UNIVERSITY OF PUNE

B. Tech. Biotechnology

Third Year Syllabus (2008)

Structure for
T. E. Biotechnology (2008)

TERM – I

Subject Code No.	Subject	Teaching Scheme			Examination Scheme				**Total marks**
		Theory	Practical	TW/ Drawing	Paper	Practical	Oral	TW	
315461	Genetics Engineering	3	4		100	50		25	175
315462	Mass Transfer	4	2		100			50	150
315463	Heat Transfer	4	2		100			50	150
315464	Fermentation Technology I	4	2		100		25	50	175
315465	Computational Techniques and Biostatistics	3			100				100
		18	10		500	50	25	175	**750**

TERM – II

Subject Code No.	Subject	Teaching Scheme			Examination Scheme				**Total marks**
		Theory	Practical	TW/ Drawing	Paper	Practical	Oral	TW	
315466	Reaction Engineering	4	2		100			50	150
315467	Fermentation Technology II	4			100				100
315468	Bioseparation I	3	2		100	50			150
315469	Immunology and Diagnostics	3	2		100		50		150
315470	Bioinformatics & Management	4	2		100		25	25	150
315471	Seminar		2					50	50
		18	10		500	50	75	125	**750**

T.E. BIOTECHNOLOGY

SEMESTER I

GENETIC ENGINEERING (315461)

Teaching scheme:
Theory: 3 hr/week
Practical: 4 hr/week

Exam Scheme:
Paper: 100 Marks
Practical: 50 Marks
Term Work: 25 Marks

UNIT 1 **[8 Hrs]**

Techniques and tools in genetic engineering, Southern Blotting, PCR-design and optimization, RTPCR, Automated DNA sequencing method, sequencing strategies and analysis and applications, micro arrays, flow cytometry, Enzymes used in GE: DNA modifying enzymes, restriction enzymes, modifying enzymes, DNA ligase, polymerase for GE

UNIT 2 **[8 Hrs]**

Cloning vectors, Plasmids, Multiple cloning sites, selection markers, lambda phage, phgemids, cosmids, M13 vectors, vectors for cloning in eukaryotic cells, Expression Vectors, artificial chromosomes (BACs, YACs)

UNIT 3 **[8 Hrs]**

Gene libraries, Cloning strategies: DNA cloning, cDNA synthesis, genomic DNA libraries, cDNA library, amplification of gene libraries, identifying the products of cDNA clones, isolation, selection of recombinants

UNIT 4 **[8 Hrs]**

Screening libraries, Screening of recombinant clones, sequencing, and synthesis of gene, different methods of gene isolation, techniques of DNA sequencing, artificial DNA synthesis, PCR cloning

UNIT 5 **[8 Hrs]**

Gene transfer technologies, Transformation, Transfection, Translocation, Conjugation. Modification of bacteria and viruses: live vaccines, transgenesis and cloning, Animal transgenesis, Application of transgenic animals, transgenic plants and their applications

UNIT 6 **[8 Hrs]**

Applications of rDNA technology in health and agriculture: Humulin, Hep B, factorVIII, DNA diagnostics, BT cotton, Golden rice etc, DNA markers for improvement of quality and yield of crops. RFLP, RAPD, AFLP, Gene therapy, Human genome project.

Practicals:

1. Isolation of template DNA
2. Isolation of vector DNA
3. RE digestion of vector and template
4. Ligation with plasmid DNA
5. Transformation
6. Selection of recombinants
7. Conformation of insert
8. PCR
9. Real time PCR (demo)

Text Books:

1. Principles of Gene manipulation and Genomics by Primrose and Twyanman (Blackwell Publishers)
2. From genes to genomes: concepts and applications of DNA technology by J. W. Dale and M.V.Schantz (Wiely Publishers.)

Reference Books:

1. Molecular biotechnology by Pasternack and Glick
2. From Genes to clones by Winnacker. PANIMA
3. Gene cloning and DNA Analysis: An introduction (4th edition) by T. A. Brown
4. Molecular cloning by Sambrook, et al

MASS TRANSFER (315462)

Teaching Scheme:
Theory: 4 hr/week
Practical: 2 hr/week

Exam Scheme:
Paper: 100 Marks
Term Work: 50 Marks

UNIT 1 **[10 Hrs]**

Introduction, General principles of Mass Transfer, Classification of Mass Transfer Operations, Choice of separation method, Methods of conducting mass transfer operations, Design principles

Diffusion and Mass transfer, Types of diffusion - Molecular diffusion, Turbulent diffusion, Diffusion in Solids, Fick's and Maxwell law of diffusion, Molecular Diffusion in gases and liquids, Diffusivities of gases and liquids, types of solid diffusion, Numericals relating various types of diffusion, Theories of Mass transfer, Mass, Heat and Momentum transfer analogies.

Introduction to Inter phase mass transfer, Equilibrium, Two resistance theory, Local and overall mass transfer coefficients, Use of local overall, coefficients, Stages, Cascades.

UNIT 2

[8 Hrs]

Distillation Definition, Vapor-liquid equilibria for Ideal and Non-ideal systems, Relative volatility, Ideal solutions-Raoult's law, Azeotropes, Positive and negative deviations from Ideality, Multi component system, Methods of distillation-Continuous rectification, Differential, Flash, Azeotropic, Extractive, Low pressure, Steam distillation, Batch rectification, Molecular distillation

UNIT 3 **[9 Hrs]**

Tray tower calculations

Continuous rectification for binary system, Multistage tray towers-McCabe Thiele method, Tray efficiencies, Reflux ratio-Total reflux, Minimum reflux ratio, Optimum reflux ratio, Fenske's equation, Types of reboilers, Types of condensers-Total condensers, partial. Condensers, NTU, HTU, HETP concept and calculations

UNIT 4 **[9 Hrs]**

Gas Absorption, Mechanism of gas absorption, Equilibrium in gas absorption, Ideal liquid solutions, Non ideal liquid solutions, Choice of solvent for absorption, L/G ratios for absorbers, Absorption factor, Real trays and Tray efficiency, Use of Reflux, absorption with chemical reaction, Material balances – one component transferred in counter current flow, Numericals relating counter current operations

UNIT 5 **[9 Hrs]**

Drying, Definition, Principles, Equilibrium in drying, Drying hysterisis, Types of moisture binding, Drying operations, Batch drying, Rate of batch drying, Rate of drying curve, Mechanism of batch drying, Mechanism of moisture movement in solid continuous drying, Time required for drying, Classification of drying equipments, Numericals relating drying operations

UNIT 6 **[8Hrs]**

Crystallization, Principle rate of crystal growth, Population balance and size distribution, Calculations of yield, Enthalpy balances, Equipment

Practicals:

1. Liquid liquid Diffusion – To calculate the Diffusion Coefficient for a liquid – liquid system
2. Solid liquid diffusion – To calculate the Diffusion Coefficient for a solid –liquid system
3. Process of Crystallization and its Characteristics
4. Simple Distillation
5. Steam Distillation
6. Multistage crosscurrent liquid - liquid extraction
7. Batch/continuous leaching
8. Tray Dryer – To study the characteristics of Tray Dryer
9. Interphase Mass Transfer Coefficient – To calculate the individual and overall Mass Transfer Coefficient
10. Fluidized Bed Dryer – To study the characteristics of Fluidized bed Dryer
11. Wetted Wall Column – To find the mass transfer coefficient in a wetted wall Column
12. Spray Dryer – To study the design and Operating Principles of Spray Dryer

Note on Term Work:

- Minimum number of experiments – 8
- Minimum number of assignments – 2 (out of remaining experiments)
- Besides experimental work, evaluation of term work should be done through periodic tests
- Record of assessment of practical should be maintained on continuous basis

Textbooks:

1. Mass Transfer Operations – Treybal R.E., McGraw Hill
2. Unit Operations of Chemical Engineering, McCabe W.L. and Smith J.C. , McGraw Hill

Reference Books:

1. Chemical Engineering, Vol I & II – Coulson J.M. and |Richardson J.F., McGraw Hill
2. Principles of Unit Operations in Chemical Engineering, Foust A.S.
3. Design of Equilibrium Stage Processes - Smith B.D.

HEAT TRANFER (315463)

Teaching Scheme: **Exam Scheme:**
Theory: 4 hr/week **Paper: 100 Marks**
Practical: 2 hr/week **Term Work: 50 Marks**

UNIT 1 **[8Hrs]**

Introduction: Modes of heat transfer, conduction, convection, and radiation, Significance of dimensional analysis in heat transfer, units of various quantities used in heat transfer dimensional analysis, Importance of dimensional analysis in experimental design and data reduction.

UNIT 2 **[8 Hrs]**

Conduction: Fourier's law of heat conduction, thermal conductivity of liquid, gases and solids, Differential equation from shell balance for unsteady and steady state conduction. Introduction to unsteady state condition, Steady state condition in infinitely long slab, infinitely long hollow cylinder and hollow spheres, Thermal resistance in composite slab and cylinder, Concept of thermal resistance, thermal conductance and contact resistance, Heat losses through pipe, thermal insulation and optimum thickness of insulation, properties of insulator, Heat transfer from extended surfaces with uniform cross section, classification of extended surfaces, efficiency of longitudinal fin.

UNIT 3 **[8 Hrs]**

Convection: Newton's law of cooling, individual and overall heat transfer coefficient, Natural and forced convection in laminar and turbulent flow. Principal and heat balance equation in laminar flow and empirical equations for turbulent flow through tube, through annulus, over the plate, Concept of thermal boundary layer and its significance. Heat transfer with phase changes: Condensation: Modes and features: Theory and derivation of Nusselt's equation, Condensation on vertical plate and horizontal plate. Heat transfer in boiling liquids: Pool boiling of saturated liquid, Concept of maximum heat flux and critical temperature drop.

UNIT 4 **[8 Hrs]**

Radiation: Fundamental facts and definition of terms: Emissivity absorptivity, black body, gray body, opaque body, Stefan Boatmen law, Kirchoffs law, Planks law, Wien's law, Basic equation of heat transfer by radiation, various cases of radiation between two surfaces, the shape factor.

UNIT 5 **[8 Hrs]**

Heat exchange equipment: Types of heat exchangers including compact heat exchangers, parallel flow arrangement, fouling factor, LMTD in parallel and counter flow, Effectiveness NTU method.

UNIT 6 **[8 Hrs]**

Evaporation: Types of evaporators, performance, capacity and economy, Boiling point elevation, heat transfer coefficients, Material balance calculations, Multiple effect evaporators: Methods of feeding, capacity and economy, effect of liquid head and boiling point elevation

Practicals:

1. Heat conduction
2. Natural convection
3. Thermal radiation-determination of emissivity
4. Double pipe heat exchanger
5. Shell and tube heat exchanger
6. Plate Heat exchanger
7. Heat transfer in agitated vessels
8. Double effect evaporator
9. Open pan evaporator
10. Heat pipe demonstrator
11. Fluidized bed heat transfer

Text Books:

1. J P Holman, "Heat Transfer" 9th edition, Tata McGraw Hill Publications, New Delhi (2004)
2. S. P. Sukhatme, "A Textbook on Heat Transfer", 4th ed, Universities Press (India), 2005

Reference Books:

1. Frank Kreith, Mark Bohn, "Principles of Heat Transfer" 5th edition, PWS Publishing company, Boston (1997)
2. D. Q. Kern, "Process Heat Transfer", 11th ed., Tata Mc Graw Hill Publication, New Delhi
3. Bird R.B., Stewart W.E., Lightfoot E.N. "Transport phenomena" 2ed., Wiley Publications,2002
Sinnout R.K. "Coulson Richardson's chemical engineering vol.6" pergamonpress, 1993

FERMENTATION TECHNOLOGY I (315464)

Teaching Scheme:
Theory: 4 hr/week
Practicals: 2 hr/week

Exam Scheme:
Paper: 100 Marks
Orals: 25 Marks
Term Work: 50 Marks

UNIT 1 **[8 Hrs]**

Introduction to Microbial Fermentation, microbial / Industrial fermentation: Applications for production of industrially important products, Examples of classical fermentation systems, Concept of upstream processing - Screening and isolation of microbes, Preserving industrially important microbes, Inoculum preparation, Monod growth kinetics

UNIT 2 **[8 Hrs]**

Media Preparation and optimization, Different types of media, nutrient supply, sources of nutrients i.e. carbon, nitrogen etc., effect of media components on fermentation, media preparation, optimization for maximum yield

Sterilization: Need for sterilization, different types of sterilization techniques – their mechanism of destruction, *in situ* sterilization, HTST

UNIT 3 **[8 Hrs]**

Microbial production of industrially important products: Alcohols and acids, Microbial fermentation of organic acids viz. Citric, gluconic, fumeric, itaconic, gibberellic and kojic acids, Activities of lactic acid bacteria and industrial production of lactic acid, Activities of acetic acid bacteria and production of vinegar

Alcohol Production: wine and other alcoholic beverages, glycerol, beer

UNIT 4 **[8 Hrs]**

Production of Antibiotics and Microbial enzymes, Antibacterial antibiotics: penicillin, streptomycin, chloromycetin, tetracyclines, semisynthetic penicillins; Antifungal antibiotics, Microbial production of vitamins B2 and B12

Microbial Enzymes: Production, isolation and use of microbial enzymes,

Immobilization - Types and applications

UNIT 5 **[8 Hrs]**

Different types of fermentation: Submerged and solid state fermentation, advantages and disadvantages, applications

Types of Fermenters, Submerged fermenters: Stirred tank, Bubble Column, Air lift, Hollow fiber etc., Modes of operation in stirred reactors: discontinuous batch operation, continuous operation, semi-continuous reactors, and periodic fed-batch cultivation

Solid State fermenters: Tray bioreactors, packed bed, hollow fiber etc.

Advantages and Disadvantages, Configuration and applications,

Advanced Fermenter designs:

Microfermenters for Rapid screening and analysis of Biochemical processes, Animal & Plant Cell Reactor Technology, Disposable Fermenters:- case study- Therapeutic Antibody Production

UNIT 6 **[8 Hrs]**

Fermentation Scale up and economics: Scale-up: Principles, theoretical considerations & techniques used, Sterilization, inoculum development, operation parameters Concept of downstream processing, Fermentation and product recovery costs, yields, product recovery, product purity, fermentation efficiency, case example such as ethanol economics

Introduction to GMPs

Practicals (Any 8):

1. Isolation and screening of industrially important microorganisms.
2. Study of fermenter design
3. Kinetics of cell growth
4. Kinetics of product formation
5. Fermentation of any two microbial products
6. Use of alginate for cell immobilization.
7. Effect of temperature/ pH in fermentation
8. Effect of aeration in fermentation
9. Solid state Fermentation
10. Calculation of fermenter efficiency and cost of product
11. Effect of different media components (Carbon, Nitrogen etc.) on fermentation

Text books

1. Industrial microbiology: Casida Newage Publication 2001
2. Principles of Fermentation Technology, Second Edition, Stanbury, Whitaker, S. Hall, Elsevier publication
3. Biochemical Engineering Fundamentals by Bailey and Ollis (McGraw Hill, New York.)

Reference Books

1. Enzymes: Trevor, Horwood, 2001
2. Industrial microbiology: Prescott and Dunn CBS publications 4th Edition, 1999
3. Comprehensive Biotechnology Vol. 1- 4: M.Y. Young (Eds.), Pergamon Press.
4. Biotechnology: A Text Book of Industrial Microbiology: T.D. Brock, Smaeur Associates, 1990.
5. Bioprocess Engineering Principles by Paulin M.Doran (Academic Press, London)
6. Biochemical Engineering by Aiba S., Humphrey. A.E and Milli N.F

COMPUTATIONAL TECHNIQUES AND BIOSTATISTICS (315465)

Teaching Scheme: **Exam Scheme:**
Theory: 3 hrs/week **Paper: 100 Marks**

UNIT 1 **[6 Hrs]**

Linear and Polynomial Regression: Method of Least Squares: Fitting of a straight line using linear regression, fitting of a parabola using polynomial regression, fitting of other curves.

UNIT 2 **[10 Hrs]**

Interpolation, Finite differences and Interpolation: Forward differences, backward differences, central differences, Factorial notation.
Newton's Interpolation formulae with equal intervals: Newton's forward and Newton's backward formulae.
Interpolation with unequal intervals: Lagrange's formula, divided differences

UNIT 3 **[6 Hrs]**

Numerical Integration: Newton Cote's quadratic formulae;
Trapezoidal rule, Simpson's $1/3^{rd}$ rule, Simpson's $3/8^{th}$ rule, Weddle's rule

UNIT 4 **[10 Hrs]**

Solutions of Algebraic equations: Bisection method, Regular false method
Solutions of linear simultaneous equations: Newton Raphson method, deductions from NR method.
Solutions of Non linear simultaneous equations: Newton Raphson method for non linear equations.

UNIT V **[8 Hrs]**

Biostatistics: Introduction to Biostatistics
Sampling: Introduction, theoretical basis of sampling, Sample method, Essentials of Sampling, random and systematic sampling, cluster sampling, Sample size- determination of sample size, sampling errors.
Diagrammatic and graphic presentation: Introduction, Significance of graphs and diagrams, General rules for constructing diagrams, Types of diagrams (Bar, pie chart etc), Frequency distribution graphs.

UNIT VI **[8 Hrs]**

Types of averages: Introduction, Types of averages, Calculation of Arithmetic mean, Median, Mode, Geometric mean, Harmonic mean for discrete series, continuous series, individual observations, Standard deviation, and Mean deviation.
Tests of Significance: Students t - distribution (parametric), Chi square test (non parametric),

Text books:

1. Numerical methods for scientific and engineering computation, 5th edition, M.K.Jain, R.K.Jain, S.R.K.Iyengar, New Age International Publishers.
2. Higher Engineering mathematics, Dr. B.S.Grewal, Khanna Publishers.
3. Statistical methods, S.P.Gupta ,Sultan chand and Sons Educational Publishers, New Delhi.

Reference books:

1. Numerical methods for Engineers with software and programming applications, Steven C Chapra, Reynolds P Canale.

T.E. BIOTECHNOLOGY

SEMESTER II

REACTION ENGINEERING (315466)

Teaching Scheme: **Exam Scheme:**
Theory: 4 hr/week **Paper: 100 Marks**
Practical: 2 hr/week **Term Work: 50 Marks**

UNIT 1 **[8 Hrs]**

Fundamentals of Reaction Engineering, Introduction: Classification of reactions - single and multiple reactions, elementary and non elementary reactions, Definition and significance of rate of reaction ,molecularity and order of reactions, factors affecting rate of reaction – Temperature dependency, activation energy, Arrhenius and Collision theory ; comparison, kinetic models for non-elementary reactions - searching for a reaction mechanism, concept of rate controlling step

UNIT 2 **[8 Hrs]**

Introduction to Reactor Design, Different types of reactors: Batch (Constant and variable volume), Mixed flow reactor, plug flow reactor – concept of space time and space velocity, Analysis of batch reactor data, conversion, performance of different reactors and their comparison, performance equations, problems on performance and conversion

UNIT 3 **[8 Hrs]**

Non-ideal Reactor Systems, Definition of non-ideality, age distribution, RTD studies, Distribution curves – the E, F and C curves, their significance and the relation between them, conversion in a non-ideal system, Models for non-ideal reactions, dispersion model, tanks in series model segregated flow model.

UNIT 4 **[8 Hrs]**

Heterogeneous Reactions, Introduction – examples of heterogeneous systems: solid-liquid systems, catalysis, surface kinetics, the concept of rate controlling step, fluid particle reactions – progressive conversion model, shrinking core model, determination of rate controlling step

UNIT 5 **[8 Hrs]**

Heterogeneous Systems, Mixed flow reactors, packed bed catalytic reactor, fluidized bed reactors, slurry and trickle bed reactors, performance equation for porous catalysts, pore diffusion, Thiele's modulus, effectiveness factor, recycle reactor

UNIT 6 **[8 Hrs]**

Application of reaction engineering to biochemical reactions

Michaelis Menten kinetics, enzyme inhibition kinetics – competitive and non-competitive, enzyme deactivation kinetics

Microbial growth kinetics: Product distribution, fractional yields, substrate and product limiting microbial fermentation, Monod growth kinetics, Kinetic implications of endogenous and Maintenance metabolism, environmental effects on growth kinetics,

Practicals (Any 8):

1. Reaction kinetics of first order reaction.
2. Reaction kinetics of pseudo first order reaction-Acid catalyzed hydrolysis of methyl acetate
3. Reaction kinetics of a second order reaction – Saponification of ethyl acetate.
4. Design of PFR
5. Design of CSTR
6. Design of CSTR combination in first order reactions
7. Non ideal reactions-F & C curves in CSTR
8. Non ideal reactions-F & C curves in PFR
9. Evaluation of PFR followed by CSTR
10. Design of two PFR in series

Textbooks

1. Chemical Reaction Engineering: Levenspiel O, John Wiley Publishers.
2. Elements of Chemical Reaction Engineering: H. Scott, Fogler, Academic Press

Reference Books

1. Chemical Engineering Kinetics: Smith J., Mc Graw Hill Publication
2. Reactor design and analysis: Bishoff and Fromment; Oxford University Press

FERMENTATION TECHNOLOGY II (315467)

Teaching Scheme: **Exam Scheme:**
Theory: 4 hr/ week **Paper: 100 Marks**

UNIT 1 **[9 Hrs]**

Fermenter design and operation, Parameters affecting fermenter performance: pH, foam, temperature, dissolved oxygen, nutrient supply, effect of rheological properties and its importance in fermentation operation

Aeration and agitation – impeller design, agitator power requirement, oxygen requirement of microorganisms, mass transfer theory, diffusional resistance to oxygen transfer, measurement of mass transfer coefficient and factors effecting them, effect of aeration and agitation in mass transfer, effect of shear

UNIT 2 **[9 Hrs]**

Equipments for processing fermentation products, Need of different unit operations for processing fermentation broths and products, Configuration, applications, advantages and disadvantages of various equipments - bubble columns, tray towers, packed towers, agitated vessels, thickeners, trickle bed reactors, continuous countercurrent decanters, membrane contactors, vacuum dryers, freeze dryers, spray dryers, centrifuges, drum filters, rotary filters

UNIT 3 **[9 Hrs]**

Adsorption and Ion Exchange

Definition, Types of Adsorption - Physical and Chemical, Nature of adsorbents, Adsorption Isotherms - Langmuir, Freundlich, BET, Heat of adsorption, Introduction to Pressure Swing Adsorption (PSA), and Temperature Swing Adsorption (TSA), Equipments for adsorption

Principles of Ion Exchange, Techniques and applications, Equilibria and rate of ion exchange

UNIT 4 **[9 Hrs]**

Solid – Liquid Extraction (Leaching): Definition, Preparation of the solid, Factors effecting leaching operations, Methods of operation, Single stage leaching, Continuous counter current leaching, Constant and variable underflow, Leaching equipments, Calculation of single stage and multistage leaching processes

UNIT 5 **[9 Hrs]**

Membrane Separation Techniques : Classification of separation techniques, Definition of a membrane, Criteria of membrane separation processes, Types of membranes, Advantages of membrane separation processes over conventional separation techniques, Industrial Applications, Membrane separations - Micro filtration, Ultra filtration, Reverse Osmosis, Piezodialysis, Electro dialysis, Membrane electrolysis, Pervaporation, Carrier mediated transport- liquid membranes, Membrane contactors, Polarization phenomenon, Membrane fouling, Membrane modules and Industrial applications of all processes

UNIT 6 **[9 Hrs]**

Liquid-Liquid Extraction (Solvent extraction) : Definition, Fields of usefulness, Ternary liquid equilibria, Equilateral triangular coordinates, Mixture rule, Choice of solvent, Material balances - Single stage extraction, Multistage crosscurrent, countercurrent and co current extraction, Types of extractors – stage type and differential type

Text Books:

1. Treybal R.E. “Mass Transfer Operation”
2. Richardson J. F. and Coulson J.M. “ Chemical Engineering”, Vol. I , II
3. Smith B.D., “ Design of Equilibrium Stage Process”.
4. Principles of Fermentation Technology, Second Edition (9780750645010): PF Stanbury, S. Hall, A. Whitaker
5. Bioprocess Engineering Principles by: Pauline Doran Publisher: Academic Press

Reference Books

1. Foust A.S., “ Principles of Unit Operations”
2. Henley E. J. and Seader H.K. “Stage wise Process Design” , McGraw Hill
3. McCabe and Smith, “ Unit Operations in Chemical Engineering”
4. King C. J. “ Separation Processes”, McGraw Hill
5. Marcel Mulder**,** Basic Principles of Membrane Technology, 2nd Ed., Kluver, 1996. Richard Baker, Membrane Technology and Applications, Wiley, 2004

BIOSEPARATIONS I (315468)

Teaching scheme:
Theory: 3 Hrs / week
Practicals: 2 Hrs / week

Exam scheme:
Paper: 100 Marks
Practical: 50 Marks

UNIT 1 **[8 Hrs]**

An overview of Bioseparations, Mechanical and enzymatic methods of cell disruption, importance of cell disruption in product release, homogenization, ultrasonication, extraction, absorption, adsorption

UNIT 2 **[8 Hrs]**

Chromatography –Separation Technique, Classification of chromatographic techniques, General description of column chromatography, chromatography column dynamics, Chromatographic terms and parameters,
Practice of chromatography, HPLC; scale up of chromatography, planar chromatographic techniques, process consideration in preparative chromatography. Types of chromatography

UNIT 3 **[8 Hrs]**

Basic separation techniques: sedimentation, centrifugation, ultracentrifugation, gradient centrifugation, filtration, micro/ultra filtration, use of membranes (semi permeable) in purification, reverse osmosis

UNIT 4 **[8 Hrs]**

Leaching, crystallization, lyophilzation, drying. Chemistry of extraction, selection of solvent, use of solvent extraction in antibiotic separation, affinity extraction/ chromatography

UNIT 5 **[8 Hrs]**

Importance of separation techniques in biotechnology, its scope from research to industry, Synthesis of Bioseparation Processes,Process analysis,Process Economics, Illustrative Examples

UNIT 6 **[8 Hrs]**

Industrial applications with examples, Separation of bioconversion products/ secondary metabolites e.g. Steroids and antibiotics

Practicals (Any 8)

1. Adsorption on charcoal: Application in removal of unwanted dye.
2. Clarification Techniques: Sedimentation
3. Lab scale Homogenization of Baker’s Yeast
4. Precipitation of proteins using Ammonium Sulphate.
5. Use of blender for disruption of plant tissues
6. Dialysis of proteins followed by concentration of proteins with dialysis bag.
7. Chromatography for separation of biomolecules
8. Use of sonicator for cell disruption
9. To use flocculation as a unit operation
10. Aqueous two phase extraction.

Textbooks

1. Bioseparation: Downstream processing for Biotechnology, Belter, P.A. and Cussler, E.L., Hu, W.S. Wiley, New York.
2. Biosepration Engineering: Principles, practice and economics, Wiley, Interscience

Reference Books

1. Unit Operation of Chemical Engineering, McCabe, W.L., Smith, J.C. and Harritt, P., McGraw Hill.
2. Separation Process Principles. Seader, J.D, and Henley, E.J. Wiley.

IMMUNOLOGY AND DIAGNOSTICS (315469)

Teaching Scheme:
Theory: 3 hr/week
Practical: 2 hr/week

Exam Scheme:
Paper: 100 Marks
Orals: 50 Marks

UNIT 1 **[8 Hrs]**

Overview of immune system, innate and adaptive immunity, Physiological barriers against infection, phagocytosis, inflammation, humoral immunity, Cells and organs of immune system,

UNIT 2 **[8 Hrs]**

Antigens, Structure and function of antibody, Activation of B cells, theories of antibody production- clonal selection theory, organization and expression of Ig genes, generation of antibody diversity, Monoclonal Antibody, Hybridoma Technology, antigen antibody interactions- principles and applications, cross reactivity, precipitation, agglutination, RIA, ELISA, Western blotting

UNIT 3 **[8 Hrs]**

Cell mediated immunity, Major Histocompatibility Complex (MHC), graft rejection, GVH, antigen processing and presentation, T cells

UNIT 4 **[8 Hrs]**

Immune effector mechanisms, cytokines, complement system, cell mediated effector responses, cytotoxic T cells, Natural killer cells, ADCC, hypersentitive reactions-allergen, reaginic antibody, Type I-IV reactions

UNIT 5 **[8 Hrs]**

Vaccines, active and passive immunization, attenuated vaccines, role of adjuvants, anti-sera, immunoglobulins, toxoids, recombinant vaccines, subunit vaccines, DNA vaccines

UNIT 6 **[8 Hrs]**

Immune system in diseases, autoimmunity, cancer and immune system, TB, Immunodeficiency, AIDS

Practicals:

1. Peripheral blood smear
2. Quantitation detection of immunoglbulin using precipitation reaction
3. Haem-agglutination
4. Determination of antibody titer by Radial Immuno Diffusion (RID)
5. Ouchterlony Immunodiffusion
6. ODD
7. ELISA: a) Coating, b) Blocking, c) washing, d) Ag-Ab reaction, e) HRP Detection
8. Demonstration of Western Blotting: a) SDS PAGE, b) Blotting, c) Blocking, d)Hybridization, e) Detection

Text Books

1. Kuby- Immunology (4th Edition) by R. A. Goldsby, T.J. Kindt, B.A. Osborne.
2. Essentials of Immunology (6th Edition): Ivan Roit- Blakswell Scientific Publications, Oxford, 1988

Reference Books

1. Fundamentals of Immunology: Paul W.E. (Eds.) Raven Press, New York, 1988.
2. Antibodies A laboratory Manual: Harlow and David Lane (1988), Cold spring harbor laboratory.

Bioinformatics & Management (315462)

Teaching Scheme:
Theory: 4 hrs/week
Programming: 2 hrs/week

Exam Scheme:
Paper: 100 Marks
Oral: 25 Marks
Term Work: 25 Marks

Unit 1 **(8 Hrs.**)

Introduction to Bioinformatics, Terminologies used in Bioinformatics, Scope and Goal of Bioinformatics, Overview of applications of Bioinformatics, Databases, Database Management system, Data structure, Database query language,Relational Model, Object Model, Object oriented and Relational databases, Network of databases for Entrez and SRS. Overview of Biological Databases.

Unit2 **(8 Hrs)**

DNA sequencing, Nucleotide databases as Genbank, Dna Data Bank of Japan (DDBJ), European Molecular Biology Laboratory (EMBL), NCBI's Data model, Specialized genomic recourses as SGD, UniGene, TDB. Sequence retrieval systems such as Entrez and SRS.

Unit 3 **(8 Hrs)**

Protein structures, Levels of Protein sequence and Structural organization, Protein databases, Primary protein sequence Databases as PIR, MIPS, SWISS-PROT, TrEMBL. Composite Protein sequence databases as NRDB, OWL. Secondary databases as PROSITE, PRINTS, Blocks. Structure Classification databases as SCOP, CATH, PDB. Various analytical tools for protein Structure Visualization.

Unit 4 **(8 Hrs.)**

Introduction to sequence alignment, Pairwise and Multiple Sequence Alignment, Dot Plot, Needleman Wunsch Algorithm, Smith Waterman Algorithm, Local and Global Sequnce Alignment, Substitution Matrices such as PAM And BLOSUM, Calculation of alignment's statistical significance, Importance of Identity matrixes, gaps and penalties, Heuristic methods such as FASTA, Working of FASTA and Variants, BLAST, Working of BLAST and different variants of BLAST.

Unit 5 **(8 Hrs)**

Introduction to Phylogeny, Homologes, orthologs and paralogs, Construction of a phylogenetic tree, Different types of trees as rooted and unrotted trees. Phylogenetic analysis, Methods of Phylogenetic analysis as Distance method, Application of bioinformatics in vaccine designs, Drug designing – Ligand based and Structure based, scoring function for Docking, HTS, QSAR.

Unit 6 **(8 Hrs)**

Introduction to biotechnology Management, General introduction to management studies, Correlation of the management and biotechnology industry, Organizational management in biotechnology companies, various disciplines in management. Technology transfer management in Biotechnology

Practicals:

1. **Introduction to the NCBI:** Use of different features and services enlisted in NCBI.

2. **Database searches:** Search and retrieval of sequence data from Nucleotide databases as Genbank, DDBJ, EMBL.

3. **Database search Engines:** Search and retrieval of sequence and structure data using query engines such as Entrez and SRS.

4. **Structure Visualization and Analysis**: Use of different visualization software such as RasMol, SwissPDBViewer to visualize protein structures and understand secondary structural motifs, tertiary structures etc

5. **BLAST and FASTA**: Use of BLAST and FASTA programs, interpretation of results to identify homologues of genes/proteins from databases

6. **Pair-wise Sequence Alignments** and their interpretation/analysis: sequence alignments using implementations of Needleman-Wunsch and Smith-Waterman algorithms

7. **Multiple Sequence Alignments** using CLUSTAL-W method with analysis of the alignments to find conserved, variable regions.

8. **Sequence and Structure Classification**: Search and retrieval of data from sequence and structure classification data bases with analysis of search results (e.g. PFAM, SCOP databases)

Text Books

1. Introduction to Bioinformatics, by Arthur M. Lesk Oxford University Press, Oxford University Press.
2. Bioinformatics- Methods & Applications by S.C.Rastogi, N. Mandiratta, P. Rastogi.
3. Principles of management- Knoots and O.Donnell

Reference Books

1. Bioinformatics Sequence and Genome Analysis by David W. Mount, 2nd edition, Cold Spring Harbor Laboratory Press.
2. Bioinformatics: A practical guide to the analysis of genes and proteins A.D. Baxevanis and B.F.F. Ouellette (Eds). 2002 John Wiley and Sons.
3. Bryan Bergeron, “Bioinformatics computing”, Pearson Education [BB].