STRUCTURE OF POST GRADUATE PROGRAMME
M.E. BIOCHEMICAL ENGINEERING AND BIOTECHNOLOGY
SHIVAJI UNIVERSITY, KOLHAPUR.
JULY 2008-09.

COURSE STRUCTURE

Semester-I

Sr. No.	Name of Subject	Teaching Scheme				Examination			
		L	T	P	Total	Theory	T/W	P/O	Total Marks
1.	Advanced Bioreaction Engineering	3	1	--	4	100	25	--	125
2.	Advanced Biological Thermodynamics	3	1	--	4	100	25	--	125
3.	Advanced Microbiology & Biochemistry	3	1	--	4	100	25	--	125
4.	Advanced Bioseparation Processes	3	1	--	4	100	25	--	125
5.	Elective –I	3	1	--	4	100	25	--	125
6.	Laboratory-1	1	-	2	3	--	75	50	125
7.	Seminar - I	--	--	4	4	--	50	--	50
	Total				**27**				**800**

L: Lecture; T/P: Tutorial/ Practical; T/W: Term Work; P/O: Practical /Oral Exam.

Semester-II

Sr. No.	Name of Subject	Teaching Scheme				Examination			
		L	T	P	Total	Theory	T/W	P/O	Total Marks
1.	Bioreactor Design	3	1	--	4	100	25	--	125
2.	Advanced Enzyme Technology	3	1	--	4	100	25	--	125
3.	Advanced Food Technology	3	1	--	4	100	25	--	125
4.	Advanced Genetic Engineering	3	1	--	4	100	25	--	125
5.	Elective-II	3	1	--	4	100	25	--	125
6.	Laboratory-2	1	-	2	3	--	75	50	125
7.	Seminar-II	--	--	4	4	--	50	--	50
	Total				**27**				**800**

L: Lecture; T/P: Tutorial/ Practical; T/W: Term Work; P/O: Practical /Oral Exam.

- **ELECTIVES**

Elective - I

1. Immunotechnology
2. Biosensor Technology
3. Environmental Biotechnology
4. Animal Biotechnology

Elective - II

1. Plant Biotechnology
2. Pharmaceutical Biotechnology
3. Advanced protein Engineering
4. Advanced Bioinformatics

Semester-III

Sr. No.	Name of the Subject	Teaching Scheme				Examination .			
		L	T	P	Total	Theory	T/W	P/O	Total Marks
1.	Industrial Training	--	--	--	--	--	50	--	50
2.	Seminar-III	--	--	1	1	--	25	25	50
3.	Dissertation Phase	--	--	2	2	--	100	--	100
	Total				3				200

Semester-IV

Sr. No.	Name of the Subject	Teaching Scheme				Examination .			
		L	T	P	Total	Theory	T/W	P/O	Total Marks
1.	Dissertation Phase	--	--	4	4	--	100	100	200
	Total								**200**

NOTE : 1. An Industrial Training of 4 weeks to be completed during the vacation period after Semester –II. The report shall be submitted at the beginning of Semester –III

2. Independent practical's may be held under each course. However, for examination purposes, a single comprehensive 2 – 3 days practical will be held for each semester covering different courses offered during that examination.

SEM-I

Paper No. - 1

ADVANCED BIORECATION ENGINEERING

Lecturer: 3 Hrs/ week
Tutorials/ Practical: 1
Theory: 100 marks
Term work: 25 marks
Total: 125 Marks

Homogenous Reactions

i. **Basic reaction theory:** Reaction Thermodynamics, Reaction yield, Reaction rate, Reaction kinetics, Effect of temperature on reaction rate.
ii. **Calculation of Reaction Rates from Experimental Data:** Average Rate –Equal area method, Mid-point slope method.
iii. **General reaction Kinetics for biological system:** Zero –order kinetics, First-order kinetics, Michaelis-Menten Kinetics, effect of conditions on enzyme reaction rate.
iv. **Determining enzyme kinetic constant from batch data:** Michaelis-Menten plot, Lineweaver Burk plot, Eadie-Hofstee plot. Langmuir plot, Direct linear plot.
v. **Kinetics of enzyme deactivation.**
vi. **Yield in cell culture:** Overall and Instantaneous yields. Theoretical and observed yields.
vii. **Cell growth kinetics:** Batch Growth, Balanced growth, Effect of substrate concentration.
viii. **Growth kinetics with plasmid instability.**
ix. **Production kinetics in cell culture:** Product formation directly coupled with Energy metabolism, product formation indirectly coupled with energy metabolism. Product formation not coupled with energy metabolism.
x. **Kinetics of substrate uptake in cell culture:** Substrate uptake in the absence of product formation. Substrate uptake with product formation.
xi. **Effect of culture condition on cell kinetics:**
xii. **Determining cell kinetic parameters from batch data:** Rates of growth, product formation and substrate uptake, μ_{max} and K_s
xiii. **Effect of Maintenance on Yields:** Observed yields, Biomass yield from substrate, Product yield from Biomass, Product yield from substrate.
xiv. **Kinetics of cell death.**

Heterogeneous Reactions

i. **Heterogeneous reaction in bioprocessing.**
ii. **Concentration gradients and reaction rates in solid Catalysts:** True and observed reaction rates, interaction between mass transfer and reaction.
iii. **Internal mass transfer and reaction:** Steady state shell mass balance, concentration profile: First-order kinetics and spherical geometry, concentration profile: zero –order kinetics and spherical geometry. Concentration Profile:

Michaelis –Menten Kinetics and spherical Geometry, Concentration profiles in other geometries, Prediction of observed reaction rate.

iv. **The Thiele modulus and effectiveness factor:** First order kinetics, zero order kinetics Michaelis-Menten Kinetics, The observable Thiele modulus, Minimum Intracatalyst Substrate concentration.

v. External mass transfer.

vi. Liquid solid mass transfer correlations: Free moving spherical particles.

vii. **Experimental Aspects:** Observed Reaction rate, effective diffusivity.

viii. Minimizing mass transfer effects: Internal mass transfer, external mass transfer.

ix. Evaluating the true kinetic parameters.

x. General comments on Heterogeneous reactions in Bioprocessing.

Books:

1. Atkinson B and F Mavituna. Biochemical Engineering and Biotechnology hand book.
2. Bailey J.D. and D.F. Ollis. Biochemical Engineering Fundamental.
3. Shuler M.L. and F. Kargi Bioprocess engineering.
4. Biochemical Engineering principals, Pauline m Doran.
5. Biochemical Engineering Lee J.M Prentice Hall
6. Biochemical Process technology- Jackson, A.T. et.al.
7. Bioreaction engineering- Principle Nilesons S. and Villadsen J
8. Biochemical reactor- Atkinson B Pion Ltd. London.
9. Shuler M.L Bioprocess Engineering basic concept.
10. Fogler H.S. Elements of Chemical reaction Engineering
11. Smith J.M- Chemical Engineering Kinetics.
12. Chemical Reaction Engineering -, Levenspile O

SEM-I

Paper No. – 2

ADVANCED BIOLOGICAL THERMODYNAMICS

Lecturer:3 Hrs/ week
Tutorials/ Practical: 1
Theory: 100 marks
Term work: 25 marks
Total: 125 Marks

1) Reviews of Laws of Thermodynamics

i. First law of thermodynamics- Enthalpy, Standard state, Heat capacity, energy, conservation.

ii. Second Law of Thermodynamics- Entropy, Entropy of the Universe, Isothermal system, protein denaturation, Irreversibility and life.

2) Gibbs free energy

i. **Gibbs free energy theory** -Equilibrium, Reversible processes, Phase transitions,Chemical potential, Equilibrium constant.

ii. **Gibbs free energy application**

3) Statistical thermodynamics

i. Boltzmann distribution

ii. Partition function

iii. Multistate equilibria

iv. Protein heat capacity function

v. Helix – coil transition theory

4) Binding Equilibrium:

i. Single site model

ii. Oxygen transport

iii. Scatchard plots and Hill plots

iv. Allosteric regulation

v. Proton Binding

5) Biochemical Thermodynamics

i. Acidity of solutions

ii. Ionization of Biochemical's

iii.Solubilities of weak acids, weak bases, and pharmaceuticals as a function of pH

iv. Binding of a ligand to a substrate

v. Other examples of Biochemical reactions.

vi. Protein concentration in an ultracentrifuge

vii. Gibbs-Donnan equilibrium and membrane potentials

viii. Coupled chemicals reactions.

ix. Thermodynamic analysis of Fermentor and other Bioreactors.

Books:

i. Atkins P.W. – Physical Chemistry
ii. Atkins D.E.-(1977) Cellular energy metabolism
iii. Berdahl D.- (1993) Conversion in Encyclopedia of applied physics.
iv. Blaxter .- (1989) Energy metabolism in Animals and man.
v. Fruton J.S. (1999) Proteins enzymes and gene.
vi. Gennix R.B. (1989) Biomembranes, molecular structure and function.
vii. Harris D. (1995) Bioenergetics at glance.
viii. Lodish H. et.al. (1995) Molecular cell Biology.
ix. Wriggle worth, J. (1997) Energy and life London.
x. Haynie D.T. Biological Thermodynamics.
xi. Chemical, Biochemical and Engineering Thermodynamics- Stanley

SEM-I

Paper No.- 3

ADVANCED MICROBIOLOGY AND BIOCHEMISTRY

Lecturer:3 Hrs/ week
Tutorials/ Practical: 1
Theory: 100 marks
Term work: 25 marks
Total: 125 Marks

1) **Introduction to Cell Structure of Microorganisms.**

2) **Central pathways of carbohydrate metabolism in Microorganism.**

i. Conversion of compounds to intermediate usable in central pathway.
ii. Mechanism of ATP production.
iii. Metabolic steps involved in the generation and use to reducing energy.
iv. Oxygen involvement in energy generation reaction.
v. Metabolic intermediate
vi. Metabolic and genetic regulatory system.

3) Energy Production and metabolic transport

i. Phosphorylation.
ii. Oxidative phosphorylation.
iii. Electron transport system.
iv. Metabolite transport, measurement and conversion of PMF (Proton motive face) of PMF
v. Anaerobic respiration.
vi. Structure of f1, f0 and ATP- O Peron
vii. Specific transport system.
viii. Histidine permease.

4) Metabolism of substrates other than Glucose,

i. Lactose, Galactose, Maltose, Mannitol, Fucose and Rhamnose mellibiose, Rattinose, Pectin and Aldohexuronate, Cellulose and Starch.
ii. Metabolism of aromatic compounds.

5) Fermentation Pathways

i. Fermentation balance
ii. Lactic Acid- producing fermentation

iii. Fermentation of mixed acid type.

iv. Propionic acid fermentation.

v. Acetic acid fermentation.

vi. Butyric acid and solvent producing fermentation.

6) Biosynthesis and metabolism of Lipids.

i. Lipids and Fatty acids

ii. Phospholipids.

iii. Biosynthesis and degradation of fatty acids

iv. Biosynthesis and degradation Phospholipids.

v. Ring containing fatty acids

vi. Plasmalogenes.

vii. Biosynthesis of isoprenoids

7) Nitrogen metabolism

i. Biological nitrogen fixation.

ii. Nitrogen fixation process

iii. Symbiotic nitrogen fixation.

iv. Inorganic nitrogen metabolism.

v. Assimilation of inorganic nitrogen.

vi. General reaction of amino acids.

vii. The stickland reaction.

8) Biosynthesis and metabolism of amino acids

i. Glutamate and α- ketoglutarate family.

ii. Aspartic family

iii. Pyruvate family

iv. Serine-Glycine or Triose family

v. Aromaic amino acid family

vi. Histidine

9) Macromolecular synthesis and processing

i. Biosynthesis of purine.

ii. Biosynthesis of pryimidine..

iii. Bacterial nucleotide

iv. Structural and replication of DNA.

v. RNA Synthesis, processing and turnover.

vi. Ribosomes structure and synthesis.

vii. Translation, protein folding and protein traffic.

viii. Antibiotics that affect nucleic acid and protein synthesis.

10) Bacterial Genetics.

i. DNA Exchange.
ii. Recombination
iii. Mutagenesis
iv. Repan.

Books:

i. Pelczar M.J- Microbiology-.

ii. Introduction to Environmental Biotechnology

iii. Nelson DL- Principles of Biochemistry.

iv. EL- Mansi- Fermentation Microbiology and Biotechnology.

v. Kumar H.D.-Industrial Microbiology- Prescott S.C Modern concept in biotechnology

vi. Scragg Alan- Environmental Biotechnology.

Irfan Ali Khan - Advances in biotechnology

vii. waites M.J- Industrial Microbiology- An Introduction

viii. Casida L.E- Industrial Microbiology

ix. Schlegel Hans G -General microbiology 7th ed.

x.Moat- Microbial physiology

SEM-I

Paper No.- 4
ADVANCED BIOSEPARATION PROCESSES

Lecturer:3 Hrs/ week
Tutorials/ Practical: 1
Theory: 100 marks
Term work: 25 marks
Total: 125 Marks

1. Media:
Preparation, storage, Handling and sterilization of media in large scale; Screening for fermentation media.

2. Plant cell culture techniques:
Introduction requirements, Techniques, Media, Constituents, Media selection; Practical applications of cellular totipotency; plant cell fermentation and production of secondary metabolites; somatic embryogenesis, induction, development and maturation of somatic embryos; large scale production of somatic embryos, synthetic seeds; Androgenesis; Endosperm culture; Bioprocess consideration in using plant cell cultures, Bioreactors for suspension cultures, immobilized cell and for organized tissues; Genetic engineering of plants.

3. Animal Cell Culture Techniques:
Introduction: Media for culturing cells and tissues; Cell cultures as sources of valuable products; Animal Bioreactors- production of MAbs and therapeutic proteins; mammalian Genome; ***In-vitro*** and ***In-vivo*** embryo production; Embryo transfer technology; Cryopreservation of embryos; Insect cell culture; Transgenic animals; Transgenic animals as bioreactors for production of human therapeutic proteins; Marker assisted selection and genetic improvement live stock; gene mapping in farm animals; Data mining in animal biotechnology.

4. Microbial cell culture techniques:
Media preparation, sterilization, culture maintenance;Growth and development of micro organism; single colony purification; culture characterization; Biochemical characterization; Antibiotic sensitivity; Screening (Primary and Secondary screening); Replica plating; Conjugational genetic transformation; Generalized transduction. Estimation of cell mass, study of different phases of microbial growth, mass and energy balance, study of growth inhibition kinetics.

5. Fermentation Technology
Introduction; Bioprocess monitoring; Oxygen transfer in fermentor; Optimization of fermentations; Bubble-column Bioreactors; Solid state fermentations in industry; Strategies used to optimize product yield; Biotransformation; Bioprocess Engineering. Study of product formation, kinetics in a fermentation process and it's relation between specific product formation rate and specific growth rate. Comparison between aerobic and anaerobic

bioconservation processes,power consumption in fermentation process and its correlation with rheology of the fermentation fluids. Effect of agitator type and speed on the mixing time in a bioreactor. Estimation of Ka in a fermentation process . Heat balance across a batch, sterilization process. Assemble and characterization of pH/D.O. electrodes.

6. Role of Downstream processing in biotechnology:

Role and importance of downstream processing in Biotechnological processes; problems and requirements of bioproduct purification; Economics and downstream processing in Biotechnology; Cost cutting strategies, process design criteria for various classes of bioproducts; Physicochemical basis of bioseparation processes.

7. Recovery and Enrichment operations:

Introduction: Flocculation, Sedimentation, Centrifugation and Filtration methods (Theory and Design); Membrane based separations (Micro- and Ultra filtration) theory and design of equipment; Applications; Precipitation methods with salts, Organic solvents, and polymers; Extractive Separations; Aqueous two-phase extraction; Supercritical extraction; Into product removal/ integrated bioprocessing.

8. Membrane Technology:

Merits of the process; Classification; Theoretical models for membrane processes; Use of membrane diffusion as a tool for separating and characterizing naturally occurring polymers; Enzyme processing using ultra filtrate\ion membranes; Separation by solvent membranes; Electrodialysis; reverse osmosis; Solute polarization and cake formation in membrane ultra filtration- causes, consequences and control techniques.

9. Modeling and Simulation of Bioprocesses

Types of kinetic models. Data mooting and analysis, parameter estimation. Numerical integration techniques, parameters sensitivity analysis, statistical validity, Discrimination between two models, physiological state markers and its use in the formulation of structural model. Development of compartment and metabolic pathway models for intracellular state estimation.Dynamic simulation of batch, fed- batch, steady and transient cellular metabolism. Numerical optimization of bioprocesses using mathematical models.

Books:

1. Plant cell culture: A practical approach by R.A. Dixon and Gonzales, IRL Press
2. Animal cell culture techniques by Ina Freshney
3. Product recovery in Bioprocess Technology- BIOTOL series 1990
4. Bioseparations – down stream processing for biotechnology by belter P.A., Cussier E. Wiley Interscience pub. 1988.
5. Bioseparations: Principals and Techniques by B. Sivasankar, PHI 2005.
6. Bioprocess technology- Fundamentals and application shuler et.al.
7. Principal of fermentation technology- Stanbury Oxford et.al.
8. Bioprocess Engineering Basics concepts- Shuler etal.
9. Process Biotechnology fundamentals- Mukhopadhya
10. Bioprocess Engineering Principles- Doran Paulin
11. Process system analysis
12. Control – Coughanowar D.R
13. Biotechnology Theory and techniques Vol.1 – Plant Biotechnology Animal Cell culture and immune biotechnology by Chirikjian J.G.
14. Animal Biotechnology – Ranga M.M

SEM-I

ELECTIVE-I

Paper No. 1

IMMUNOTECHNOLOGY

Lecturer: 3 Hrs/ week
Tutorials/ Practical: 1
Theory: 100 marks
Term work: 25 marks
Total: 125 Marks

1. **Hybridoma techniques and monoclonal antibody production**-myeloma cell lines-fusion of myeloma cells with antibody producing B-cells-fusion methods- selection and screening methods for positive hybrids-cloning methods-production, purification and characterization of monoclonal antibodies. Application of monoclonal in biomedical research, in clinical diagnosis and treatment. Production of human monoclonal antibodies and their applications.
2. **T-Cell Cloning-**mechanism of antigen recognition by T and B-lymphocytes. Structure, function and synthesis of lymphokines-Importance of antigen presentation and MHC class II molecules in T-cell cloning- antigen specific and alloreactive T-cell cloning-use of T-cell cloning in understanding the immunologically relevant antigens and T-cell eptiopes-application of T-cell cloning in vaccine development.
3. **Immunity to viruses, bacteria and parasites** Genetic control of immune response-MHC associated predisposition to diseases-infectious disease, leprosy, tuberculosis, malaria, filariasis, amoebiasis, rabies, typhoid, hepatitis, AIDS.
4. **Principles and strategy for developing vaccines?** Newer methods of vaccine preparation-Conventional and modern types of vaccines-virus vaccines, DNA vaccines and specific vaccines. Techniques of preparation of vaccines, Human recombinant antibodies and their applications in medicine and industry.
5. **Immunodiagnosis of infectious diseases.** Polyclonal antibodies, their production and application, Western blot analysis, Immunohistochemistry, Immunoenzymatic ferritin technique , Elisa principle and application , Radioimmunoassay ,Chemiluminosis.
6. **Characterization of animal cells and their implication on process design:** Nutritional requirements and serum free culture of mammalian cells, Kinetics of growth and product formation. Reactor systems for large scale production using animal cells. Purification of antibodies.

Books:

1. **"**Monoclonal antibodies: Principle and practice" by J.W.Goding Academic Press.
2. **"**Hybridoma Technology in the Biosciences and Medicine" T.A.Sringer (Editor) Plenum Press, N.Y.
3. "Hybridoma Techniques: A Laboratory Course" by VR.Muthukkaruppan,S. Baskar and F.Sinigagalia, Macmillan India Ltd.
4. "Basic and Clinical Immunology" by D.P Stites,J.D.Stobo, H.H.Fudenberg J.V. Wells.5th Edition Large Medical Publications.
5. Isolation,Characterization and Utilization of T?lymphocyte clones" by C.Garrison Fathman,F.W.Fitch academic Press.
6. "Immunotechnology: Principle, Concepts and applications" by Anthony Moran, Publisher John Wiley and Sons,2006.
7. Kuby,J-Immunology,5th edn.(W.H.Freeman & Co,N.Y.2003).
8. Abdul,K. Abbas, Andrew K Lightman, Jordan S Pober, Cellular and Molecular Immunology (Saunders College Pub,,1998.
9. Principles of gene manipulation Old & Primrose.
10. Garrison Fathman,C.and Fitch,F.W.-Isolation,Characterization and utilization of T lymphocyte clones.
11. Ivan Roitt,Jonathan Brostoff and David Male –Immunology,3rd Edn.(Mosby Year Book Europe.Ltd,.England,1993)
12. Paul W.E.(Eds)-Fundamentals of Immunology,(Raven Press, New York,1998)
13. Harlow and David Lane –Antibodies: A laboratory manual, 1998 (old spring harbor laboratory).
14. Silverstein, Arthur M-A history of Immunology,(Academic Press ISBN: 021643770X).
15. Fernandex-Botran, Rafael-Advanced Methods in Cellular Immunology,(CRC Press ISBN:0849321255)
16. Roderick Nairn and Mathew Helbert-Immunology for Medical Students, (Mosby Intl.Ltd.2002).

SEM-I

ELECTIVE - 1

Paper No. - 2

BIOSENSOR TECHNOLOGY

Lecturer: 3 Hrs/ week
Tutorials/ Practical: 1
Theory: 100 marks
Term work: 25 marks
Total: 125 Marks

1. Introduction to biosensors.

2. Measurement and Instrumentation the sensitivity , specificity and linearity and measurement of biological sensing elements and transducer systems, their sensitivity specificity and linearity.

3. Classification of biosensors. Transduction principles used in Bisector, Biocomponent of the sensor.

4. Enzyme and whole cells based bio sensors. Affinity biosensors, amperometric biosensors, immunosensors, ELISA, plant cells, pesticide biosensor.

5. DNA Probe organic acids, antigen-antibodies reaction, biochemical detection of organelles, receptors, sensors for pollution gases stability and reusability of sensors.

6. Selected examples and further development of biosensors.

7. Flow injection analysis based biosensors, microbial, potentiometer, thermistor devices, FET, fiber optics Bioluminescence, Microbial biosensors, Application

Books :

1. Yang V.C. and T.T.Ngo.2000.Biosensors and their Applications, Academic/Plenum Publishers.
2. Ashok Mulchandani and Kim R Rogers, Enzyme and Microbial bio sensors:
3. Techniques and Protocols,(Eds.);Humana Press Totowa ,NJ,1998.
4. A.P.F. Turner, G.S. Wilsons Biosensors: Fundamentals and Applications, Oxford Science Publications, Oxford.
5. Reability and reconstruct ability concepts applied to bioprocess control, Hunt, Suand Meyer theorem, Lyapunov's stability.

6. Biosensors based on amperometric, potentiometric thermistor, Engineering Biosensors: kinetics design applications, Devices FET, fiber optics, Bioluminescence, microbial biosensors application.
7. Cooper, J.M.Biosensor.

SEM-I

Elective -1

Paper No. 3

ENVIRONMENTAL BIOTECHNOLOGY

Lecturer: 3 Hrs/ week
Tutorials/ Practical: 1
Theory: 100 marks
Term work: 25 marks
Total: 125 Marks

1. Environmental Pollution

Water, air and noise (introduction, source and effects pollutions): Waste water-communal, sewage and industrial effluents; Types of waste, properties and steps involved in aerobic and anaerobic treatments; Methanogenesis-Methanogenic, acetogenic and fermentative bacteria technique processes and conditions; concept of Biofuels.

2. Treatment Of Industrial Wastes

Waste water characteristic; Biological waste treatment; Kinetic models, unit operations, design, principle and modeling of activated sludge process, Trickling filters, Fluidized expanded reactor, Up flow anaerobic sludge blanket reactor, contact process, Fixed/packed reactor, Hybrid reactors, sequential batch reactors; Bioconversions of agricultural and of highly organic waste material into gainfully utilizable products-biogas, hydrogen cellular and food and feed stocks; Case studies (At least 05).

3. Decontamination Engineering/Bioremediation

Introduction; Process strategies for bioremediation through microbes and plant; Bioremediation by industries; Biotechnology processes for oil recovery, microbial oil recovery, toxic waste treatment, petroleum waste treatment; Exploiting microbial metabolism Bioremediation of organic contaminants, Heavy metals and Nitrogenous waste; Industrial waste treatment by reverse osmosis and ultra filtration.

4. Waste Disposal And Management

Introduction; Dairy, Pulp, dye, leather and pharmaceuticals, solid waste management; legislation of environmental problems; Microbial strain improvement with view to develop scavengers; Microbiological and biochemical aspects of waste water treatment processes; Biohazard monitoring and control-Risk assessment, hazard monitoring, remedial measures, technique and control strategies; Case studies (At least 05).

5. Applications

Treatment of Municipal Waste And Industrial Effluents; Animal oils; Renewable And Non Renewable Resources; Modern Fuels And Their Environmental Impacts; Biotechnological Inputs In Producing Good Quality Natural Fibers; Degradation of Pesticides and other Toxic Chemical by Microorganisms Toxin As A Natural Pesticide; Biofertilizers Nitrogen Fixing Microorganisms Enrich The Soil with assimilable Nitrogen; Bioremediation Using Microbes; Phytoremediation; Treatment of Distillery Effluents; Biofilms; Biomonitors of Environmental, Bioindicators.

Books :

1. Environmental biotechnology by Foster C.F.,John ware D.A Ellis Horwood limitedl;1987.
2. Biotechnology: A text book of industrial microbiology; T.D.Brock Smaeur Associates, 1990.
3. Environmental Biotechnology by Alan Scragg, 2nd Ed.Oxford University Press.
4. Waste-water Engineering-treatment and resource: Metcalf Eddy-TATA Mgralll Hill 4th Ed.
5. Trivedi, R.K.-Biotechnological Applications in Environmental Management
6. Environmantal Microbiology.

SEM-I

Elective – 1

Paper No - 4

ANIMAL BIOTECHNOLOGY

Lecturer: 3 Hrs/ week
Tutorials/ Practical: 1
Theory: 100 marks
Term work: 25 marks
Total: 125 Marks

1. **Introduction, history and scope-**
   I.Power
   II. Application
   III. Objectives
   IV. Advantages

2. **Balanced salt solutions and simple growth media, serum and its quality, medium sterilization**

3. **Basic techniques of animal cells culture & their application.**
   I. Cell bank
   II. Techniques
   III. Equipments and material.
   IV. Primary and established cell line cultures.
   V. Tissue culture media, balanced salt solutions and simple growth medium, chemical, physical and metabolic functions of different constituents of culture medium , Role of carbon dioxide, Role of serum and supplements, Measurement of viability and toxicity.

4. **Gene Cloning Vectors**
   I. Plasmids
   II. Bacteriophages
   III. Shuttle Vectors
   IV. Gene Cartridges

5. Techniques –

I. Isolation of DNA
II. Labeling
III. Mapping Gene's on chromosomes.
IV. Cleaving DNA
V. Blotting technique
VI. Detection of RFLP
VII. DNA Sequencing.

6. Transgenic animal technology

I. Outline
II. Rodent Cloning and transgenesis
III. Expression of foreign gene.
IV. Use of transgenic animal
V. Transgenic mice as a model
VI. Genetic Engineering.

7. In Vitro fertilization and embryo transfer.

8. Molecular biological techniques for rapid diagnosis of genetic diseases and gene therapy.

9. Chemical carcinogenesis, transfection, oncogenes and antioncogenes.

10. Preservation and maintenance of animal cell lines, cryopreservation and transport

Books :

1. Molecular Biotechnology : Primrose
2. Animal Cell Biotechnology: R.E. Spier and J.B Griffiths (1988), Academic press.
3. Living resources for Biotechnology, Animal cells: A Doyle,R.Hay and B.E. Kirsop (1990), Cambridge University Press, Cambridge.
4. Animal Biotechnology: Murray Moo-Young (1989), Permagon Press, Oxford.
5. Ranga, M. M Animal Biotechnology.
6. Srivastava, A.K.-Animal Biotechnology.

SEM –I

Lecturer: 1 Hrs/ week
Tutorials/ Practical: 2 Hrs
Term work: 75 marks
P/O: 50 marks
Total: 125 Marks

Laboratory -1

1. Isolation of industrially important microorganisms for microbial processes.
2. Determination of thermal death point (TDP) and thermal death time of microorganism.
3. Determine growth curve of supplied microorganism and also determine substrate degradation process.
4. Microbial production of antibodies (Penicillin)
5. Use of alginate for cell immobilization.
6. Production and estimation of alkaline protease
7. Determination of oxygen transfer rate.
8. Determination of mixing time in bioreactors.
9. Determination of specific growth rate (M) and growth yield (Y_x) , Specific Product formation rate (Q1) and substrate consumption rate.
10. Study of Kinetics of cell Growth.
11. Study of Kinetics of product formation.
12. Kinetics Study of amylase fermentation.
13. Animal cell Culture in static phase and spinner flask

SEM-II

Paper No. -1

BIOREACTOR DESIGN

Lectures: 3Hrs. /Week
Tutorial/Practical: 2
Theory: 100 marks
Term Work: 25 marks
Total: 125 marks

1. **Reactor Operation**
   Batch operation of a mixed Reactor, Total time for Batch Reaction cycle, Fed batch operation of a Mixed Reactor, Continuous operation of a Mixed Reactor, Chemostat with Immobilised cells, chemostat Cascade, chemostat with cell recycle, continuous operation of a pulg-flow reactor. Comparison between major modes of reactor operation, Sterilization.

2. **Ideal Bioreactors: -** Fed batch reactors, enzyme-catalyzed Reactions in CSTRs, CSTR reactors with Recycle and wall growth. The ideal plug flow tubular reactor.
3. **Reactor Dynamics:** Dynamic models, stability.
4. **Reactors with non ideal Mixing:-**Mixing times in agitated tanks, Residence time distributions models for non ideal reactors, mixing Bioreactors Interactions.
5. **Immobilized Biocatalysts:** - Formulation and Characterization of Immobilized cell Biocatalyst, application of Immobilized cell Biocatalysts.
6. **Multiphase Bioreactors:** - Conversion of heterogeneous substrates, packed bed reactors, Bubble-column Bioreactors, Fluidized bed bioreactors, Trickle bed Reactors.
7. **Fermentation Technology:** - Medium formulation design and operation of a typical aseptic, Aerobic fermentation process alternated Bioreactor configurations.
8. **Animal and Plant cell reactor technology:** - Environmental requirements for animal cell cultivation, Reactors for large scale production using animal cells, plant cells cultivation.
9. **Mass transfer and Bioreactor design:** Gas-liquid mass transfer in cellular systems, determination of oxygen transfer rates, mass transfer for freely rising or falling bodies, forced convection mass transfer, Overall K_{la} estimates and power requirements for sparged and agitated vessels, mass transfer across free surfaces, factors affecting mass transfer coefficient.
10. **Bioreactor Instrumentation and control:** Temperature control, Control of gas supply, Control of pH, Control of dissolved oxygen, Antifoam control; Additional sensors-Redox, Air flow, Weight, Pressure, On-line measurement of biomass

11. **Mechanically Agitated and pneumatically agitated or Sparged reactors:** Effect of bubble size, sparger design, sparger location, liquid head and other design and operation parameters for Bubble column, airlift reactor, and gas induced mechanically agitated reactors, Hydrodynamics and mass transfer of sparged reactors. Applications of sparged reactors in biotechnology.

12. **Photo bioreactors:** Growth kinetics in photo bioreactor, effect of light intensity on growth, metabolite production. Design and operation parameter, types of photo bioreactors, novel photo bioreactors, considerations for scale up

13. **Solid state fermentation (SSF) Bioreactors:** growth kinetics in SSF systems, heat and mass transfer in SSF bioreactors, well mixed SSF bioreactors, tray bioreactors, packed bed bioreactors, various modes of operation of SSF bioreactors, scale up challenges for SSF bioreactors

Books

1. Bailey J.E and D.F.Ollis “Biochemical Engg.Fundamentals”.
2. O.Levenspiel “ Chemical Reaction Engg”
3. Pauline M. Doran. “Bioprocess Engineering Principles”.
4. Atkinsen,B; Brochemical reactor.
5. Nielson,J. and Villadsen; Bioreaction Engineering principles.
6. D.A. Mitchell, Solid-State Fermentation Bioreactors.
7. Chisti, M.Y., 1989. Airlift bioreactors, Elsevier applied science, London and New York.

SEM-II

Paper No. -2

ADVANCED ENZYME TECHNOLOGY

Lectures: 3Hrs. /Week
Tutorials/Practical: 2
Theory: 100 marks;
Term Work: 25 marks
Total :125 marks

1. **Introduction to enzyme: -** Introduction, Classification, Enzyme in action & specificity, Enzyme stability, monomer & oligomeric enzymes. Structure of enzymes-ray crystallography of enzymes, Extraction & Purification of enzymes, control of Enzyme activity.

2. **Enzyme kinetics & modeling of enzymatic systems:-** Kinetics of single substrate, multisubstrate enzyme catalyzed reaction, relation of kinetic parameters, microenvironmetal effects on enzyme kinetics, Mathematical modeling in E-kinetics with example.

3. **Immobilized enzymes:** - Introduction, Methods of immobilization, kinetics of immobilized enzymes & application in production of L-amino acids, & other uses, enzyme biosensors (design of E electrodes & application.).

4. **Regeneration of co-factors for enzyme biocatalysis: -** Introduction, NADP (H) regeneration ATP/NTP regeneration, sugar nucleotide regeneration, acetyl CoA enzyme regulator etc.

5. **Enzyme catalyzed organic synthesis :** Introduction, solvent systems, enzyme inactivation in organic solvents, effects on enzyme activity enzyme for mutation, organic solvents, effects on enzyme activity, enzyme formulation in organic media, lymphoid enzyme, absorbed, entrapped etc. & Applications-Kinetic resolution, asymmetric synthesis.

6. **Biotransformation with enzymes:** - Biocatalyst selections, biocatalyst treatment & mode of operation (Immobilization) & application steroids terpenes etc. Productions of molecules with flavoring properties.

7. **Enzyme as tools for stereo specific c- c bond formation in Monosaccharide & analogues**

- Enzymes like DHAP aldolase, pyruvate aldolase, tyrosine kinase & their uses
- Uses of mutagenesis to increase substrate specificity.
- Producing catalytic antibodies etc.

8. **Industrial enzymes:-** Few industrial enzymes like glucose-isomerase, cellulases, Pectinases etc.

    - Their importance, source production, optimization of fermentation medium, assay, purification, Characterization, genetic manipulation etc.

9. **Protein Engineering of Industrial enzymes:**
    - Introduction, targets by Chemo enzymatic Synthesis, rational design methods, site directed mutagenesis.
    - Chemical modification and unnatural amino acids.
    - Random method like molecular evolution, DNA shuffling, sequence space, method for mutagenesis, for recombination, sequence homology independent recombination, screening and selection.

Books:

1.Price and Lewis Stevens. Fundamentals of Enzymology
2.T. Palmer. Enzyme, Biochemistry and Clinical Chemistry
3.Ashok Pande, Colin Webb, Carlos Richard, Cristian Larroche. Enzyme Technology.
4. Nixon and Web – Enzymes.

SEM-II

Paper No. - 3.

ADVANCED FOOD TECHNOLOGY

Lectures: 3Hrs. /Week
Tutorials/Practical: 2
Theory: 100 marks;
Term Work: 25 marks
Total: 125 marks

1. **Food Chemistry:**
   i. Chemistry of the major organic constituents of food their properties and function.
   ii. Minor components of sensory importance in food including flavor compounds and pigments.
   iii. Milk products, detailed chemistry of the major components and their behavior during processing. Milk constituents and their significance.
   iv. Dairy products, chemistry and technology of dairy products including liquid milk products, cheese and fermented milks, concentrated and dehydrated milk products, butter and breads, Analysis of milk.
   v. Fresh and processed meat products, definition of meat, composition of muscles, myofibrillar proteins, regulatory and cytoskeleton proteins, conversion of muscle into meat. Normal and preserved conditions cold shortening. Thaw vigor, myoglobin and meat color. Factors affecting meat color, meat flavor, sausage manufacture, Myofibrillar protein functionality and effect of salt and phosphates on functionality, low fat meat products

2. **Food Microbiology**
   i. Microbiology in food and factors affecting their growth.
   ii. Preservation of food
   iii. Food Spoilage
   iv. Food poisoning and food borne diseases
   v. Sanitation of food plants
   vi. Bacteriology of water-Sampling, inspection

3. **Preservation Technology**
   i. Canning, dehydration, sterilization
   ii. Emulsification, sterilization, drying
   iii. Role of Lactic acid in food preservations in Sauerkraut
   iv. Waste treatment.

4. Improved technology for food processing

i. Enzymes in bakery and cereal products

ii. Enzymes in fruit juice production

iii. Enzymes in cheese making and beverage production.

5. Analysis of major food ingredients

i. Analysis of preservatives-natural and synthetic

ii. Food colors.

iii. Food flavor enhancing agents.

iv. Chemical measurements-

Detection and measurement-heavy metals, fungal toxins, bacteria-toxins, herbicides, pesticides, toxins.

6. Food Nutrition

i. Digestion and Metabolism

ii. Food availability

iii. Nutrition and Public health

iv. Problem associated with deficiencies and excess of specific factors

v. Metabolic disorders and remedies

7. Food legislation, Safety and quality control

Books:

1. T.P.Coultate – Food – The Chemistry of its components, 2nd edition Royal Society, London,1992.

2. B. Shivshanker – Food

Processing and Preservation, Prentice Hall of India Pvt. Ltd. New Delhi 2002.

3. W.C. Frazier and D. C. Westhoff – Food Microbiology, 4th ed. McGraw – Hill BookCo.,New York 1988.

4. J.M. Jay – Modern Food Microbiology, Cbs Pub. New Delhi, 1987.

5. Harrigan W. F. ,McCance M. E. – Acaemic Press, London, U. K. , Laboratory methods in food and dairy microbiology.

6. Speck M. L. – American Public Health Association, New York, Compendium of methids for the microbiological examination of food.

7. Hiremath G. G., Dhanajaya S.- College of Fisheries. Mangalore, India , A practical manual of freezing technology.

8.Thangavelu R. , Sanjeevraj P. J. – Indian society of Invetebrate Reproduction, Palani, India. Recent Advaces in Invertebrate Reproduction and Aquaculture.

SEM-II

Paper No. - 4.

ADVANCED GENETIC ENGINEERING

Lectures: 3Hrs. /Week
Tutorials/Practical: 1
Theory: 100 marks;
Term Work: 25 marks
Total :125 marks

1. Concepts in genetic engineering-A review.
2. Enzymology of genetic engineering: Restriction enzymes, DNA ligase, Polymerase etc.
3. Cloning Vehicles: Plasmids, Cosmids, Lambda phage, Charon phage, Shuttle vectors, 2m.
4. DNA plasmids, yeast plasmids.
5. Introduction of cloned genes into the host cells: Transformation, transduction, Particle gun, electroporation,liposome mediated, cultivation etc.
6. Molecular biology of DNA transfer in plants through *Agrobacterium tumefaciens*, discovering of Ti plasmids and T-DNA, opines, Expression of T-DNA genes, functional organization of the T-DNA, Ti-plasmids as gene vector, Caulimobiruses, Geminiviruses, Transposable elements, RNA viruses, viroids.
7. Analysis and expression of cloned gene in host cells: Restriction enzyme analysis, Southern blotting, Northern blotting, In-situ hybridization DNA sequencing. RFLP, PCR, RAPD, DNA finger printing, Lipase chain reaction, Ribozymes, DNA probes, antisense RNA, Expression of clonal genes.
8. Gene libraries- Construction and analysis of cDNA, m-RNA, isolation, cDNA synthesis, cloning and amplification of gene libraries, Genomic DNA libraries, YACs, BACs, Measuring activity of fused genes, Identifying the products of cDNA clones. Changing genes: Site-directed mutagenesis.
9. Tailoring model plants and animals.
10. Controlling the expression of transgene in time and space.
11. Transferring genes into animal oocytes, eggs, embryos and specific animal tissues.
12. Application and Impact of rDNA technology.
13. Ethical issues and biosafety regulation.

Books :

1. From Principles of Gene Manipulation by Old & Primrose.
2. Genes VIII by Benjamini Lewin, Oxford.
3. Genes and Genomes by M.Singer & P.Berg.
4. Genome-3, T.A. Brown.
5. Genetic Engineering, Sandhy Mitra.

Sem. – II
ELECTIVE – 2
Paper No. – 1
PLANT BIOTECHNOLOGY

Lecturer: 3 Hrs/ week
Tutorials/ Practical: 1
Theory: 100 marks
Term work: 25 marks
Total: 125 Marks

1. Introduction to PTC technology - History & methodology.

2.Special features and organization of plant cells: Totipotency, Regeneration of plants – leaves, roots , stems .

3.Plant Products of industrial importance

i. Biochemistry in brief of major metabolic pathways and products

ii. Kinetics for growth, product formation, large scale production of secondary metabolites from suspension culture and nutrient optimization,

4.Different types of plant cultures-

i.Meristem/shoot tip/nodal segment-virus free plants/ clonal propagation.

ii.Anther, pollen, ovule-double haploid plant production.

iii.Cell/callus/suspension-artificial seed production.

iv.Embryo-distant hybrid plant production.

v.Protoplast technology.

5.Pathways of regeneration and micro propagation

i.Axillary shoot proliferation

ii.Organogenesis

iii.Somatic embryogenesis.

6. Micro techniques for plant tissue culture

i.Development of callus and suspention culture of plant cell

ii.Shear sensitivity of cell culture growth and product formation

iii.Kinetics in suspension culture production on secondary metabolites.

7. Basic conventional plant breeding, green revolution.

8. Plant Transformation technology

i. Ti and Ri plasmids, CaMv, 35s promoter, shuttle, vector, Agrobacterium and reporter gene.

ii. Methods of plant transformation :particle gun, Agrobacterium mediated gene transfer

iii. Progress in Plant genetic engineering.

9. Molecular marker-aided breeding

i. Different types of DNA markers

ii. Generation of mapping population

iii.Tagging of genes with specific molecular markers.

10. Plant biodiversity.

i.Biodiversity hotspot in India

ii.Characterization of biodiversity through different biochemical and molecular methods (Chemical printing of biodiversity)

iii.Conservation strategies of biodiversity including tissue culture methods

iv.Bioprospecting of biodiversity for product development.

Books:

1. J.Hammond, P.Mc garvey and V.Yusibov (Eds) Plant Biotechnology 2000.
2. T.J.Fu G Singh and W.R.Curtis (Eds) Plant Cell and Tissue culture for reproduction of food ingredients.
3. R.J. Henry Practical application of Plant molecular biology 1997
4. Buchanan, B.B.-Biotechnology and Molecular Biology of Plants.
5. Pollard, J.W.-Basic cell culture protocol.

SEM-II
ELECTIVE-II
Paper No. - 2
PHARMACEUTICAL BIOTECHNOLOGY

Lecturer: 3 Hrs/ week
Tutorials/ Practical: 1
Theory: 100 marks
Term work: 25 marks
Total: 125 Marks

1. Drug targets classification:DNA, RNA, post-translational processing enzymes, metabolic enzymes involved in nucleic acid synthesis, G-protein coupled receptors (monomeric transmembrane proteins), small molecule receptors, neuropeptide receptors, ion channels (monomeric multi-transmembrane)proteins, ligand-gated ion channels (Oligomeric transmembrane proteins), transporters (multi-transmembrane proteins);

2. Drug Delivery and Drug targeting: Concepts of Bio availability, Process of drug absorption, Pharmacokinetic processes, Timing for optimal therapy, Drug delivery considerations for the new biotherapeutics, Parenteral delivery-intravenous, intramuscular, interperitoneal. Oral delivery and systemic delivery through oral route-Structure and physiology of Gastro Intestinal tract, Impediments against oral availability, Advantages and disadvantages of oral drug delivery .Drug targeting to CNS –Blood-Brain barrier, physiological and physiochemical factors for delivering to CNS ,current and new technologies in CNS delivery, Pulmonary drug delivery, Cell specific drug delivery, topical and intraocular drug delivery.

3. Oligonucleotides: Gene therapy in cancer treatment and in HIV infection, Antisense therapy, Ribozymes.

4. Oligosaccharides: Oligosaccharide synthesis, Heparin, Glycoproteins, Polysaccharide bacterial vaccines, Approaches to carbohydrate-based cancer vaccines.

5. Cardiovascular Drugs: Myocardial infarction agents, Endogenous vasoactive peptides, Hematopoietic agents. Anticoagulants, anthrombotics and hemostatics.

6. Chemotherapeutic Agents: Synthetic antibacterial agents, Anthelminitic agents, Antiamebic agents, Antiviral agents.

7. Endocrine Drugs: Female sex hormones and analogs, Agents affecting the immune response.

8. Enzymes: Enzymes fermentors and fermentation medium, extraction and purification of oxidoreudctase, oxidases, hydrolases, Penicillin amidases, transferases and applications of enzyme in therapeutics, clinical analysis and pharma industry.

9. Antibiotics: Antibacterial, antifungal antibiotics, screening of antibiotics procedures, inoculum and medium for commercial production of penicillin and cephalosporin, fermentation process, extraction and purification.

10.Cancer immunotherapy

Books :

1. Christine M.Bladon.John Wiley & Sons, Ltd.(2002). Pharmaceutical Chemistry
2. Manfred E.Wolff. A Wiley & Sons.Inc (2000). Burger's Medicinal Chemistry and Drug Discovery (5th edition)
3. Grietje Molema and Dirk K.F.Meijer. Wiley-VCH.(2002). Drug Targeting Organ-Specific Strategies
4. W.B.Pratt and P..Taylor,Churchill Livingston"Principles of Drug Action"
5. A.M Hillery,A.W.Lloyd and J.Swarbrick, Harwood Academic Publisher. "Drug Delivery and Targeting".
6. Murray Moo-Young(Ed)-Comprehensive biotechnology Vol.3.2004(Permagon Press)
7. Templeton and Lasic-Gene therapy 2000(Marcel and Dekkn)

SEM-II

ELECTIVE-II

Paper No. - 3

ADVANCED PROTEIN ENGINEERING

Lecturer: 3 Hrs/ week
Tutorials/ Practical: 1
Theory: 100 marks
Term work: 25 marks
Total: 125 Marks

1.Protein Folding

Structure and Folding, Mechanism of folding, chaperonins and other proteins, shape, size and conformation, motifs of protein structure, electrophoresis.

2.Domain

Alpha, beta domain, alpha/beta domain, X-Ray analysis of proteins, mathematical principles, Bragg' Law, NMR.

3.Protein Engineering Strategies.

Strategies, Random, site directed structure prediction and modeling of proteins.

4.Mass Spectrometry-based methods for protein identification and Phosphorylation site analysis.

Mass spectrometry principles, correlative mass spectrometric-based identification strategies, De novo sequencing using mass spectrometric data, separation methods for Phosphorylation site analysis, present and future challenges and opportunities.

5.Molecular Graphics

Molecular graphics in protein engineering, dynamics and mechanics, drug protein interaction and design.

6.Applications

Industry, medicine, etc.

Books:

1. Stephen H White, -Experimental Approaches; Oxford University Press.1994. Membrane Protein Structure
2. A.J.Wilkinson,P.C Moody;,March 1991 Protein Engineering in Focus
3. Jeffery L Cleland, ,January 1996 Protein Engineering Principles and Practice
4. S.R.Pennington and M.J.Dunn, Viva Books Pvt.Ltd.2001 Proteomics: From Protein sequence to Functions
5. Daniel C.Liebler, Human Press. Introduction to Proteomics

SEM-II

ELECTIVE-II

Paper No. - 4

ADVANCED BIOINFORMATICS

Lecturer: 3 Hrs/ week
Tutorials/ Practical: 1
Theory: 100 marks
Term work: 25 marks
Total: 125 Marks

1. Biological Sequence Database

Overview of various primary and secondary database that deals with protein and nucleic acid sequences. Databases to be covered in detail are GenBank, EMBL, DDBJ, SwissProt, PIR and MIPS for primary sequences. Various specialized database like TIGR, Hovergen, TAIR, PlasmoDB, ECDC etc., will also be discussed. Preliminary ideas of query and analysis of sequence information.

2.Sequence Comparison Methods

Method for the comparison of two sequences viz. Dot matrix plots, Needleman-Wusch & Smith-Waterman algorithms. Analysis of computational complexities and the relative merits and demerits of each method. Theory of scoring matrices and their use for sequence comparison.

3.Database Search Algorithms

Methods for searching sequence database like FASTA and BLAST algorithms. Statistical analysis and evaluation of BLAST results.

4.Pattern Recognition Methods in Sequence Analysis

Concept of sequence pattern, regular expression based patterns. The use of pattern database like PROSITE and PRINTS. Concept of position specific weight matrices and their use in sequence analysis. Theory of profiles and their use with special reference to PSIBLAst.Markov chains and Markov models and their use in gene finding. Concept of HMMS, the forward-backward and the Viterbi algorithm. The Baum-Welch algorithm for training a HMM. Use of profile HMM for protein family classification.

5.Introduction to Molecular Structures.

Concept of external and internal coordinates and algorithms for their interconversion. Different representation of molecular structures and their relative merits and demerits.

Experimental Methods for Molecular Structure Determination: Brief account of structure determination by X-ray crystallography and NMR spectroscopy. Validation of experimentally obtained NMR structures The Protein Data Bank (PDB) and the Nucleic Acid Data Bank (NDB).The PDB and the mmCIF file formats for the storage and dissemination of molecular structures.

6. Conformational Analysis

Concept of free energy of molecules. Introduction to various force fields and their relative merits and demerits. Techniques for Molecular energy minimization, Monte Carlo and Molecular Dynamics simulation.

7. Molecular Modeling

Methods of molecular modeling including homology modeling, threading and ab initio protein structure prediction together with their relative merits and demerits. Methods for structure-structure comparison of macromolecules with special reference to proteins.

8. Drug Design

General ideas of drug designing, 2D and 3D QASR, concept of pharmacophore and pharmacophore based searches of ligand database. Concepts of COMFA. Methods for simulated docking.

Books :

1. Wayne W.Daniel.Biostatistics:. Wiley Publication. A foundation for analysis in the health sciences
2. Bailey N.T.J (1974), English University Press Ltd. London. Statistical methods in Biology
3. Batschelet E Introduction to mathematics for life scientists ,.Springer Verlag, New York
4. Hoppensteadt F.,Pescin. C.,.Springer Verlag New York. Mathematics in medicine and life sciences
5. Scheffer W.C., Addison Wiley New York. Statistics for health Professional
6. Gribskov M Primer.M.Stockton Press. Sequence Analysis
7. Visweswara R.K.Jaypee,New Delhi. Biostatistics
8. Thomas L. John Wiley Germany. Bioinformatics From Genomes to Drugs Vol I&II
9. Luhe A. Americabios Scientific. DNA Sequencing: From experimental methods to bioinformatics.
10. Sequence analysis;A Practical approach. IRL Press.

SEM – II

Lecturer: 1 Hrs/ week
Tutorials/ Practical: 2 Hrs
Term work: 75 marks
P/O: 50 marks
Total: 125 Marks

Laboratory - 2

1. Determination and exhibition of K_m of the amylase from parotid and pancreas
2. Effect of competitive and non competitive inhibitors on the enzyme action.
3. Molecular weight determination of protein.
4. Isolation of enzyme chemotrypin. (Salt precipitation, gel filtration.)
5. Determination of c-terminal amino acids by sodium borohydrate- α amino alcohols can be distinguished by chromatography
6. Study of Structure of enzyme serine protease by X-ray crystallography.
7. Studies on oligomeric enzyme lactate dehydrogenase from- heart and muscles.(Electrophoresis)
8. To find out substrate specificity of enzymes.
9. Preparation of immobilized enzymes using ion exchange resin CM- cellulose.
10. Separation of lipids by TLC.
11. Extraction of Protein from milk, eggs and muscles.
12. Estimation of vitamin A and vitamin C from green leafy vegetables.
13. Isolation and separation of Polyphenols by chromatography
14. Cloning and expression GFP gene in *E. coli.*
15. DNA fingerprinting using RAPD.