattacharya B.C. and Banerjee R., “Environmental Biotechnology”, Oxford University Press, 2007.
2. Jordening H.J. and Winter J., “Environmental Biotechnology: Concepts and Application”. Wiley –VCH Verlag GmbH & Co., 2005.
3. <http://www.uic.edu/classes/cmeng/cmeng525/>

BT5055 – PLANT BIOTECHNOLOGY

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION TO PLANT MOLECULAR BIOLOGY 5

Genetic material of plant cells – Nucleosome structure and its biological significance – Transposons – Recombinant DNA techniques – Outline of transcription and translation.

UNIT II CHLOROPLAST AND MITOCHONDRIA 9

Structure, function – Light and dark reaction and genetic material, rubisco synthesis and assembly, coordination, regulation and transport of proteins – Mitochondria genome – Cytoplasmic male sterility and import of proteins.

UNIT III PLANT METABOLISM AND METABOLIC ENGINEERING 9

Nitrogen fixation – Nitrogenase activity, nod genes, nif genes – Bacteroids – Plant nodulins – Production of secondary metabolites – Flavanoid synthesis and metabolic engineering.

UNIT IV AGROBACTERIUM AND PLANT VIRUSES 9

Pathogenesis – Crown gall disease, genes involved in the pathogenesis – Ti plasmid, T-DNA – Importance in genetic engineering – Plant viruses and different types – Viral Vectors – Gemini virus, cauliflower mosaic virus, viral vectors and its benefits – Molecular diagnosis of plant diseases.

UNIT V APPLICATIONS OF PLANT BIOTECHNOLOGY 13

Outline of plant tissue culture – Transgenic plants – Herbicide and pest resistant plants – Molecular pharming – Therapeutic products – Functional genomics – Whole genome sequencing project – e.g. Arabidopsis and RNAi.

Total: 45

REFERENCES

1. Taylor I.E.P., “Genetically Engineered Crops: Interim Policies, Uncertain Legislation”, Haworth Press, 2007.
2. Slater A., Scott N.W. and Mark R., “Plant Biotechnology: The Genetic Manipulation of Plants”, Oxford University Press, 2008.
3. <http://www.life.umd.edu/classroom/bsci124/lec41.html>

UNIT I OVERVIEW OF GENOMES OF BACTERIA, ARCHAE AND EUKARYOTA**9**

Genome of prokaryote – *E. coli* – Genome of eukaryote – *S. cerevisiae* Genome of *H. sapiens* – Protein coding sequence, repeat sequence – SNP basic concepts on identification of disease genes – OMIM database, reference genome sequence, integrated genomic maps – Gene expression profiling – Use of SNPs for identification of genetic traits – SNPs databases (DBSNP).

UNIT II PHYSICAL MAPPING TECHNIQUES**9**

Top down and bottom up approach – Linking and jumping of cloned genome sequencing placing small fragments on map – SI assembly – Gap closure – Pooling strategies – Cytogenetic mapping techniques – DNA microarray – Understanding of microarray data – Correlation of gene expression data to biological processes and computational analysis tools – Metabolic pathways – Databases such as KEGG, EMP.

UNIT III FUNCTIONAL GENOMICS**9**

Gene finding – Annotation – ORF and functional prediction – Subtractive DNA library screening – Differential display and representational difference analysis – SAGE, TOGA application of sequence based and structure based approaches to assign gene functions – e.g., sequence comparison, structure analysis (esp. active site, binding sites) and comparison, pattern identification, use of various derived databases in function assignment.

UNIT IV PROTEOMICS TECHNIQUES**9**

Protein level estimation – Edman protein micro sequencing – Protein cleavage – 2D gel electrophoresis – Metabolic labeling – Detection of proteins on SOS gels – Pattern analysis – Mass spectrometry principles of MALDI-TOF – Tandem MS-MS peptide mass fingerprinting.

UNIT V PROTEIN PROFILING**9**

Post translational modification – Glycoprotein analysis – Phosphoprotein analysis – Protein arrays – Basic principles of bioinformatics-based tools for analysis of proteomic data – Databases such as DIP, PPI server and tools for analysis of Protein-Protein interaction.

Total 45**REFERENCES**

1. Primrose S.B., Twyman R.H and Old R.W., “Principles of Gene Manipulation and Genomics”, Seven Edition, Blackwell Science, 2006.
2. Pennington S.R. and Dunn M. J., “Proteomics: From Protein Sequence to Function”, Viva Books, 2002.
3. Liebler D.C., “Introduction to Proteomics: Tools for the New Biology”, Humana Press, 2002.
4. <http://www.courses.fas.harvard.edu/~bphys101/lecturenotes/>