



ANNA UNIVERSITY
Chennai-25.
Syllabus for

B.Tech. Industrial Bio-Technology

IB331 Genetic Engineering

2 1 0 100

1 . BASICS OF RECOMBINANT DNA 10

Role of genes within cells, elucidation of the genetic code, genetic elements that control gene expression, method of creating recombinant DNA molecules, safety guidelines of creating recombinant DNA research, restriction enzymes and mapping of DNA, plasmid and phage vectors.

2 . CONSTRUCTION OF cDNA LIBRARIES 10

Characterization of recombinant clones by southern, Northern, Western and PCR analysis. Construction of genomic and cDNA libraries, methods of nucleic acid sequencing, factors involved in expression of cloned genes.

3 . APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY 10

Site-directed mutagenesis. Methods of gene transfer

a) To plant-agrobacterium mediated, using gene gun.

b) To animals-embryo transfer, eg. Dolly Applications of recombinant technology in agriculture, pharmaceutical industry and medicine.

. TUTORIALS 15

Total No of periods: 45

Text Book:

1. Old RW, Primrose SB, " *Principles of Gene manipulation, An Introduction to Genetic Engineering* ", Blackwell Science Publications, 1993.

References:

1. Ansubel FM, Brent R, Kingston RE, Moore DD, " *Current Protocols in Molecular Biology* ", Greene Publishing Associates, NY, 1988.
2. Berger SL, Kimmer AR, " *Methods in Enzymology* ", Vol 152, Academic Press, 1987.

1 .	10
Kinetics of Homogeneous reactions-searching for mechanism-Arrhenius equation-Batch reactor analysis for kinetics.	
2 .	10
Ideal reactors-Single reactor and multiple design	
3 .	9
Multiple reactions-parallel, series and series-parallel-Design Principles-Non Isothermal reactors and pressure effects.	
4 .	8
Non ideal flow-Non ideal flow models and reactor performance.	
5 .	8
Biochemical Reactions- Cell growth-Rate equations-Stoichiometry-Mass balance-Design Equations.	

Total No of periods: 45

Text Book:

1. *" Chemical Reaction Engineering " - Third Edition-Octave Levenspiel-John Wiley.*

References:

- 1 *H.Scott Fogler, " Elements of Chemical Reaction Engineering ", 2nd edition, Prentice Hall of India Pvt Ltd.*
- 2 *Charles D. Holland " Fundamentals of Chemical Reaction Engineering ", John Wukey and Sons, 1990.*
- 3 *J.M Smith, " Chemical Engineering Kinetics ", Mc Graw Hill, 1981.*

IB333 Mass Transfer and Separation**2 1 0 100****1 . 8**

Diffusion in gases, liquids and solids-Convective mass transfer and mass transfer coefficients.

2 . 10

Vapour-liquid equilibrium-Simple, steam and flash Distillation-Distillation with reflux-McCabe Thiete method and enthalpy-concentration method.

3 . 10S_{iq}-S_{iq} equilibrium staged and Continuous extraction-solid-liquid extraction-equilibrium relation and staged leaching.**4 . 9**

Adsorption-equilibrium-Batch and fixed bed Adsorption-Ion exchange process.

5 . 8Membrane separation processes-Types s_{iq} and gas-membrane processes-Complete mixing, cross flow and Counter current flow modls.**Total No of periods: 45**

Text Books:

1. Robert E. Treybal " *Mass Transfer Operation* ", 3rd edition, Mc Graw Hill International Editions.
2. Christi J. Genekoplis " *Transport Process and Unit Operations* ", 2nd Editions, Prentice Hall of India Pvt Ltd.

References:

1. King, C.Judson, " *Separation Processes* ", 2nd edition, McGraw-Hill Chemical Engineering Series.
2. Philip A Schweitzer " *Handbook of Separation Techniques for Chemical Engineers* ", 3rd Edition Mc Graw Hill.
3. Philip C. Wankat " *Rate-Controlled Separations* ", Chapman and Hall, 1985.

1 . ENZYME ISOLATION AND ASSAY OF ENZYMATIC ACTIVITY 12

Extraction of commercially important enzymes from natural sources; Development of enzyme assays ; quantification of enzyme activity and specific activity.

2 . ENZYME KINETICS 18

Estimation of Michaelis Menten parameters, Effect of pH and temperature on enzyme activity, kinetics of inhibition.

3 . IMMOBILISED ENZYME REACTIONS 30

Techniques of enzyme immobilisation-matrix entrapment, ionic and cross linking, column packing; Analysis of mass transfer effects of kinetics of immobilised enzyme reactions; Bioconversion studies with immobilised-enzyme packed -bed reactors.

4 . MICROBIAL CULTURE STUDIES 30

Culturing of different types of microorganisms(bacteria, yeast, fungi) used in the production of commercially important products; Formulation of simple and culture media; Estimation of biomass(dry weight); substrate and product analysis; Study of Growth, substrate utilisation and product formation kinetics i shake-flask cultures.

Total No of periods: 90

1. Isolation and visualisation of plasmids on agarose gels .
2. Restriction mapping and ligation
3. Transformation, Screening for recombinants, Chemical and transposon mutagenesis.
4. Selection of hyper producers of secondary metabolites
5. Characterisation of medium components
6. Characterisation of secondary metabolites by polyacrylamide gel electrophoresis silver staining of protein on gels and HPLC.

Total No of periods: 60

Reference:

1. Freifelder D, " Molecular Biology ", Jones and Bartlett Publishers Inc. 1987.

1 . WHAT IS BIOINFORMATICS 5

Scope of Bioinformatics-Elementary commands and Protocols, ftp, telnet, http. Primer on information theory.

2 . SEQUENCING ALIGNMENT AND DYNAMIC PROGRAMMING 10

Introduction-Strings-Edit distance two strings-string similarity local alignment gaps-parametric sequence alignments-suboptimal alignments-multiple alignment-common multiple alignment methods.

3 . SEQUENCE DATABASE AND THEIR USE 10

Introduction to databases-database search-Algorithms issues in database search-sequence database search-FASTA-BLAST-Amino acid substitution matrices PAM and BLOSSUM.

4 . EVOLUTIONARY TREES AND PHYLOGENY 10

Ultrasonic trees-parsimony-Ultrametric problem-perfect phylogeny-phylogenetic alignment-connection between multiple alignment and tree construction.

5 . SPECIAL TOPICS IN BIOINFORMATICS 10

DNA Mapping and sequencing-Map alignment-Large scale sequencing and alignment-Shotgun-DNA sequencing-Sequence assembly-Gene predictions-Molecular predictions with DNA strings

Total No of periods: 45

References:

1. Dan Gusfield, " *Algorithms on Strings Trees and Sequences* ", Cambridge University Press, 1997.
2. P.Baldi,S Brunak, *Bioinformatics; " A Machine Learning Approach "*, MIT Press, 1998.

1 . DESIGN AND ANALYSIS OF BIOREACTORS 12

Modelling of Non-Ideal Behaviour in Bioreactors, Tanks-in-series and Dispersion models-application to design of continuous stirrers; Design and operation of novel bioreactors -Air-lift loop reactors; Fluidized- bed bioreactors, Stability analysis of bioreactors.

2 . BIOREACTOR SCALE -UP 8

Regime analysis of bioreactor processes, Correlations for oxygen transfer. Scale up criteria for bioreactors based on oxygen transfer and power consumption.

3 . MONITORING OF BIOPROCESSES 12

On-line data analysis for measurement of important physico-chemical and biochemical parameters; Methods of on-line and off-line biomass estimation; microbial calorimetry; Flow injection analysis for measurement of substrates. Product and other metabolites; State and parameter estimation techniques for biochemical processes; Computer-based data acquisition, monitoring and control-LABVIEW Software.

4 . MODERN BIOTECHNOLOGICAL PROCESSES 4

Recombinant cell culture processes, guidelines for choosing host-vector systems, plasmid stability in recombinant cell culture, limits to over expression, Modelling of recombinant bacterial cultures; Bioreactor strategies for maximising product formation; Bioprocess design considerations for plant and animal cell cultures.

5 . MODELLING AND SIMULATION OF BIOPROCESSES 9

Study of Structured Models for analysis of various bioprocess; Model simulation using MATLAB-SIMULINK and ISIM software packages.

Total No of periods: 45

1 . THE IMMUNE SYSTEM	8
Introduction, Lymphocytes, their origin and differentiation, antigens, their structure and classification, complement and their biological functions, types of immune responses, anatomy of immune response.	
2 . HUMORAL IMMUNITY	8
B-Lymphocytes and their activation, structure and function of immunoglobulin, immunoglobulin classes and subclasses, genetic control of antibody production, mono-clonal antibodies and diagnosis, idiotypic and antibodies, major histocompatibility complex.	
3 . CELLULAR IMMUNOLOGY	8
Thymus derived Lymphocytes (T Cells) their classification antigen presenting cells (APC), macrophages, langerhans cells, their origin and function, mechanisms of phagocytosis, identification of cell types of immune system, immunosuppression, immune tolerance.	
4 . IMMUNITY TO INFECTION	7
Hypersensitivity reactions, mechanisms of T cell activation, cytokines and their role in immune response macrophage activation and granuloma formation.	
5 . TRANSPLANTATION	7
Graft rejection, evidence and mechanisms of graft rejection, prevention of graft rejection, immunosuppressive drugs, HLA and disease, mechanisms of immunity to tumour antigens.	
6 . AUTO IMMUNITY	7
Auto antibodies in humans, pathogenic mechanisms, experimental models of autoimmune disease treatment of auto immune disorders.	

Total No of periods: 45

Text Books:

1. *Roitt I, " Essential Immunology ", Blackwell Scientific Publications, Oxford, 1991.*
2. *Benjamin E and Leskowitz S, " Immunology - A Short Course ", Wiley Liss, NY, 1991.*

1 . 45

The legal and socioeconomic impacts of biotechnology, public education of the process of the processes of biotechnology involved in generating new forms of life for informed decision making Biosafety regulation and national and international guidelines r-DNA guidelines, Experimental protocol approvals, levels of containment Environmental aspects of biotech applications, Use of genetically modified organisms and their release in environment Special procedures for r-DNA based product production. Intellectual property rights, TRIPS, International conventions patents and methods application of patents, Legal implications, Biodiversity and farmers rights. Beneficial applications and development of research focus to the need of the poor, Identification of directions for yield effect in agriculture, aquaculture etc, Bioremediation.

Total No of periods: 45

References:

1. Sasson A, " *Biotechnologies and Development* ", UNESCO Publications, 1988.
2. Sasson A, " *Biotechnologies in developing countries present and future* ", UNESCO Publishers, 1993.
3. Singh K. " *Intellectual Property Rights on Biotechnology* ", BCIL, New Delhi.

IB345 Genetic Engineering Lab

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1. Preparation of DNA-genomic and plasmid.
2. Agarose gel electrophoresis.
3. Transfer to membrane (Southern)
4. Hybridisation
5. Expression of beta-galactosidase and assay.
6. RFLP analysis
7. Cloning of DNA into plasmid vector
8. Transformation
9. Selection of recombinants
10. plaque lift.

Total No of periods: 90

Reference:

1. Old RW and Primrose SB, " Principles of gene manipulation ", BlackWell Scientific Publications, 1992.

1. Isolation of useful micro-organisms from natural samples.
2. Growth of micro-organisms estimation of Monod parameters.
3. Temperature effect on growth-estimation of energy of activation and Arrhenius constant for micro-organisms.
4. Batch, fed batch and continuous cultures a) Estimation of Monod parameters. b) Pure and mixed cultures c) Production of Secondary metabolites in synthetic and complex industrial media.
5. Identification of growth factors transient pulse experiment.
6. Screening of process variables single dimensional search, blackett surman design, design expert etc.
7. Study of rheology of fermentation, broth and power determination

Total No of periods: 90

1 . COMPONENTS OF ENVIRONMENT 9

Components - Water, air and land - Inter-relationship between components - Subcomponents; Ecosystem - Structure and functional components of ecosystem - Development and evolution of ecosystem - Energy flow and material cycling in ecosystem - Natural and man made impacts on water, air and land; Environment and development - Concept of sustainable development.

2 . SCIENCE OF ENVIRONMENT 9

Chemistry, Physics and biology of water, air and land; Stress on the Chemistry, Physics and Biology of water, air and land owing to the impacts; Environmental quality objective and goals - Policies on development projects and their impacts, with emphasis on the branch of engineering of the student.

3 . CURRENT ENVIRONMENTAL ISSUES 9

Current Environmental issues at Country level - management of municipal sewage, municipal solid waste, Hazardous waste and Bio-medical waste - Air pollution due to industries and vehicles; Global issues - Biodiversity, Climatic change, Ozone layer depletion.

4 . ENGINEERING INTERVENTIONS TO REDUCE THE ENVIRONMENTAL STRESSES 9

Minimisation of Stress - Principles of Physics, chemistry and biology in engineering interventions such as waste treatment - Flow sheets of engineering interventions relevant to the Engineering discipline of the student - Waste minimisation techniques - Clean technology options - Standards of performance of the interventions.

5 . 9

(A) TOOLS FOR ENVIRONMENTAL MANAGEMENT 6

Environmental impact assessment; Precautionary Principle and Polluter Pays Principle; Constitutional provisions, Legal and economic instruments in Environmental Management; Role of Non-government organisations - Community participation environmental management works; International conventions and protocols; Pollution Control Boards and Pollution Control Acts.

(B) FIELD STUDY 3

In-depth study of environmental issues at least one environmentally sensitive site relevant to the discipline of the student and preparation of a report thereupon.

Total No of periods: 45

Text Books:

1. *G.M.Masters, " Introduction to Environmental Engineering & Science ", Prentice Hall, New Delhi, 1997*
2. *J.G. Henry and G. W. Heike, " Environmental Science & Engineering ", Prentice Hall International Inc., New Jersey, 1996.*

References:

1. *S. K. Dhameja, Environmental Engineering and Management, S. K. Kataria and Sons, New Delhi, 1999.*
2. *State of India's Environment - A Citizen's Report, Centre for Science and Environment and Others, 1999.*
3. *Shyam Divan and Armin Rosencranz, Environmental Law and Policy in India, Cases, Materials and Statutes, Oxford University Press, 2001.*

1 . ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' - variety of moral issues - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy - professions and professionalism - professional ideals and virtues - theories about right action - self-interest-customs and religion - uses of ethical theories

2 . ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as experimentation - engineers as responsible experimenters - codes of ethics-a balanced outlook on law-the challenger case study

3 . ENGINEER'S RESPONSIBILITY FOR SAFETY 9

Safety and risk - assessment of safety and risk - risk benefit analysis-reducing risk-the three mile island and Chernobyl case studies.

4 . RESPONSIBILITIES AND RIGHTS 9

Collegiality and loyalty - respect for authority - collective bargaining - confidentiality - conflicts of interest - occupational crime - professional rights - employee rights - intellectual property rights (IPR)-discrimination.

5 . GLOBAL ISSUES 9

Multinational corporations - environmental ethics-computer ethics-weapons development-engineers as managers-consulting engineers-engineers as expert witnesses and advisors-moral leadership-sample code of conduct.

Total No of periods: 45

Text Book:

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York 1996.

References :

- 1. Charles D. Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, 1999.*
- 2. Laura Schlesinger, "How Could You Do That: The Abdication of Character, Courage, and Conscience", Harper Collins, New York, 1996.*
- 3. Stephen Carter, "Integrity", Basic Books, New York, 1996.*
- 4. Tom Rusk, "The Power of Ethical Persuasion: From Conflict to Partnership at Work and in Private Life", Viking, New York, 1993.*

1 . ROLE OF DOWNSTREAM PROCESSING IN BIOTECHNOLOGY 6

Role and Importance of downstream processing in biotechnological processes. Problems and requirements of bioproduct purification. Economics of downstream processing in Biotechnology, cost -cutting strategies, characteristics of biological mixtures, process design criteria for various classes of bioproducts(high volume, low value products and low volume, high value products), physico-chemical basis of bioseparation processes.

2 . PRIMARY SEPARATION AND RECOVERY PROCESSES 12

Cell distribution methods for intracellular products, removal of insolubles, biomass(and particulate debris) separation techniques, flocculation and sedimentation, centrifugation and filtration methods.

3 . ENRICHMENT OPERATIONS 12

Membrane-based separations(micro and ultrafiltration theory, design and configuration of membrane separation equipment, applications, precipitation methods(with salts, organic solvents, and polymers, extractive separations, aqueous two phase extraction, supercritical extraction) insitu product removal, integrated bioprocessing.

4 . PRODUCT RESOLUTION/FRACTIONATION 9

Adsorptive chromatographic separations processes, electrophoretic (all electrophoresis techniques including capillary electrophoresis) hybrid separation technologies(membrane chromatography, electrochromatography etc).

5 . PRODUCT POLISHING 6

gel Permeation Chromatography, dialysis, Crystallisation.

Total No of periods: 45

References:

1. *Wankat P.C, " Rate Controlled Separations ", Elsevier, 1990.*
2. *Belter PA and Cussler E, " Bioseparations ", Wiley, 1985.*
3. *" Product Recovery in Bioprocess Technology ", BIOTOL Series, VCH, 1990.*
4. *Asenjo J.M, " Separation processes in Biotechnology ", 1993, Marcel Dekker Inc.*

1 . MICROSCOPY 7

Microscopic identification of various microorganisms; phase contrast and confocal microscopy; SEM-TEM microscopy.

2 . METHODS OF BIOCHEMICAL ANALYSIS 7

Glucose, sugars, carbohydrates, lipids, proteins and nucleotides; enzymatic assays of various metabolites.

3 . ELECTROPHORETIC TECHNIQUES 7

Electrophoresis of proteins and nucleic acids; ID & 2D Gels; pulsed-field electrophoresis; capillary electrophoresis; western blotting; gel documentation.

4 . NUCLEOTIDE AND DNA ANALYSIS 7

DNA purification, PCR-based analysis; DNA fingerprinting; DNA sequencing.

5 . IMMUNO-TECHNIQUES 8

Antiserum production, immunofluorescence, immunohistochemistry ELISA; location of cells in tissues immunoblotting; monoclonal antibodies.

6 . ANALYSIS OF BIOPROCESSES 9

Analysis of biomass; measurement of dry weight and biomass composition; analysis of substrate uptake and product formation rates; measurement of BOD and COD in wastewater; Gas analysis for O₂ and CO₂; flow injection analysis; computerised data acquisition of bioprocesses.

Total No of periods: 45

Reference:

1. Readings in Scientific American, W.H.Freeman, 1985-1993.

1 . STRUCTURE OF PROTEINS 15

Primary structure and its determination, secondary structure prediction and determination of supersecondary structure and domain in proteins, quaternary structure, methods to determine tertiary and quaternary structures, post translational modification.

2 . STRUCTURE FUNCTION RELATIONSHIP OF PROTEINS 15

DNA binding proteins, prokaryotic and eukaryotic transcription factors, DNA polymerases, Membrane proteins and receptors, bacteriorhodopsin, photosynthetic centres, epidermal growth factor, insulin and ODGF receptors and their interaction with effectors , protein phosphorylation, immunoglobulins, Nucleotide binding proteins, enzyme serine proteases, ribonuclease, lysozyme.

3 . PROTEIN ENGINEERING AND PROTEIN DESIGN 15

Protein data base analysis, methods to alter primary structure of proteins, examples of engineered proteins, protein design, principles and examples.

Total No of periods: 45

References:

1. Moody PCE, and AJ Wilkinson, " Protein Engineering ", IRL press, Oxford, 1990.
2. Creighton TE, Proteins, Freeman WH, Second Ed, 1993.
3. Branden C, Tooze R, " Introduction of protein structure ", Garland, 1993.

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Handling of animals/raising of antibodies, purification of antibodies/immunodiffusion, agglutination and precipitation, enzyme linked immunoabsorbant assay (ELISA), purification of lymphocytes from peripheral blood, identification of cell populations by rosettes, immunofluorescence, preparation of gels, types of electrophoresis.

Total No of periods: 60

Reference:

1. *Talwar GP and Gupta SK, " A handbook of practical and clinical immunology ", Vol 1 and 2, CBS Publications, 1992.*

IB435 Downstream Processing Lab

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Cell disruption techniques, solid-liquid separation methods-filtration, sedimentation, centrifugation, product enrichment operations, precipitation, ultrafiltration, two phase aqueous extraction, high resolution purification, preparative liquid chromatographic techniques, product crystallisation and drying.

Total No of periods: 60

Reference:

1. Scopes AK, " Protein Purification ", IRL Press, 1993.

1. INTRODUCTION**9**

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.

2. TQM PRINCIPLES**9**

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, PDCA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

3. STATISTICAL PROCESS CONTROL (SPC)**9**

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.

4. TQM TOOLS**9**

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.

5. QUALITY SYSTEMS**9**

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 BOOK:

1. Dale H.Besterfield, et al., Total Quality Management, Pearson Education Asia, 1999. (Indian reprint 2002).

REFERENCES:

1. James R.Evans & William M.Lindsay, The Management and Control of Quality, (5th Edition), South-Western (Thomson Learning), 2002 (ISBN 0-324-06680-5).
2. Feigenbaum.A.V. “Total Quality Management, McGraw-Hill, 1991.
3. Oakland.J.S. “Total Quality Management Butterworth – Heinemann Ltd., Oxford. 1989.
4. Narayana V. and Sreenivasan, N.S. Quality Management – Concepts and Tasks, New Age International 1996.
5. Zeiri. “Total Quality Management for Engineers Wood Head Publishers, 1991.