M.Sc. BIOPROCESSING

I-BIOINSTRUMENTATION

Marks: Theory – 50, Practical – 25

Unit I: Centrifugation and Cell Disintegration

Basics: Basic principles of centrifugation, RCF and other factors affecting sedimentation, sedimentation velocity, sedimentation equilibrium, sedimentation coefficient, factors affecting Standard Sedimentation Coefficient.

Instrumentation: Types of centrifuge machines, Rotors, Preparative and analytical centrifuges, Applications of Boundary Sedimentation, Band sedimentation, Determination of Molecular weights.

Cell Disintegration: Physical, chemical and enzymatic methods of microbial, plant and animal cell disintegration.

Unit II: Chromatographic and Electrophoretic Techniques

Chromatographic techniques: History Basic principles, Partition coefficient, the nature of partition forces, counter current distribution, Introduction to planar and column chromatography.

Theory, principle and applications of Paper, Thin Layer, Gel Filtration, Ion Exchange, Affinity, Reverse phase chromatographic techniques, GLC and HPLC, Some specialized techniques of chromatography.

Electrophoretic Techniques: Basic Principles of Electrophoresis, Types of electrophoresis: free, zone and capillary electrophoresis.

Theory, principles and applications of Paper, Cellulose acetate and Gel Electrophoresis, Isoelectric focusing, Specialized Electrophoretic techniques viz., Discontinuous gel electrophoresis, Immunoelectrophoresis, Gradient, 2-D gel and Pulse-field gel electrophoresis, High voltage electrophoresis.

Unit III: Spectroscopy

Basics: Basic principles, Laws of absorption, Absorption spectrum, Chromophore concept.

Theory, Principles, Instrumentations and Applications of UV-Visible and IR spectrophotometry, Fluorescence, NMR, Atomic absorption, Mass, Raman, CD, ORD and Flame spectrophotometry, Luminometry, ESR Spectrometry, Mossbauer Spectrophotometry, LASER and X-Ray Diffraction methods, Flowcytometry.

Unit IV: Radio-Isotopic Techniques

History, Introduction to Isotopes and Radioactivity, Radioactive Decay, Production of Isotopes, Synthesis of radioactive compounds, Radioactive labeling procedures, Interaction of radioactivity with matter, Use of radio isotopes in Life Sciences, Commonly used isotopes, Safety aspects.

Detection and Measurement of radioactivity: Methods based upon Gas Ionization (ionization chambers, Proportional Counters and Geiger-Muller counters), Photographic methods, Methods based upon Excitation (Scintillation counters and their types).

Principles and applications of Tracer Techniques, Autoradiography and its applications, Dosimetry.

Unit V: Introduction to Bioreactors and Monitoring and Control of various parameters

Introduction to Bioreactors: Design of a basic fermenter, Bioreactor configurations, Reactors of specialized applications (Tube reactors, Fluidized-bed reactors, Cyclone reactors, Trickle flow reactors and Packed-Bed reactors).

Monitoring and control of various parameters: Sensors, Different types of fermentation instrumentation, Methods of measuring following process variables and their control: Temperature, Gas and Liquid flow, Pressure, Agitator shaft power, Rate of stirring, Foam sensing and control, Weight, Microbial Biomass, Dissolved oxygen, Inlet and exit gas analyses, pH and dissolved carbon dioxide.

Online analyses and other chemical factors, Computer control of fermenters.

Practicals:

1. Paper chromatography of amino acids by ascending and descending methods.
2. Separation of sugars by chromatography.
3. TLC of lipids.
4. TLC of antibiotics.
5. Column chromatography for proteins, pigments.
6. Paper electrophoresis.
7. Agarose gel electrophoresis.
8. PAGE and determination of molecular weights.
9. Cell disintegration.
10. Cell fractionation and assay of marker enzymes.
11. Friske Dosimetry.
12. Spectrophotometric analyses of proteins and nucleic acids.
13. Use of centrifugation techniques for separation of blood cells, isolation of chloroplast, isolation of microbial enzymes, etc.
14. Experiments related to PCR.
15. Experiments related to microscopy.

Reference Books:

1. Biophysical Chemistry: Principles and Techniques; by Nath & Upadhyay; Himalaya Publishing House.
2. Practical Biochemistry: Principle and Techniques; by Keith Wilson & John Walker; Cambridge University Press.

M.Sc. BIOPROCESSING
PaperII –Microbiology
Marks: Theory – 50, Practical – 25

Unit-1 Introduction to microbiology and microscopic techniques.

History – Discovery of microorganisms, Spontaneous generation versus biogenesis, Recognition of microbial role in disease causation and fermentation.

Bacterial morphology and structure – size, shape and arrangement of bacterial cells, Ultra structure of typical bacterial cell - Structure ,chemical compositions and functions of : Capsule and slime layer; Cell wall : Gram positive and Gram negative bacteria; Unit membrane; Flagella : Arrangement, mechanism of flagellar movement; Pili; Ribosomes; Nuclear material; Mesosome.

Unit – II Diversity of the microbial world

Microbial diversity – archea, bacteria, eukarya. Classification systems (Phenatic, Numerical, new approaches including ribotyping, rRNA sequencing)

General characteristics of actinomycetes, fungi, algae, viruses.

Archebacteria (Survival mechanism and importance of thermophiles, psycrophils, methanogns, alkalophiles, acidophiles, halophiles).

Unit – III Nutrition and cultivation of microorganisms

Common nutritional requirements – Energy sources, C,N,P,O,S,H, micronutrients, growth factors, water etc.

Nutritional classification on the basis of organic and inorganic compounds.

Cultivation - Properties of a good culture medium, Solid and liquid culture.

Definition, concept, use and types of different culture media (Natural, Synthetic, complex, selective, differential, enrichment, assay, minimal, maintenance media)

Isolation of pure cultures (Spread plate, streak plate, pour plate etc). Maintenance and preservation of pure cultures, Significance of pure culture, Culture collections, Cultivation of anaerobes

Unit – IV Microbial growth and sterilization techniques

The growth curve, Mathematics of growth, Brief introduction to - Diauxy growth; Synchronous growth; Continuous culture, Measurement of microbial growth (measurement of cell numbers, cell mass-turbidometry, dry wet etc), Factors influencing microbial growth – solutes, water activity, pH, temperature, oxygen concentration.

Sterilization by physical methods (temperature, radiations. Removal) and chemical means (Disinfectants - Phenolics, alcohols, halogens, heavy metals , quaternary ammonium compounds, aldehydes), Sterilization using gases (sulfur dioxide, ethylene oxide) and other agents.

Unit – V Microbial physiology;

Sporulation - Types of endospores, Sporulating bacteria, Structure of endospore, stages of sporulation and endospore germination.

Nutrient uptake – Passive diffusion, facilitated diffusion, active transport, Group translocation.

Practical

1 Practical based on staining
2 Demonstration of bacterial motility by hanging drop technique
2 Micrometry
3 Measurement of bacterial growth
4 Demonstration of presence of bacteria from – soil/ water/ air/ milk
5 Demonstration of yeast, fungi, actinomycetes, algae, protozoa
6 Demonstration of environmental factors on bacterial growth
7 Demonstration of passive transport in *S. cerevisae*
8 Demonstration of active transport

M.Sc. BIOPROCESSING
Paper-III BASIC BIOCHEMISTRY
Marks: Theory – 50, Practical – 25

UNIT I
Structure and function of Biomolecules, carbohydrates, proteins, lipids and nucleic acids. Biochemical separation methods. Vitamins, enzymes and coenzymes.

UNIT-II
Biological membranes and transport across them. Bioenergetics, major anabolic and catabolic pathways of carbohydrate metabolism and their regulation; glycolysis, TCA cycle, pentose phosphate pathway, galactose metabolism, electron transport and oxidative phosphorylation, gluconeogenesis.

UNIT-III
Lipid metabolism; transport and oxidation of fatty acids in animal tissues, glycerol metabolism, biosynthesis of fatty acids and triacylglycerol.
Protein metabolism; out lines of amino acid metabolism and their significance.

UNIT-IV
Nucleotide metabolism: Biosynthesis & degradation of purine & pyrimidine nucleotide

UNIT-V
Typical metabolic pathways of microbes; Entner-Duodoroff pathway, glyoxilate cycle, phosphoketolate pathway. Biochemical aspects of Hormone Action.

Practicals

1) Introduction to basic laboratory instruments like – pH meter, colorimeter, single pan balance - calibration,centrifuge etc.
2) Preparation of reagents, buffers etc.
3) Determination of total amino acid concentration by ninhydrin method.
4) Estimation of protein concentration by
   i) Biuret method ii) Lowry method iii) Spectrophotometric method
   iv) Dye binding method.
5) Estimation of reducing sugar concentration by
i) DNSA method

6) Estimation total sugar concentration by
   i) Phenol-H2SO4 method ii) Anthrone method
7) Determination of fructose concentration by resorcinol method.
8) Isolation of characterization of casein from milk.
9) Isolation and characterization of starch from potato.
10) Estimation of Inorganic phosphate by Fiske & Subbarow Method

REFERENCES:

1. Lehninger A.L., Neston D.L., "Principles of Biochemistry", N.M. Cox, CBS Publishers & Distributors.
2. Lubert Stryer "Biochemistry", W.H. Freemen & Co. , New York.
3. Weil J.H. "General Biochemistry", New Age International (Pvt. Ltd.).
4. Murray R.K. and others (Eds). Harper's Biochemistry, 25th Edn. Appleton and Lange Stanford.
5. Practical Biochemistry : An Introductory Course by Fiona Frais.
6. Methods in Enzymology Vol. I by S.P.Colowick and N.O.Kaplan eds.
7. Basic Biochemical Methods 2nd ed by R.R.Alexander and J.M.Griffith
8. Biochemical Methods 2nd ed. by S.Sadasivam and A. Manickam.
9. Hawk's Physiological Chemistry ed. by Bernard L Oser.
10. A Textbook of Practical Biochemistry by David Plummer.
11. Laboratory Mannual in Biochemistry by S. Jayaraman

M.Sc. BIOPROCESSING
Paper-IV Molecular Cell Biology
Marks: Theory – 50, Practical – 25

Unit I Cell Structure and function
Diversity of cell size and shape, Cell theory, Structure of prokaryotic and eukaryotic cells Organization and functions of subcellular organelles of bacteria, yeast, plant and animal cells,

Unit II Cell Division
Cell division, Molecular control of cell division, Abnormal cell division – leading to tumor , cell cycle, and cell cycle regulation, cell death and its regulation, cell division in prokaryotic cells.

Unit III, Biomembranes & Cell Architecture:
Structure & function of biomembranes i.e. plasma membrane,E.R.membrane, mitochondrial & chloroplast membrane and membranes in Nitrobactor sp.
Preparation & applications of liposomes.
The Cytoskeleton : Types of filament system (actin, intermediate filament, microtubules), structure and function.

Unit IV Cellular Interactions
Cell-cell interaction : Nerve cell –muscle cell interaction, Rhizobium –legume interaction, Cell- cell interaction observed in Myxobacteria & Bdelovibrio life cycles. Siderophores producing microbes and its applications

Unit V Cell signaling
Overview of intracellular signaling mechanisms, Concept of receptors, Receptor Ligand interactions, endocrine autocrine paracrine transmissions, Coupling of receptors to different signal transducing machinery, G proteins, structure,fution, adenylate cyclase system, cAmp, protein kinase &CREB proteins ,calcium channels, and second messengers.

Practicals
1 Effect of detergents on membrane permeability
2 Isolation of cellular organelles
3 study of marker enzymes from the isolated organelles
4 Preparation of liposomes
5 Growth and assay of siderophores

M.Sc. BIOPROCESSING
Paper II - Advanced Enzymology
Marks: Theory – 50, Practical – 25

Unit I
Enzymes
Classification - IUB system, rationale, overview and specific examples. Characteristics of enzymes, enzyme substrate complex. Concept of active centre, binding sites, stereospecificity and ES complex formation. Effect of temperature, pH and substrate concentration on reaction rate. Activation energy. Transition state theory. Enzyme activity, international units, specific activity, turnover number, end point kinetic assay

Unit II
Enzyme Kinetics
Michaelis - Menten Equation - form and derivation, steady state enzyme kinetics. Significance of Vmax and Km. Bisubstrate reactions. Graphical procedures in enzymology - advantages and disadvantages of alternate plotting. Enzyme inhibition - types of inhibitors - competitive, noncompetitive and uncompetitive, their mode of action and experimental determination.
Enzyme catalysis-Factors affecting catalytic efficiency - proximity and orientation effects, distortion or strain, acid - base and nucleophilic catalysis. Methods for studying fast reactions. Chemical modification of enzymes. Isoenzymes and multiple forms of enzymes.

Unit III
Structure function relations
Lysozyme, ribonuclease, trypsin, carboxypeptidase, phosphorylase, aspartate transcarbamylase, glutamine synthetase and phosphofructo kinase. Multi enzyme complexes - pyruvate dehydrogenase and fatty acid synthetase; Na - K ATPase.

Unit IV
Allosteric interactions:
Protein ligand binding including measurements, analysis of binding isotherms, co-operativity , Hill and Scatchard plots and kinetics of allosteric enzymes.
Enzyme regulation:
Product inhibition, feedback control, enzyme induction and repression and covalent modification. Allosteric regulation.

Unit V
Immobilized enzymes:
Relative practical and economic advantage for industrial use, effect of partition on kinetics and performance with particular emphasis on charge and hydrophobicity (pH, temperature and Km). Various methods of immobilization - ionic bonding, adsorption, covalent bonding (based on R groups of amino acids) , microencapsulation and gel entrapment. Immobilized multienzyme systems
Biosensors - glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors

Practical

1] Purification of protein (Enzyme) by ion exchange chromatography. [DEAE cellulose
chromatography]
2] Identification and quantitation of activity of amylase/ cellulose/ amyloglucosidase/ invertase/ alkaline phosphatase (salivary/microbial/animal/plant source].
3] Determination of specific activity.
4] Determination of activity in presence of activators.
5) Determination of activity in presence of inhibitors.
6] Determination of optimum pH
7] Determination of optimum temperature
8] Determination of Km
9] Study of competitive, non-competitive inhibitors

Suggested readings:

1) Methods in Enzymology Vol. I and II by S.P.Colowick and N.O.Kaplan eds.
2) Basic Biochemical Methods 2nd ed by R.R.Alexander and J.M.Griffith.
3) Hawk's Physiological Chemistry ed. by Bernard L Oser.
4) A Textbook of Practical Biochemistry by David Plummer.
5) Laboratory Mannual in Biochemistry by S. Jayaraman.
6) Practical Biochemistry by Clarke and Switzer
7) Methods in Enzymatic analysis by Bergmeyer, Vol I –III
8) Fundamentals of Enzymology Price and Stevens
9) Enzymes Dixon and Webb
10) Isoenzymes By D. W. Moss
11) Immobilized Biocatalysts W. Hartneir
12) Selected papers Allosteric Regulation M. Tokushige

M.Sc. BIOPROCESSING
SEMESTER II
Industrial Bioprocess

Unit I: Basic concepts of bioprocess and Fermentation Process

Historical development of bioprocess technology- overview of traditional and modern applications of biotech process, role of bioprocess in biotech industry, Generalized process flow sheets.

Growth stoichiometry calculations, Stoichiometry predictions based on Gibbs energy dissipation, Growth kinetics from a thermodynamic view, Kinetics of microbial growth and product formation. Phases of cell growth in batch cultures, Kinetic modelling of microbial growth, Monodmodel, Kinetics of growth in batch culture. Growth of filamentous organisms. Growth associated (primary) and non-growth associated (secondary) product formation kinetics, Leudeking-Piret models, substrate and product inhibition on cell growth and product formation. Introduction to Structured Models for growth and product formation. Continuous culture w.r.t. substrate utilization, specific growth rate, steady state chemostat, Fed batch fermentations: yield of biomass, products, calculation of productivity, substrate utilization kinetics.

Unit II: General requirements of fermentation process -I

Basic design and construction of fermentor and ancillaries, Main parameters to be monitored and controlled in fermentation processes. Reactors for specialized applications- tube reactors, packed bed reactors, fluidized bed reactors, cyclone reactors, trickle flow reactors, their basic construction and types for distribution of gases. Ideal reactors- single reactors and multiple design, Multiple reactors- parallel, series and series-parallel-design principles-Non Isothermal reactors and pressure effects, Non Ideal flow models and reactor performance.

Measurement and control: Structure of process models, Kinetic rate expressions, Advanced modelling considerations, Process supervision and control, Open loop control, Closed loop control, Valves systems in bioprocessing.

Overview of aerobic and anaerobic fermentation processes and their application in biotech industry, Solid substrate fermentation and its application.

Unit III: General requirements of fermentation process-II

Medium requirements for fermentation processes, Carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design and usage of various commercial media for industrial fermentations, thermal death kinetics of micro organisms, batch and continuous heat, sterilisation of liquid media,
Filter sterilisation of liquid media, Air, Design of sterilization equipment.

Inocula development, storage of cultures for repairs, fermentation.

Scale-up and Scale-down processes.

Unit IV: Enzymatic Bioconversion Processes and Downstream Processings and Process Economics

Kinetics and thermodynamics of enzyme-catalyzed reactions, techniques of enzyme immobilisation, Basic design and configuration of immobilised enzyme reactors, applications of immobilised enzyme technology.

Downstream processing: a multistage operation, solid-liquid separation, Release of intracellular components, Concentration of biological products, Product purification by different methods, Product formulation, Monitoring of downstream processing, Process integration.

Process economics: The starting point, Cost estimates, Process design, Design exercise, Capital costs estimates, Operating costs estimates, The costs case- to build or not to build.

Unit V: Isolation, Selection and Improvement of culture

Screening and isolation of microorganisms, Primary and secondary screening, Metabolic screening, Enrichment and specific screening for the desired product.

Strain improvement for the selected organisms – Mutation and screening of improved cultures, random and strategic screening methods of strain improvement for primary and secondary metabolites with relevant examples. Use of recombinant Technology, Protoplast fusion techniques for strain improvement of primary and secondary metabolites. Production of recombinant molecule in heterologous system, Problems associated with SIP, Improvement of characters other than products and its application on the industry.

Importance of media in fermentation, Media balancing after strain improvement. Preservation of cultures after SIP.

Practicals:

1. Isolation of industrially important microorganisms from environment.
2. Determination of Growth Curve of a industrial organism and compute substrate degradation profile, specific growth rate, and growth yield.
3. Screening and enrichment for a primary metabolite from the environment.
4. Screening and enrichment for secondary metabolites from the environment.
5. Strain improvement for highest yield of a product.
6. Random and strategic screening for a metabolite.
7. Media balancing experiments.
8. Media formulation experiments.
9. Alcohol fermentation using different substrates and its downstream processing.
10. Production of invertase by yeast using immobilization processes.
11. Inoculum development.

Reference Books:

1. Bailly & Ollis, Biochemical Engineering Fundamentals; Tata McGrew Hills, New York.
2. Stanberry & Whitttttkar, Principles of Fermentation Technology, Pergeomon Prress, Oxford.
3. Creuger & Creuger, Biotechnology, A Textbook of Industrial Microbiology, Sinaeur Associates.
4. H. J. Rehm & Reedg, Biotechnology, A comprehensive Treatise VCH.
5. L. E. Cassida, Industrial Microbiology, Willey Eastern.
6. Applied Microbiology series.
7. Veiph W. F., Bioprocess Engineering Kinetics, Mass Transport, Reactors and Gene Expressions, John Willey and Sons.
8. Atkinsons B., Biochemical Reactors, Pion Ltd. London.
9. Battley E. H., Energetics of Microbial Growth, John Willey & sons.
10. Davis J. E. & Demain A. L., Manual of Industrial Microbiology and Biotechnology, II ed., ASM Publications.
11. Nelson J. Villadesom, Bioreaction Engineering Principles, Plen & Press, New York.
12. Roels J. A., Energetics & Kinetics in Biotechnology, Elsevier, Biomedical Press, Amsterdam.
13. Stphanopolous G., Nelson J. & Arstodoua, Metabolic Engineering Principles & Methodologies, Academic Press, San Diago.
14. Chisti Y., Encyclopedia of Bioprocess Technology – Fermentation Biocatalyst & Bioseparation, Vol. 5, John Willey & Sons, New York.
15. Doran, Bioprocess Engineering Principles, Academic Press, London.
16. Van't Riet K. & Pranper J., Basic Bioreactor Design, Mercel Dekkar, New York.
17. Aengo J.A. Ed, Separation process in Biotechnology, Mercel Dekkar, New York.
18. Belter P. A. Cussler, El & Hu W – S., Bioseparations: Downstream Processing for Biotechnology, John Willey & Sons.
19. Colin Ratledge & Bjorn Kristiansen, Basic Biotechnology, Cambridge University Press.

M.Sc. (Bioprocessing) Syllabus

Paper III : Bioinformatics II

Unit I

Introduction to Bioinformatics, it's scope and applications.Major resourses in Bioinformatics (NCBI/EBI/Expasy) GenBank/EMBL/DDBJ, NBRF-PIR, SwissProt. Biological databases-primary database, secondary database, composite database, derived database. Various nucleotide databases, protein databases. Search engines-Entrez, SRS. PubMed, PubMedCentral, OMIM.Motifs, Domains, Patterns, Conserved domains and their databases.

Unit II

BLAST,FASTA,Various BLAST programs(nBLAST, nBLASTp, xBLAST, BLASTp, PHI-BLAST, PSI-BLAST).
Sequence alignment-pairwise alignment,multiple alignment,tools for alignments(CLUSTAL X,CLUSTAL W).Sequence analysis.Structure analysis.
Structure alignment,structure analysis,protein structure prediction methods.molecular modeling.

Unit III

DNA microarray.protein microarray,their types.Microarray applications in Bioprocessing.Bioarray.
Meatbolomics.proteomics.Genomics,Functional Genomics.
Microbial databases(TIGR,VBI,MPIDB etc.). Microbial Genome databases(MBGD etc.).
Microbial Rosetta stone database.Metabolic pathway databases.
Microbial gene expression, Microbial expression technology,metabolic engineering,genetic engineering in bacteria.Genetics of microbes.

Unit IV

Molecular interactions - protein-protein, protein-dna, biomolecular interactions.
Molecular visualization tools (RasMol, RasTop),Molecular modeling softwares-SpdbViewer.
Meatbolomics.proteomics.Genomics,Functional Genomics.Applications of all –omics in Genetics.Gene prediction softwares,Gene finder software.
Dynamic programming,Search engines(eg.:Google)

Unit V

Primer design softwares, gene expression analysis, technologies for gene expression analysis (microarrays, SAGE). Phylogenetic methods. Phylogenetic analysis.Applications of phylogeny analysis. Comparison of Phylogenetic Trees obtained using DNA seq. Vs. protein. Seq. Vs. Full Genomes. Gene Finding and Sequence Annotation.

Practical

Exploring the integrated database system at NCBI server and querying the PUBMED and GenBank databases using the ENTREZ search engine

Exploring the integrated database system at EBI server and searching the EMBL Nucleotide database using the SRS search engine

Exploring and querying the SWISSPROT database

Exploring and querying the PIR database

Database (homology) searches using different versions of BLAST and interpretation of the results to derive the biologically significant relationships of the query sequences (proteinsIDNA) with the database sequences

Database (homology) searches using different versions of FASTA and interpretation of the results to derive the biologically significant relationships of the query sequences (proteinsIDNA) with the database sequences Pair-wise local alignments of protein and DNA sequences using Smith-Waterman algorithm and interpretation of results. Pair-wise global alignments of protein and DNA sequences using Needleman-Wunsch algorithm and interpretation of results to deduce homology between the sequences

Multiple sequence alignments of sets of sequences using web-based and stand-alone version of CLUSTAL. Interpretation of results to identify conserved and variable regions and correlate them with physico-chemical and structural properties Exploring and using the derived databases: PRO SITE, PRINTS, BLOCKS, Pfam and Prodom for pattern searching, domain searches etc.

References

Introduction to Bioinformatics; Attwood
Bioinformatics; C,V. Murthy
Bioinformatics;

M.Sc. BIOPROCESSING
SEMESTER II
Membrane Biophysics & Transport Processes

Unit I: Membrane structure

Various membrane models, Carbohydrate, Lipids & Proteins, Components of cell membrane, Principles of membrane organization & stability, Biogenesis of cell membrane, Molecular motion in membrane & membrane fluidity, Protein-Lipid interactions, Phase properties of biological membranes.

Unit II: Membrane potential and Membrane Energetics

Nature and magnitude of cell surface charge, Hodgkin Huxley equation, membrane impedance, Relation between membrane potential and cell characteristics, Zeta, Stern, and total electrochemical potential, Helmholtz-Smoluchowski equation; its correction by Debye-Huckle theory. Thermodynamic and kinetic approaches to membrane potential, Calculation of electrochemical potential by Nernst equation, Transmembranes potential and its measurement by microelectrodes.

Flow sheet of membrane energetics, Chloroplast membrane and energy transduction, Energy transduction through mitochondrial membrane.

Unit III: Transport across the membrane and Active Transport

Diffusion, Fick,s law, Diffusion in two compartments, and multi compartment systems, Mechanisms of simple diffusion and facilitated diffusion, Diffusion of non-electrolytes across the membrane, Rate theory of membrane transport, electrodiffusion, Osmosis, Osmotic pressure Osmotic equilibrium, Donnan equilibrium, Flow of water and of solute, Electroosmosis, Molecular basis of aqueous channels.

Nature, Selective permeability of biomembrane, Selectivity and ion specificity of biomembrane, Role of carriers in ion transport (eg. – Valinomycin & Gramicidin), Transporting ATPase-Na-K ATPase, Calcium ion transporting, Transport of macromolecules with and without vesiculation and by intermediate mechanism.

Unit IV: Fundamentals of Mass transfer:

Molecular and convective mass transfer, diffusivity and mass transfer coefficients, gas-liquid exchange and mass transfer, Oxygen transfer, Critical oxygen transfer, Determination of kLa, Mass transfer equipments-Distillation, Absorption and adsorption equipments, Introduction to transport phenomenon, transport properties, system and control of volume. Development of velocity, temperature and concentration profiles, overall mass transfer, momentum and energy balances. Differential mass,

momentum and energy balances. Turbulent transport mechanism and analysis of mass, momentum and energy transfer. Momentum, energy and mass transfer analogies.

Unit V: Heat Transfer and Sterilization

Heat Transfer, Steady and Unsteady state heat conduction. Aeration/Agitation – its importance, Sterilization of Bioreactors, Nutrients, Air supply, Products and Effluent. Process variables and Control scale of bioreactors. Mixing problems and mixing equipments, mechanical size reduction and size separation.

Practicals:

1. To determine partial characteristics of membrane protein by SDS-PAGE.
2. Analysis of bacterial and yeast membrane lipids by TLC and their estimation.
3. To determine osmolarity of solutions by using Osmometer.
4. Passage of molecule through dialysis membrane and demonstrations of Donnan membrane equilibrium.
5. To study the interactions of detergent and other membrane active agents with bacterial membrane and yeast membrane and effect of incubation time, Temperature and concentration.
6. To study the permeability of model membrane (liposomes) anions.
7. Preparation of liposomes.
8. To demonstrate cell fusion using high DC (Direct Current) field.
9. To measure the membrane potential using Fluorescence techniques.
10. To measure membrane conductance.
11. To study the phase transition in lipid bilayer membrane.
12. Determination of TDP and TDT of organisms.

Reference Books:

1. Fundamentals of momentum, heat and mass transfer-James (Charles & Robert, John Wiley & Sons).
2. Transport phenomenon-Robert & herry (Mc Graw Hill)
3. Elements of transport phenomena- Leighton & Donald (Mc Graw Hill)
4. Transport processes & unit operations- Christie J Gearikoplis (Prentice Hall, India)
5. Mass transfer-Patil (Nirali Prakashan)
6. Engineering heat transfer-Gupta & Prakash
7. Fundamentals of engineering heat and mass transfer-R C Sachdev.
8. Ryo Sato, Yasuo Kagawa (1982), Transport and Bioenergetics in Biomembrane, Japan Scientific Societies Press.
9. Clarsson I., M. Moller (1990), The plant Plasma Membrane (Structure, function and molecular biology), Springer-verlag
10. Jurgen Kiefer (1990), Biological Radiation Effects, Springer-verlag.
11. Bernard Pullman (1978), Proteins in physicochemical Biology, Academic Press.
12. A.Kotyk, K. Janacek and J. Koryta (1988), Biophysical chemistry of membranes

functions, John Wiley and sons.
13 E. Edward Bittar (1980), Membrane structure and function, John Wiley and sons.
N. Lakshminararyanaiah (1984), Membrane Structure and function, John Wiley and sons.
14 David J. Swosett, Patric A. Kenny, R. Eugene, Johnston (1987), The physics of diagnostic imaging, Chapman and Hall Medical.
15 R.Glaser, D. Gingell (1990), Biophysics of the cell surfaces, Springer-verlag.
.J. B. C. Findlay and W. H. Evans (1987), Biological Membranes a practical approach, ORL press.
16 . G.Giebisch, D. C. Tosteson, H.H. Ussing (1978), Membrane Transport in Biology, Springer-verlag.
17 .Vladimir P. Skulachev (1988), Membrane Bioenergetics, Springer-verlag.
18 D.C. Posteson (1969), The Molecular basis of membrane function, Prentice-Hall, Inc.

M.Sc.Bioprocessing 2nd (3rd and 4th semester) syllabus

3rd Semester Syllabus

Paper No.	Paper Name	Theory Marks	Practical Marks	Total Marks
IX	Molecular Biology	50	25	75
X	Applied Fermentation Technology-I	50	25	75
XI	Cell culture Techniques	50	25	75
XII	Environmental Biotechnology and Food Processing	50	25	75

4th Semester Syllabus

Paper No.	Paper Name	Theory Marks	Practical Marks	Total Marks
XIII	Pharmaceutical Manufacturing Processes and Research Methodology	50	25	75
XIV	Applied Fermentation Technology-II	50	25	75
XV	Total Quality Management and Professional Ethics	50	25	75
XVI	Chemical reaction engineering	50	25	75

3rd Semester syllabus

IX	**Molecular Biology**	**50(T)**	**25(P)**	**75**

Unit I

Genetic Material

Discovery of genetic material-Experimental evidences,Genome of bacteria viruses & Eukaryotic Cell, C-value Paradox,Cot value,repetitive & Non-repetitive DNA,organelle Genome: mitochondria & chloroplast,Topological Manipulation of DNA

Nucleosomes: Nucleosomes as sub unit of chromatin,organization of histone Octamer, modes of Epigenic inheritance.

Unit II

DNA Replication and Mutation

Replication of DNA is semiconservative, semidiscontinuous & Primed by RNA, Direction of Replication with experimental evidences, replicons. Replication of bacteria & Structure of Pol III holoenzyme . Machanism of replication of chromosomal DNA,circular plasmids,Teleomers, ϕX174 and Organelle genome.

Replication of eukarotes & DNA polymerase of eukaryotes, role of Licencing factor of eukaryotes during replication, replication of leading & lagging strand. Constancy & Catalytic efficiency of polymerases.

Mutation:

Types of mutation: point ,frame Shift,lethal,conditional lethal,inversion & deletion,null mutation, Reversion of mutation,intra & intergenic suppression. Enrichment of mutant of of single type. Spontaneous & induced Mutation: Physical & chemical mutagen

Unit III

Repair & Recombination

Repair of DNA:

Repair mechanism in prokaryotes: 1] Light dependant repair - photo reactivation. 2] Light independant repair: a) excision repair, b) mismatch repair, c) sos repair and d) recombination repair.

Eukaryoptic repair mechanism: 1) Excision repair in Eukaryotes – a] global genome – nucleotide excision repair (GG-NER) and b]transcription coupled - nucleotide excision repair [TC-NER], 2) Base excision repair (BER) and 3) Double strand break repair in eukaryotes.

Recombination:

Recombination between heteroduplex DNA, Holliday intermediate, Proteins involved in Recombination, Role of recA, rec BCD pathway in E. coli, Single strand assimilation in bacteria. Conjugation in bacteria., replication & transfer of DNA , Transduction- Generalised and Specialised mechanisms, Recombination hot spots. Gene conversions.

Transposons- Insertion sequences and Composite transposons, phages as transposons, Replicative , non –replicative & conservative transpositions. Controlling elements of maize- autonomous and nonautonomous elements. P- elements in Drosophila., Retroviruses and retroposons.

Unit IV

Transcription

Prokaryotic transcription: Prokaryotic RNA polymerase & its sub unit s,Sigma factor & Specificity of binding to DNA ,structure of bacterial promoter & their consensus

sequences. Inition of Trancription,elongation & termination,rho dependent & rho independent termination of transcription & post transcriptional modification .

Eukaryotic transcription: RNA polymerase-types & sub units,promoter elements for RNA pol I, pol II and pol III, initiation of transcription by RNA pol I, pol II and pol III and transcription factors involved in initiation, ,elongation & termination of transcription.

chromatin structure & its effect on transcription: a) chromatin structure and gene activity, b) effects of histones on transcription of genes, c)Histone acetylation d) Histone deacetylation, e) chromatin remodeling and f) Nucleosomes and transcription elongation.

post trancrptional modification of r RNA, t RNA & m RNA,polyadenylation,intron splicing,role of snurps

Unit V

Translation

Experiment on Direction of protein synthesis, t-RNA as Adaptor, ribosomes & their organization in prokaryotes & eukarotes.

Bacterial translation: polycistronic RNA in bacteria ,initiation of translation in bacteria small sub unit ,its accessory factor ,SD sequences in bacteria ,initiator t-RNA,elongation of translation,tranlocation & termination mechanism.

Eukaryotic translation: initiation, elongation and termination. Role of ribosomal RNA in protein synthesis and summary of genetic code.

Post translational modification of proteins, protein folding, membrane localization, localization in organelles, co-tranlational transfer through ER, transport of proteins to nucleus, oligosaccharide addition to proteins

Practical

1. Spontaneous mutation in bacteria by Fluctuation test.

2. Induced mutation using chemical mutagens.

4. Induced mutation using physical mutagens

5. Auxotroph enrichment by ampicillin method.

6.Dark Repair mechanism in E.Coli.

7. Light repair mechanism in E.coli.

8.Repair mechanism in Yeast

9.Study of genotype & its Conformation.

10. Gene expression in E.coli.

Refrences:

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2.David Friedfielder-Essentials of Molecular Biology,Jonnes & Barlett Publication

3.J.Kendrew-Encyclopedia of Molecular Biology,Black Well Scientific Publication

4.Weaver-Molecular Biology

5.J D Watson,N H Hopkins,J W Roberts-Molecular Biology of the Gene,Benjamin Cummings Publ.co.inc.California

6.J.Darnell,et al Molecular Biology of the cell (2 nd edition) Garland publishing inc.

7.Meyers R A (ed), Molecular Biology & Biotechnology.VCH Publisher NY inc

8.Alberts B ,et al Molecular Biology of the cell ,Gerland Publishing inc.

9.Watson J D,Recombinant DNA

10.Malacimski,Essentials of moleculars Biology

11.Stansfield,Molecular Biology

12.Walker,Molecular Biology & Biotechnology

13. Brown T A,essentials of Molecular Biology Vol 1 & vol II

14.Dale,Molecular Genetics Of Bacteria

X	Applied Fermentation Technology-I	50(T)	25(P)	75

UNIT I

Industrial Fermentation and Production of:

Role of Microbes in food Processes, operation and production; Production of SCP and SCO; Baker's yeast; Algal proteins; Idli; Sauerkraut; Vinegar; Pickling; Mushroom cultivation; Microbial production of food additives like colors and flavors.

Alcoholic Beverages: Beer; Wine; Rum; Gin; Whisky; Brandy; Vodka.

UNIT II

Food Bioprocessing

Starter cultures their biochemical activities, production and preservation of Soy sauce; Fermented meat sausages. Application of microbial enzymes in food industry

Vinegar fermentation

Unit III

Food Preservation and Biosensors

Fermentation as a method for preserving foods. Deoxygenating and desugaring by glucose oxidase, beer mashing and chill proofing and various other enzyme catalytic actions in food processing. Classification of fruit juices. Post harvest technology and different methods of food preservation. Genetically modified foods. Biosensors in food

Unit IV

Dairy Bioprocessing

Microbiology of fermented milk products (acidophilus milk, yoghurt). Role of microorganisms in beverages – tea and coffee fermentations. Microbiology of cheese and cheese production. Utilization and disposal of dairy by-product - whey.

Unit V

Quality assurances in foods

Foodborne infections and intoxications; bacterial with examples of infective and toxic types –, Clostridium, Salmonella, Shigella, Staphylococcus, Campylobacter, Listeria. Mycotoxins in food with reference to Aspergillus species. Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI.

Practicals:

1. Production and estimation of lactic acid by Lactobacillus Sp. Or Streptococcus Sp.
2. Extraction and estimation of diacetyl.
3. Sauerkraut fermentation
4. Isolation of food poisoning bacteria from contaminated foods,

Dairy products

5. Extraction and detection of afla toxin for infected foods.
6. Preservation of potato/onion by UV radiation
7. Production of fermented milk by Lactobacillus acidophilus.
8. Rapid analytical techniques in food quality control using microbial Biosensors.
9. Alcohol production and alcoholic beverages production.
10. Production of citric acid.

11. SCP production.

Rferences:

1. Food Microbiology. 2nd Edition By Adams

2. Basic Food Microbiology by Banwart George J.

3. Food Microbiology: Fundamentals and Frontiers by Dolle

4. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2 by Joshi.

5. Fundamentals of Dairy Microbiology by Prajapati.

6. Essentials of Food Microbiology. Edited by John Garbult. Arnold International

7. Microbiology of Fermented Foods. Volume II and I. By Brian J. Wood.Elsiever Applied Science Publication.

8. Microbiology of Foods by John C. Ayres. J. Orwin Mundt. William E. Sandinee. W. H. Freeman and Co.

9. Dairy Microbiology by Robinson. Volume II and I.

10. Food Microbiology: Fundamentals and Frontiers. 2nd Edition by Michaell P. Doyle, Larry R. Beuchat and Thomas I. Montville (Eds.), ASM Publications.

11. Bacterial Pathogenesis A Molecular Approach. 2 nd Edition. 2001 by Abigail A.Salyers and Dixie D. Whitt. ASM Publications.

12. Advances in Applied Microbiology by D. Pearlman, Academic Press.

13. Biotechnology, A textbook of industrial Microbiology by Creuger and Creuger, Sinaeur associates.

XI	Cell culture Techniques	50	25	75

Plant cell culture:

Unit I

Introduction to plant tissue culture

Plant tissue culture (PTC): Media composition, phytohormones and their selective usage, selection of media for specific applications, media sterilization.

Initiation of tissue culture: Cellular totipotency, media for initiation of callus, dynamics of callus growth, measurement of growth, Organogenesis and factors controlling its application, Genome instability in reaction to morphogenesis, Somaclonal variation and its application, micro propagation and its application.

Cell suspension culture: suspension cultures in stationary and stirred tank reactors, construction of STR for plant cell cultures and scale up, embryogenesis in free cells, Isolation of single cells and their culture, measurement of growth, protoplast isolation , culture, regeneration and fusion of protoplasts, generation of cybrids and hybrids, cryopreservation of plant cells.

Unit II

Plant Genetic Engineering and Vectors

Vectors: Plasmid vectors, Agro bacterium Ti plasmids, organization of T-DNA, Vir genes and their organization , integration of T-DNA into plant genome, Vectors derived from Ti plasmid ,binary vectors.

Plant viral vectors: CaMV based vectors, Gemini Viruses, TMV based vectors.

Transformation techniques: Agro bacterium mediated co-culture method, direct gene transfer methods, chemical electroporation, and particle gun.

Animal cell culture:

Unit III

Introduction to Animal tissue culture

Animal tissue culture: Natural and artificial media, Serum and its importance, Serum free media, chemically defined media, Protein free media, sterilization of glassware and media.

Initiation of cell culture: Primary cultures, disaggregating of tissue by mechanical, chemical and enzymatic methods, Secondary cultures, Cell strains, Cell lines and their maintenance, Transformed cell lines and their characteristics, Growth of cells in monolayer, suspension. Assessment of cell growth and preservation, Measurement of cell death, Apoptosis

Unit IV

Cell culture, Organ Culture and vectors

Animal organ cultures, various cells used in tissue culture and their uses, cell synchronization, Cell cloning and micromanipulations, Artificial skin, large scale culturing of animal cells: Monolayer cultures in roux bottles, roller bottle, multitray, synthetic hollow fiber, bead bed reactors, micro carrier cultures, heterogeneous reactors. Suspension cultures in stirred tank reactors, continuous flow cultures, airlift fermentor, immobilized cultures of animal cells.

Plasmid vectors: SV40 based vectors, binary vectors, retroviral plasmid constructs. Viral vectors: SV40 replacement vectors, retroviral vectors, Vaccine viral vector, baculoviral vectors.

Unit V

Applications of cell culture techniques:

Animal cell culture products: Vaccines, interferon's, Recombinant proteins, Antibodies.

Plant tissue culture and biosynthesis of secondary products. Plant secondary metabolites manipulation of different pathways (Metabolic engineering) application of suspension cultures, genetic stability, some of the important products from suspension cultures.

Practicals

Plant cell culture

1. Introduction to plant tissue culture
2. Media preparation, Sterilization
3. Induction of callus culture
4. Suspension culture
5. Plant regeneration from callus
6. Agro bacterium mediated transformation
7. Gene transfer in plant cell
8. Protoplast isolation and fusion
9. Preparation of media and filter sterilization

Animal cell culture

10. Introduction to Animal culture
11. Establishment of primary culture, secondary culture
12. Preservation of cell lines
13. Regeneration of frozen cells in vitro
14. Marker gene assay
15. Gene transfer into animal cells.

Reference:

1. R.J. Henry, Practical application of plant molecular biology, Chapman and Hall
2. Kalyan Kumar DE: Introduction to plant tissue culture `q
3. Bhojwani: plant tissue culture
4. Monte;; S.H. Mathews J.A., Mc Kee RA: Principles of plant biotechnology
5. Biotechnology, Annua; review, three volumes
6. Freshney R.I, Animal cell culture a practical approach, IRL press
7. Rehm and Reid, Biotechnology, 7 volumes
8. J. HamondP. McGaravey and V. Yusibov (Eds), Plant biotechnology springer verlag 2000
9. T.J. Fu, G. Singh and W.R. Curtis (Eds), Plant cell and tissue culture for the production of food ingredients, Kluwer Acedemic press 1999
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11. Dixon , Plant Cell culture
12. Srivastava, Plant Tissue culture and molecular Biology
13. Freshney culture of animal cells (3rd Edition), Wiley liss
14. J.R.W. Masters animal cell culture practical approach Oxford
15. R.Basega Cell growth and division , A practical approach, IAL press
16. M Batlez and AL. dawson, cell culture, labfax Bios Scientific publications Oxford
17. Martia Animal Cell culture technique , Springer
18. Methods in enzymology series
19. Plaket: Transgenic animal technology, A lab handbook

20. John R.W., Animal cell culture
21. Batter M (ed) Manmohan cell biotechnology. A practical approach, Oxford university press, new York
22. Spier R.E. The encyclopedia of Cell Technology, John Wiley and sona, New York.

XII	Environmental Biotechnology and Food Processing	50	25	75

UNIT I

Effluent treatment techniques

Microbiology of wastewater and solid waste treatment: - Waste-types-solid and liquid waste characterization, primary, secondary and tertiary treatments (in detail). Treatment schemes for effluents of dairy, distillery, tannery, sugar and antibiotic industries (Types, microbes used, types of Effluent Treatment Plants). Bioconversion of Solid Waste and utilization as fertilizer. Bioaccumulation of heavy metal ions from industrial effluents .

Unit II

Applied Environmental Bioprocess

Air pollution and its management; Bioremediation; Biochips; Bioplastics; Bio-weapons Bioinsecticides; Biofertilizers; Microbial surfactants;; Biofuel; Biohydrogen; Biodiesel.

Unit III

Bioremediation of Xenobiotics

Microbiology of degradation of xenobiotics in the environment, ecological considerations, decay behaviour, biomagnification and degredative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants and pesticides. Genetically Modified Organisms released and its environmental impact assessment and ethical issues.

Unit IV

Global environmental problems

Ozone depletion, UV-B, green house effect and acid rain, their impact and biotechnological approaches for management. . Containment of acid mine drainage applying biomining [with reference to copper extraction from low grade ores].

Unit V

Intellectual property and Ethical issues:

Intellectual prpety rights, (IPR), patents, trademarks, copy right, secrets, IPR and plant genetic respurces (PGR), Patenting of biological materials, international conventions, International coopettion obligations with patenet applications, Implication of patenting, current issues, hybridoma technoliogy etc. Patenting of higher plant and animals; transgenic organisms and isolated genes, patenting of genes and DNA sequences, plant breeder's right and farmer's rights.

EC structure and tools; Directives Decision on Regulation (and how to find them); Biotechnology and the law: summary of some current legislation in fore/ Cartagna Protocol 1989 EDA rules. Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in industry. Regulatory aspects of quality control. Quality assurance and quality management in industries ISO, WHO and US certification. Design and layout of sterile product manufacturing unit. Designing of Microbiology laboratory. Safety in microbiology laboratory.

Guidelines for microbial and animal cell cultivation. Safety and the genetic manipulation of organisms. Mnaufacture and evaluation of medicinal products. Regulation of biotechnology in the food industry.

Practicals:

1. Physical analysis of sewage/industrial effluent by measuring total solids, total dissolved solids and total suspended solids.

2. Determination of indices of pollution by measuring BOD/COD of different effluents.

3. Bacterial reduction of nitrate from ground waters

4. Isolation and purification of degradative plasmid of microbes growing in polluted environments.

5. Recovery of toxic metal ions of an industrial effluent by immobilized cells.

6. Biotransformation of toxic chromium (+ 6) into non-toxic (+ 3) by Pseudomonas species.

7. Isolation of aromatic hydrocarbon degrading bacteria.

8. Microbial dye decolourization/adsorption.

9. Biofertilizer production.

10. Bioinsecticide production.

References:

1. Bioremediation by Baker K.H. And Herson D.S. 1994.. MacGraw Hill Inc. N.Y.

2. Waste Water Engineering - Treatment, Disposal and Re-use by Metcalf and Eddy, Inc., Tata MacGraw Hill, New Delhi.

3. Pollution: Ecology and Biotreatment by Ec Eldowney, S. Hardman D.J. and Waite S. 1993. - Longman Scientific Technical.

4. Environmental Microbiology edited by Ralph Mitchell. A John Wiley and Sons. Inc.

5. Waste Water Microbiology 2nd Edition by Bitton.

6. Chemistry and Ecotoxicology of pollution. Edited by Des. W. Connell, G.J. Miller. Wiley Interscience Publications.

7. Environmental Biotechnology. Edited by C. F. Forster and D.A., John Wase. Ellis Horwood Ltd. Publication.

8. Advances in Waste Water Treatment Technologies. 1998. Volumes II and I by R. K. Trivedy. Global Science Publication.

9. Biocatalysis and Biodegradation: Microbial transformation of organic compounds. 2000 by Lawrence P. Wacekett, C. Douglas Hershberger. ASM Publications.

10. A Manual of Environmental Microbiology. 2nd Edition. 2001 by Christon J. Hurst (Chief Editor), ASM Publications.

11. Biodegradation and Bioremediation, Academic Press, San Diego.

12. Biotechnology in the sustainable environment, Plenum Press, N.Y.

13. Basic Principles of Geomicrobiology by A. D. Agate, Pune.

4th Semester Syllabus

Paper No.	Paper Name	Theory Marks	Practical Marks	Total Marks
XIII	Pharmaceutical Manufacturing Processes and Research Methodology	50	25	75
XIV	Applied Fermentation Technology-II	50	25	75
XV	Total Quality Management and Professional Ethics	50	25	75
XVI	Chemical reaction engineering	50	25	75

XIII	Pharmaceutical Manufacturing Processes and Research Methodology	50	25	75

Unit – 1

Antibiotics and synthetic antimicrobial agents

Antibiotics and synthetic antimicrobial agents; Classification of antibiotics; antibiotic research; Isolation of new antibiotics; Hybrid antibiotics.

Industrial production of: Aminoglycosides, b lactams, tetracyclines, ansamycins, macrolide antibiotics. Antifungal antibiotics, antitumor substances. Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolinone antimicrobial agents. Chemical disinfectants, antiseptics and preservatives

Unit – 2

Mechanism of action of antibiotics

Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis). Molecular principles of drug targeting. Drug delivery system in gene therapy. Bacterial resistance to antibiotics. Mode of action of bacterial killing by

quinolinones. Bacterial resistance to quionolinones. Mode of action of non – antibiotic antimicrobial agents. Penetrating defenses – How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion).

Unit – 3

Other Pharmaceutical Products

Industrial Production of: Vitamins: Cyanocobalamin and Riboflavin. New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine clinical trials. Other pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase).

Unit – 4

Spoilage of pharmaceutical Products, Regulatory practices, biosensors and applications in Pharmaceuticals. Microbial contamination and spoilage of pharmaceutical products (sterile injectibles, non injectibles, ophthalmic preparations and implants) and their sterilization. Manufacturing procedures and in process control of pharmaceuticals. Financing R&D capital and market outlook. IP, BP, USP. Government regulatory practices and policies, FDA perspective. Reimbursement of drugs and biologicals, legislative perspective. Rational drug design. Immobilization procedures for pharmaceutical applications (liposomes).Macromolecular, cellular and synthetic drug carriers. Applications of microbial enzymes in pharmaceuticals. Pharmaceutical biosensors.

Unit –5

Research Methodology

Research: A way of Thinking- Applications of Research, Definitions of Research, Characteristics of Research,

i) Types of research

- Application
- Objectives
- Type of Information Sought

ii) Paradigms of Research

Research Process: A quick Glance - The Research Process an eight step model:

Step I: Formulating a research problem

Step II: Conceptualizing a Research Design

Step III: Constructing a instrument for data collection

Step IV: Selecting a sample

Step V: Writing a research Proposal

Step VI: Collecting Data

Step VII: Processing Data

Step VIII: Writing A research Report

Reviewing the Literature

i) Reasons for Reviewing Literature

- Bring Clarity and Focus to your Research Problem
- Improve your Methodology
- Broaden your Knowledge base in your Research area

ii) Procedure for Reviewing the Literature

- Search for existing Literature
- Review the Literature selected
- Develop a theoretical framework
- Develop a conceptual framework

iii) Writing up the literature reviewed

Formulating a Research problem

1) The research problem
2) The importance of formulating a research problem
3) Sources of Research Problem
4) Considerations in selecting a research problem
5) Steps in the formulation of a research problem
6) The formulation of a objectives
7) Establishing operational definitions

Identifying Variables

i) The definition of a variable

ii) The difference between a concept and a variable

iii) Concepts, Indicators and Variables

iv) Types of Variables

- From the viewpoint of causation
- From the viewpoint of study design
- From the viewpoint of the unit of measurement

v) Types of measurement scale

- The normal or classificatory scale
- The ordinal or ranking scale
- The Interval scale
- The ration scale

Constructing Hypothesis

1) The definition of a Hypothesis
2) The function of a Hypothesis

3) The characteristics of a hypothesis

4) Types of Hypothesis

5) Errors in testing a hypothesis

The research design

1) The definition of a research design

2) The function of a research design

Selecting a method of data collection

i) Collecting data using primary sources

- Observation
- The interview
- The questionnaire

ii) Collecting data using secondary sources

- Problems with using data from secondary sources

Collecting data using attitudinal scales

i) Functions of attitudinal scales

ii) Difficulties in developing an attitudinal scale

iii) Types of attitudinal scale

- The summated rating or Likert scale
- The equal-appearing-interval or Thurstone scale
- The cumulative of Guttman scale

iv) The relationship between attitudinal and measurement scales

Establishing the validity and reliability of a research Instrument

i) The concept of Validity

- Types of validity

ii) The concept of Reliability

- Factors affecting the reliability of a research instrument
- Methods of determining the reliability of an instrument

Sampling

i) The concept of sampling

ii) Sampling Technology

iii) Principles of sampling

iv) Factors affecting the inference drawn from the a sample

v) Aims in selecting a sample

vi) Types of sampling

- Random probability sampling design
- Non random probability sampling design
- The 'mixed' sampling design

vii) The calculation of sample size

Writing a research proposal

1) The research proposal
2) The preamble introduction
3) The problem
4) The objectives of the study
5) The hypothesis to be tested
6) The study design
7) The setting
8) Measurement procedures
9) Sampling

10) Analysis of Data

11) Structure of Report

12) Problems and limitations

13) Work Schedule

14) Appendix

Considering ethical issues in data collection

i) Ethics

ii) Stakeholders in research

iii) Ethical considerations concerning research participants

- Collecting information
- Seeking consent
- Providing incentives
- Seeking sensitive information
- The possibility of causing harm to participants
- Maintaining confidentiality

iv) Ethical issues relating to the researcher

- Avoiding bias
    - Types of Bias
- Provision of deprivation of a treatment
- Using appropriate research methodology
- Correct reporting
- Using information

v) Ethical considerations regarding the sponsoring organization

- Restrictions imposed by the sponsoring organization

- The use of Information

Processing data

i) Editing data

ii) Coding data

- Developing a code book
- Pre-testing a code book
- Coding the data
- Verifying the coded data

iii) Developing a frame of analysis

- Frequency distribution
- Cross tabulation
- Constructing the main concepts

Statistical procedures

iv) Analyzing data

v) The role of computers in Research

vi) The role of statistics in Research

Displaying data

i) Tables

- Structure
- Types of Tables
- Types of Percentages

ii) Graphs

- The histogram
- The bar chart

- The stacked bar chart
- The 100 per cent bar chart
- The frequency polygon
- The cumulative frequency polygon
- The stem-and-leaf display
- The pie chart
- The line diagram or trend curve
- The area chart
- The scattergram

Writing a research Report

1) Research writing in general
2) Referencing
3) Writing a bibliography
4) Developing an outline
5) Writing about a variable

Practicals:

1. Spectrophotometric / Microbiological methods for the determination of Griesofulvin.

2. Bioassay of chlorempheniсol by plate assay method or turbidiometric Assay method.

3. Treatment of bacterial cells with cetrimide, phenol and detection of Leaky substances such as potassium ions, aminoacids, purines, Pyrimidines and pentoses due to cytoplasmic membrane damage.

4. To determine MIC, LD 50 of Beta-lactum/aminoglycoside/ tetracycline/ansamycins.

5. Sterility testing by Bacillus stearothermophilus

6. Sampling of pharmaceuticals for microbial contamination and load (syrups,

suspensions, creams and ointments, ophthalmic preparations).

7. Determination of D value, Z value for heat sterilization in pharmaceuticals.

8. Determination of antimicrobial activity of a chemical compound (Phenol, resorcinol, thymol, formaldehyde) to that of phenol under Standardized experimental conditions.

References

1 . Pharmaceutical Microbiology – Edt. by W.B.Hugo & A.D.Russell Sixth edition. Blackwell scientific Publications.

2. Analytical Microbiology –Edt by Frederick Kavanagh Volume I & II.Academic Press New York.

3. Quinolinone antimicrobial agents – Edt. by David C. Hooper, John S.Wolfson .ASM Washington DC.

4. Quality control in the Pharmaceutical Industry - Edt. by Murray S.Cooper Vol.2. Academic Press New York.

5. Biotechnology – Edt. by H.J.Rehm & G.Reed, Vol 4. VCH Publications, Federal Republic of Germany.

6. Pharmaceutical Biotechnology by S.P.Vyas & V.K.Dixit. CBS Publishers & Distributors, New Delhi.

7. Good Manufacturing Practices for Pharmaceuticals Second Edition, by Sydney H.Willig, Murray M.Tuckerman, William S.Hitchings IV. Mercel Dekker NC New York.

8. Advances in Applied Biotechnology Series Vol 10, Biopharmaceuticals in transition. Industrial Biotechnology Association by Paine Webber. Gulf Publishing Company Houston.

9. Drug Carriers in biology & Medicine Edt. by Gregory Gregoriadis. Academic Press New York.

10. Quality Assurance in Microbiology by Rajesh Bhatia, Rattan lal

11. Ihhpunjani. CBS Publishers & Distributors, New Delhi.

XIV	Applied Fermentation Technology-II	50 (T)	25(P)	75

Unit I

Enzymes and Amino Acids

Introduction to enzymes; Industrial production of: Amylases, Glucose isomerases, Lipases, L-asparginases, Pectinases, Proteases, Xylases, Rennin, Penicillin acylases, Lactases. Applications of enzymes in industries. Introduction to amino acids; Commercial uses of amino acids; Industrial production of: L-glutamic acid, L-tryptophan, L-lysine.

Unit II

Organic Feedstocks and Organic acids

Introduction to organic feedstocks; Industrial production of: Ethanol, Acetone-butanol, Glycerol. Introduction to Organic acids; Industrial production of Lactic acid; Citric acid; Acetic acid; Propionic acid; Butyric acid, Gluconic acid.

Unit III

Microbial transformations and Bioleaching

Introduction of microbial transformations; Types of bioconversion reactions; Procedures for biotransformation; Applications of bioconversions; Transformation of steroids and sterols; Transformation of nonsteroid compounds; Transformation of antibiotics; Transformation of pesticides.

Introduction to bioleaching; Organisms for leaching; Chemistry of microbial leaching; Commercial processes; Copper leaching; Uranium leaching

Unit IV

Ergot Alkaloids and Extracellular Polysaccharides

Introduction to ergot alkaloids; Occurrence and significance; Developmental cycle of Claviceps; Structure; Biosynthesis; Production of ergot alkaloids; Regulation of alkaloid production in cultures; Strain development and applications.

Introduction to Extracellular polysaccharides; Biosynthesis; Inustrial production of: Xanthan, Pullulan, Alginate, Dextran.

Unit V

Immobilization and Other Fermentation Processes

Immobilization of microbial cells and enzymes- techniques, stability,uses,and applications

General methods of production, producing organisms, purification, and applications of: Gibberellins, Triglycerides and fatty acids, Enzyme inhibitors.

Practicals:

1. Production of Organic acids by fermentation
2. Production of Amino acids by fermentation
3. Microbial Enzyme production and its charecterization
4. Microbial polysaccharide production
5. Lipid productions from microbes
6. Ethanol production
7. Biotransformations
8. Microbial leaching
9. Enzyme/ Cell immobilization methods

References:

1 Baily & Ollis Biochemical Engineering Fundementals, Tata Mcgraw hill , New york

2 Stanbury & whittekar Principles of Fermentation technology,Pergamon Press, Oxford.

3 Creuger & Creuger, Biotechnology, A text book of Industrial Microbiology,Sinaeur Associates

4 H.J.Rehm &Reed G , Biotechnology: A comprehensive treatise ,VCH

5 L.E.Cassida, Industrial Microbiology Wiley Eastern

6 Applied Microbiology series

7 Veith W.F. Bioprocess Engineering Kinetics,Mass transport, Reactors, And Gene Expression ,John Wiley & Sons

8 Atkinson B Biochemical Reactors Pion Ltd, London

9 Davies,J.E and Demain ,A.L Manual of Industrial Microbiology and Biotechnology 2nd Edition, ASM, Publications

10 Colin Ratledge and Bjorn Kristiansen Basic Biotechnology, 2nd Ed. Cambridge University Press.

XV	**Total Quality Management and Professional Ethics**	**50**	**25**	**75**

UNIT I

1. Introduction to Total Quality Management

- Enterprise excellence through Total Quality and Productivity.
- TQM: Basic Concepts & Philosophy; Evolution and acceptability;
- TQM Principals,Implementation, Applications;
- Leadership, Customer Satisfaction, Employee Involvement;
- Continous Process Improvement;
- Supplier Partnership; Performance Measures

2. Introduction to Statistical & Probability Theory

- Data Collection, Analysis and Presentation.
- Variability Patterns; Control charts; Process Capability
- Product Audit; Acceptance Sampling; Simple Correlation
- Reliability; Maintainability; Availability

UNIT II

3. Quality and Management Systems

- International Organization for Standardisation
- QMS ISO 9000 / 9001 Standards; ISO 14000 EMS; TS 16949
- A Software Maturity Framework (CMM)
- Business Excellence and Quality Awards
- Quality Cost System; Benchmarking
- Quality Function Deployment (QFD); Taguchi`s Robust Design
- Failure Mode and Effect Analysis (FMEA); Total Productive Maintenance (TPM)

4. TQM in Manufacturing System

- Quality; Specifiying Quality; Planning for Quality; Attaining Quality
- Inspection and Controlling Quality
- Following up Quality; Improving Quality
- Managing Quality; Human Factors in Quality
- Certification / Export Inspection

UNIT III

5. TQM in Service System

- Understanding the Service System
- Service Quality Models; Customer Satisfaction; Quality Measurement;

- TQM in Healthcare, Education, Financial Services, Public Sector and other Service Systems.
- World Class Service Quality

UNIT IV

6. Medical Ethics an Introduction

- The history of Medical Ethics
- The role of Codes
- Choosing among Professional and other codifications

7. The normative Principles of Medical Ethics

- Moral Justifications and Moral Theories
- Moral Principles and rules
- The meaning and weight of Principles and Rules
- Criticism of Principles

8. The concepts of Health, Illness and Disease

- Importance of Health and Illness in Contemporary society
- Health, Disease and Scope of Medicine
- Relationship between concepts of Health, Illness and Diseases
- Normativism Vs Nonnormativism in the definition of disease
- Health as normality and disease as abnormality
- Proponents of normativism

UNIT V

9. Human Experimentations

- A historical comparison
- Ethical review procedures

- Informed Consent and ICH GCP E6 Guidelines

10. Reproductive Technologies and Genetics

- Reproductive Technologies
- Genetic testing and Screenings
- Human Gene therapy and Genetic Engineering

11. Healthcare delivery and Resource allocation

PRACTICALS

References:

1. **TQM:** Text with Cases, Third Edition (TQM: Text with Cases) by John S Oakland
2. **Total Quality: Management**, Organization and Strategy by James R. Evans
3. **Total Quality Management: Strategies and Techniques Proven at Today's Most Successful Companies (Portable Mba Series)** by Stephen George and Arnold Weimerskirch (**Hardcover** - Feb 1998)
4. **Quality Management Essentials** by David Hoyle
5. **Total Quality Management: Text, Cases, and Readings, Third Edition** by Joel E. Ross and Susan Perry
6. **Total Quality Management: Strategies and Techniques Proven at Today's Most Successful Companies (Portable Mba Series)** by Stephen George and Arnold Weimerskirch
7. **Total Quality: Management, Organization and Strategy** by James R. Evans and James W. Dean
8. **Quality Management: Introduction to Total Quality Management for Production, Processing, and Services** (4th Edition) by David L. Goetsch and Stanley B. Davis

9. **Meaningful Work: Rethinking Professional Ethics**, by Mike W. Martin (2000)
10. ***Ethics for the Professions*,** by John Rowan, John R. Rowan, Samuel Zinaich, Jr.
11. **Clinical Ethics: A Practical Approach to Ethical Decisions in Clinical Medicine**, 4th edn., by Albert R. Jonsen, Mark Siegler, and William J. Winslade (1997)

XVI	**Chemical reaction engineering**	**50**	**25**	**75**

Unit 1

1. Homogenous Reactions in the Ideal Rectors

   - Concentration Dependent Term of a Rate Equation
   - Temperature Dependent Term of a Rate Equation
   - Searching for mechanism
   - Predictability of Reaction Rate from Theory

2. Interpretation of Batch reactor design

   - Constant Volume Batch Reactor
   - Varying Volume Batch Reactor
   - Temperature and Reaction Rate
   - The search for a Rate Equation

Unit 2

3. Introduction to Reactor Design

   Ideal Reactor for a single reaction
   - Ideal Batch Reactors
   - Steady state Mixed flow reactors
   - Steady state plug flow reactors

   Design for a single Reactions
   - Size comparison of single Reactors
   - Multiple reactor systems
   - Recycle reactors
   - Autocatalytic reactors

   Design for a Parallel Reactions
   Choosing the right kind of Reactor

4. Potpourri of Multiple Reactions

- Irreversible first order reactions in series
- First order followed by zero order reactions
- Zero order followed by first order reactions
- Successive irreversible reactions of different orders
- Reversible reactions
- Irreversible series parallel reactions
- The Denbigh reaction and its special cases

Temperature and Pressure effects

- Single Reactions
- Multiple reactions

Unit 3

5. Flow patterns, Contacting and Non ideal Flow

Basics of non ideal flow

- E, the age distribution of fluids, the RTD
- Conversions in non ideal flow reactors

Compartmental Models

The Dispersion Model

- Axial dispersion
- Correlation for Axial dispersion
- Chemical Reactions and dispersion

The Tanks-In-Series Models

- Pulse response experiments and the RTD
- Chemical conversions

The convection model for Laminar flow

- The convection model and its RTD
- Chemical conversions in Laminar flow reactors

Earliness of Mixing, segregation and RTD

- Self mixing of single fluid
- Mixing of two miscible fluids

Unit 4

6. Reactions catalyzed by solids

Heterogeneous reactions

Solid catalyzed reactions

- The rate equation for surface kinetics
- Pore diffusion resistance with surface kinetics
- Porous catalyst particles
- Heat effects during reactions
- Performance equations for reactors containing porous catalyst particles
- Experimental methods for finding rates

- Product distribution in multiple reactions

The packed bed catalytic reactors

Reactors with suspended solid catalyst and fluidized reactors of various types

- Background information about suspended solid reactors
- The bubbling fluidized bed – BFB
- The K-L model for BFB
- The circulating fluidized bed – CFB
- The jet impact reactor

The deactivating Catalysts

- Mechanisms of catalyst deactivation
- The rate and performance equations
- Design

G/L reactions on solid catalysts: Trickle beds, slurry reactors, Three phase fluidized beds.

- The general rate equation
- Performance equation for an excess of B
- Performance equation for an excess of A
- Which kind of contactor to use
- Applications

7. Non catalytic systems

Fluid-Fluid reactions: Kinetics

- The rate equations

Fluid-Fluid reactors: Design

- Straight mass transfer
- Mass transfer plus not very slow reactions

Fluid-Particle reactions: Kinetics

- Selection of a model
- Shrinking core model for spherical particles of unchanging size
- Rate of reaction for shrinking spherical particles
- Extensions
- Determination of the rate controlling step

Fluid-Particle reactors: Design

Unit 5

8. Biochemical Reaction systems

Enzyme fermentation

- Michaelis - Menten kinetics (MM Kinetics)
- Inhibition by a foreign substance – Competitive and non-competitive inhibition

Microbial fermentation – Introduction and overall Picture

Substrate limiting Microbial fermentation

- Batch (or Plug Flow) fermentors
- Mixed flow fermentors

- Optimum operations of fermentors

Product limiting Microbial fermentation

- Batch or Plus flow fermentors for n = 1
- Mixed flow fermentors for n = 1

PRACTICALS

Review Write up of 25 marks on an aspect from the syllabus including historical aspects to up to date invention/evolution of the chosen aspect. Inclusion of applicability with some examples would be an advantage.

References:

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