

M Sc. BIOTECHNOLOGY SYLLABUS

M.Sc Biotechnology of two (2) years is divided into four semesters.

- Each semester is of 300 marks.
- Each semester (I,II,III) will have four theory papers each of 50 marks and 4 practical papers each of 25 marks.
- Last semester will either have four (4) practicals based on theory papers or a project equivalent to two (2) practical papers , The project will be assigned between three students. The decision to opt for the project or practicals will be at the discretion of the concerned institute.

SEMESTER I

Paper I; ;TH Computer applications and Biostatistics.

Paper II; ;TH Biomolecules and Bioenergetics

Paper III; ;TH Microbiology.

Paper IV; ;TH Bioinstrumentation.

Practical papers P1-P IV based on four (4) theory papers.

SEMESTER II

Paper V; ;TH Molecular biology.

Paper VI; ;TH Macromolecules and Molecular enzymology.

Paper VII; ;TH Cell Biology.

Paper VIII; ;TH Biology of Immune system.

Practical papers PV-P VIII based on four (4) theory papers.

SEMESTER III

Paper IX ;TH Molecular and Applied Immunology.

Paper X; TH Genetic engineering and Advance Molecular genetics.

Paper XI ;TH Bioprocess Engineering.

Paper XII ;TH Molecular and clinical Virology.

Practical papers P1X-P XII based on four (4) theory papers.

SEMESTER IV

Paper XIII ;TH Industrial and environmental Biotechnology.

Paper XIV ;TH ; Recombinant DNA technology and Bioinformatics.

Paper XV; TH Plant Biotechnology.

Paper XVI; ;TH Animal cell sciences and technology

Practical papers PXIII-P XVI based on four (4) theory papers.

INSTRUCTIONS

1. MSc Course is divided into 4 semesters
2. Each Semester will have 4 theory and 4 practical papers..In the fourth semester, there will four (4) practicals based on theory papers or a project equivalent to any two (2) practical papers, for 50 marks. The project will be assigned between three students. The decision to opt for the project or practical will be at the discretion of the concerned institute depending on the availability of chemicals, lab facility etc.
- 3. The workload of the project will be equivalent to that of 2 practical papers.**
4. One theory paper will have 4 lectures of 60 minutes duration per week and practicals will be of 6 hours duration.
5. There should be regular seminars on emerging topic for the students.
6. It is mandatory for the students to have at least 75% attendance in each semester.
7. Department shall organize lectures by subject experts on relevant topics and also arrange study tours and visit to industries and national research institutes.

Infrastructure, Facilities required for the biotechnology department

Two laboratories for part I&II each measuring at least 1000sq.ft with tables & Stools

A culture room with Laminar Air Flow measuring at least 300sq.ft

An Air conditioned Instrumentation room for sophisticated instruments with an inverter or Power generator and a source of constant supply of Power

Two Lecture halls For Part I &II with OHP

A media preparation room and a store room

A Computer and Bioinformatics lab with 5 or more Computer and printers with Internet Accessibility

Instruments Required for Conducting Practicals in M.Sc.

Biotechnology

Laminar Air Flow Hood

Incubators

Digital oven

Autoclave

Vortex mixer

Gas cylinders

High speed refrigerated centrifuge

PH meter

Digital balances

Colorimeter

Monocular Compound Microscopes with oil immersion

Hot plates

Refrigerators

Air conditioners

Laminar Flow
Different strains of E.coli
Phage lysates
Colony counter
Compound Microscopes
General purpose centrifuge
UV Cabinet
Water Bath Incubator Shaker
Incubator Shakers
Analytical balance
Spectrophotometer (UV-Vis)
Cyclomixer
Magnetic Stirrer
Water Bath
Pentium IV
Softwares for graphics & statistical analysis
Internet Accessibility
Paper Chromatography Cabinet
Columns for Chromatography
Fraction collector
Spectrophotometer
TLC kit
Gas Chromatography
Gas Generators
HPLC
Submarine Electrophoresis Apparatus
Vertical Electrophoresis Apparatus
Imuno Electrophoresis Apparatus
Horizontal Electrophoresis Apparatus
Tube gel apparatus
Power packs with constant Voltage/current adjustments
Serological Water bath
ELISA Reader
Binocular Microscope
PAGE Apparatus
Semi Dry Transfer apparatus
Immunology Teaching kits
Hamocytometer
Antibodies and conjugated antibodies
Refrigerators

Deep freezer(-20)
Microcentrifuge
Geldocumentation System
High speed refrigerated Centrifuge
Thermal cycler
Vacublot
DNA Sequencing Apparatus
High Voltage Power packs
Micropipettes
Dry bath
IEF System
Ultra centrifuge
Ultra cold Freezer
Tissue culture racks
Co2 Incubator
Inverse Phase Contrast microscope
Water bath
Low speed Refrigerated centrifuge
Membrane filtration apparatus
Lyophilisers
Fermenter
Orbital Incubator Shaker
Rotary Shakers
General purpose centrifuge
Sonicator

SYLLABUS AT GLANCE

Paper No.	Title of Theory Paper	Marks	Practicals	Marks
Semester I				
Th-I	Biostatistics & Computer Applications	50	P-I	25
Th-II	Bioenergetics and Biomolecules	50	P-II	25
Th-III	Microbiology	50	P-III	25
Th-IV	Bioinstrumentation	50	P-IV	25
Semester II				
Th-V	Molecular Biology	50	P-V	25
Th-VI	Macromolecules & Molecular Enzymology	50	P-VI	25
Th-VII	Cell Biology	50	P-VII	25
Th-VIII	Biology of Immune System	50	P-VIII	25
Semester III				
Th-IX	ImmunoTechnology & Applied Immunology	50	P-IX	25
Th-X	Advanced Molecular Genetics & Genetic Engineering	50	P-X	25
TH XI	Bioprocess Engineering	50	P-XI	25
Th-XII	Molecular & Clinical Virology	50	P-XII	25
Semester IV				
Th-XIII	Industrial & Environmental Biotechnology	50	P-XIII	25
Th-XIV	Recombinant DNA Technology & Bioinformatics	50	P-XIV	25
Th-XV	Plant Biotechnology	50	P-XV	25
Th-XVI	Animal Biotechnology	50	P-XVI	25

Semester IV can have 4 practicals or any 2 practicals and a research project for 50 marks

Paper I

COMPUTER APPLICATIONS AND BIostatISTICS

UNIT I Introduction

Introduction to Biostatistics: Common terms and notations, applications.

Sampling: Representative sample, sample size, sampling bias and sampling techniques.

Data – collection & presentation : Types of data, methods of collection of primary & secondary data, methods of data presentation., graphical representation by histogram ,polygon, ogive curve, pie diagram

Unit II Central Tendency

Measures of central tendency : Mean Median & Mode.

Measures of Variability: Standard Deviation, Standard Error, Range, mean deviation ,coefficient of variation.

. Correlation & Regression : Positive and Negative Correlation, Calculation of correlation coefficient and regression coefficient, regression , linear regression, & regression equation,. ANOVA, one and two way classification.

Unit III Tests of Significance

.Tests of significance: F-test, Z-test, t-test and chi- square test, Probability

Distribution : Binomial, Poison & Normal distribution

Computer based statistical techniques : Frequency table of single discrete variable, bubble sort, Computation of mean, variance and Standard deviation, t test, Correlation Coefficient.

Unit IV Computer applications :

Introduction to computer basics, Organization, PC, Mainframe & super computers, Concept of hardware & software, concept of file, folders and directories, Commonly used commands, Flow charts & Programming techniques, Introduction to Q Basic & C

Introduction to MS Office software covering word processing, spreadsheets and presentation softwares,

Unit V Networking Concepts

Networking fundamentals, client server, LAN, WAN, ftp telnet, internet, Nicnet, WWW, html, e mail, Introduction to MEDLINE, CCOD, & PUBMED, for accessing biological information, An introduction to Bioinformatics softwares- C/C++, Bioperl, Biojava, BioXML, BioOracle etc.

Introduction to Haward Graphics & Coral draw.

Practicals

- 1 Representation of Statistical data by histograms, ogive curves and Pie diagrams
- 2 Measurement of Central tendencies : Arithmetic Mean, median & Mode
- 3 Calculation of measures of Dispersion : Mean deviation, Standard deviation & Coefficient of Variation, Quartile deviation
- 4 Tests of Significance : Chi square test, t-test, Standard error
- 5 Creating files ,folders & directories ,Basics of operating a computer.

- 6 MS OFFICE an introduction : Creating a document using MS word, Creation of an excel spreadsheet, and use of Power Point .
- 7 Creating an e mail account sending & receiving mails
- 8 An introduction to INTERNET , search engines, websites ,Browsing, Downloading information

REFERENCES

1. Campbell R.C Statistics for biologist, Cambridge University Press, Cambridge
2. Wardlaw,A.C.(1985) Practical Statistics for experimental Biologists
3. Baily N.T.J. Statistical methods in Biology English University press
4. P.S.S. Sunderrao & J.Richard An Introduction to Biostatistics Prentice hall of India pvt.ltd. India
5. Khan, Fundamentals of Biostatistics
6. B.K. Mahajan Methods in Biostatistics, Jaypee brothers medical publisher ltd, India
7. How Computers work-2000. Ron White. Tech Media
8. How INTERNET work-2000 Preston Gralla Tech. Media.
9. INTERNET – CDC Publications ,India.
10. Colte Computer analysis of sequence data.
11. Griffith . Modern genetic analysis with CD
12. Robert sokal and James Rohlf Introduction to Biostatistics W.H. Freeman Press
13. Algorithms on strings : Trees and Sequence , Panima book House
14. Algorithms : The Spirit of Computing, Panima Book house

PAPER _ II

Biomolecules & Bioenergetics

I. Biomolecules :

Chemical composition & bonding, three- dimensional structure, chemical reactivity : bond strength ,general chemical transformation reactions in cell,cleavage & formation of C_C bond, Redox reactions, electron transport & intramolecular rearrangement.Water Weak interactions in aqueous systems, ionization of water, Weak acids & weak bases, pKa & titration curve Buffering against pH changes in biological systems, water as reactant & the fitness of the aqueous environment for living organisms.

Principles of bioenergetics : Biological energy transformation & laws of thermodynamics, concepts of entropy , enthalpy , equilibrium constant (K_{eq}) , free- energy change, free –energy change for ATP – hydrolysis

UNIT II Metabolism of Carbohydrates:

Carbohydrates : Classification, structure & properties of carbohydrates, Biosynthesis of lactose , sucrose & starch.

Glycolysis, TCA-cycle, HMP shunt pathway, gluconeogenesis, Coris cycle, glycogen synthesis. Regulation of carbohydrate metabolism & metabolic disorders. Electrontransport chain, oxidative phosphorylation &

UNIT III Photosynthesis

Anabolism of Glucose in Plants, C3& C4 Plants , different pathways of photosynthesis, pigments involved in the reactions, photosynthetic bacteria, their pigments, cyclic and noncyclic Photophosphorylation

UNIT IV Lipids:

Definition of lipids, classification , storage , membrane lipids,.essential & nonessential fatty acids, general reactions, functions, biosynthesis and degradation of fatty acids,triglycerides,phospholipids,cholesterol,prostaglandins,metabolic disorders.

UNIT V: Hormones and Vitamins

Classification of hormones, endocrine glands, functions and mechanism of action of hormones, role of hormones in reproduction, control of fertility, gametogenesis, role of hormones in growth, hormonal disorders,
Vitamins- classification, functions, role in metabolism, vitamins as cofactors

Practicals

- Estimation of carbohydrates by qualitative methods
- Estimation of carbohydrates by quantitative method
 - Purification of polysaccharides
 - Acid values & Iodine number of fat
 - Saponification values of fats
 - Isolation and purification of lipids from microbes and eukaryotes
 - Phosphate estimation
 - Ammonia estimation
 - Simple assays for vitamins and hormones
 - Estimation of pKa values of amino acids
 - Preparation of Starch, glycogen, Lecithin, Cytochrome C

Reference Books

- Cohn & Stump – Outline of Biochemistry Wiley Eastern Ltd.
- Harpers Review of biochemistry – Prentice Hall
- Cregnton – Protein Structure & Molecular Properties
A. L. Lehninger, D. L. Nelson & M M Cox – Principles of Biochemistry.
- Lubert Stryer – Biochemistry
- David Meltzer – Biochemistry : The Chemical Reactions of living Cells – Academic Press, New York
- Dixon & Webb –Enzymes
- J. Jayraman- Practical Biochemistry
- Plummer. –Practical Biochemistry.
- Horton; principles of biochemistry.
- 10.**Hames; Instant Notes in Biochemistry.
- Holme ; Analytical Biochemist
- A.C.Deb Fundamentals of biochemistry
- Ramakrishnan , Text book of Medical Biochemistry, Orient Longman
Zuby - Biochemistry 4th edition
Boyer- Concepts in Biochemistry
- Cooper -The tools of Biochemistry

Paper III

Microbiology

Unit I .Microscopic Techniques:

Properties of light, Microscopic resolution, numerical aperture, types of lens aberration & their correlation. Principles & applications of light microscopy: Bright field microscopy, dark field microscopy, Phase contrast microscopy, fluorescence microscopy, NIDC microscopy, confocal microscopy. Principles & applications of Electron Microscopy: SEM, TEM, STEM, High voltage electron microscopy. Principles & applications of Cytophotometry and Flowcytometry. Stain & staining: Classification of stains, Staining theories and staining techniques: Negative, Monochrome and Differential Stainings (Gram, capsule, spore & acid fast staining).

Unit II. The diversity of the microbial world:

Bacterial taxonomy, New approaches to bacterial taxonomy, classification including ribotyping, rRNA sequencing, characteristics of primary domains Imp. genera from gram negative bacteria, gram positive bacteria, cyanobacteria, actinomycetes, fungi & slime molds. Archebacteria; Survival mechanism and their importance (thermophiles, psychrophils, methanogens, alkalophiles, acidophiles, halophiles.) .Metabolic diversity among Microorganisms:

Unit III Microbial growth

Growth: Bacterial cell division, generation time, specific growth rate, Monoauxic, diauxic & synchronized growth curves, various methods to obtain synchronized cultures, applications of growth curves, direct & indirect methods of microbial growth assessment, sporulation & germination, Effect of environmental factors on microbial growth, Control of microorganisms by physical & chemical agents. Antimicrobial chemotherapy.

Unit IV Nutrition:

Modern concepts of microbial nutrition, autotrophic, heterotrophic, saprophytic & parasitic microbes, microbial culture media, techniques of culture collection, isolation, purification, cultivation & preservation of microbes.

Unit V . Microbial physiology;

Sporulating bacteria, stages of sporulation, cytologicval and macromolecular changes during sporulation.

Microbila toxins; detection and molecular mechanism of action.

Microbial stress response, stress proteins and their role in normal cellular physiology.

Practicals

- 1 Staining of microorganisms : Gram staining, acid fast staining,negative staining & other methods
- 2 Microscopic examination of bacteria, Yeasts & molds
- 3 Isolation &Maintanance of Organisms by plating techniques & serial dilution methods
- 4 Storage & preservation of microorganisms
- 5 Isolation of pure cultures from soil water and air
- 6 Growth curve of microorganisms
- 7 One step growth curve for coli foms
- 8 Measurement of bacterial population by turbidometry, serial dilution ,methods
- 9 Effect of temperature,pH ,C/N sources on microbial growth.
- 10 Biochemical charecterization of selected microorganisms
- 11 Micrometry
- 12 Assay of antibiotics

References:

1. Stenier R.Y et al ., General microbiology Mc Millan Press. Inc.
2. Madigan M.T.,et al brock biology of microorganisms J prentice hall Inc.
3. Pelczar ., Reid et al., Microbiology, TMH Publication.
4. Glazer A.N et al ., Microbial biotechnology and fundamentals of applpie microbiology. Freeman.
5. Purohit; Microbiology- Fundamentals and applications.
6. Johri B.N 2000 Extremeophiles. Springer Verlag, NY
7. Singer; Experiments in microbiology.
8. Schiegel; General Microbiology.
9. Talaro; Foundations in Microbiology.
10. Ananthanarayan; text book of microbiology.
11. Cappucinno; Microbiology – a laboratory manual. 4th ed.
12. Bergys Manual Vol 1-4
13. Harrigan W.E. ,Laboratory methods in Food Microbiology, Academic Press
14. Toratora, Funke & Care, Microbiology : An Introduction
15. Salley Fundamental Principles of Bacteriology
16. Atlas : principles of Microbiology
17. Methods in Microbiology series
18. Prescott Microbiology 3rd edition with free students manual
19. Macane Microbiology –Essentials and application

PAPER IV

BIOINSTRUMENTATION

Unit I Chromatographic techniques

Theory, principle & applications of paper, thin layer, gel filtration, ion exchange, affinity, hydrophobic, gas-liquid & high pressure/performance liquid (HPLC).

Unit II Electrophoresis

Electrophoresis : Basic principles of electrophoresis, theory & applications of paper , starch gel, Agarose, Native and denaturing PAGE and Isoelectric focusing

Unit III Centrifugation And Cell Disintegration

Types of centrifuge machines, preparative and analytical

Centrifuges, differential centrifugation, sedimentation velocity, sedimentation equilibrium , density gradient methods and their applications.

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

Unit IV Spectroscopy

Spectroscopic Techniques: Theory and applications of UV-visible, IR, fluorescence, NMR , Atomic Absorption ,CD, ORD, and Mass, Raman spectroscopy.

Unit V Radio Isotopic Techniques:

Use of radio isotopes in life sciences, radioactive labeling, principle and application of tracer techniques, detection and measurement of radioactivity using ionization chamber, proportional counter Geiger- Muller and scintillation counters ,autoradiography and its applications,Dosimetry

Practicals

Paper III

1. Paper Chromatography of amino acids- Ascending and Descending methods
2. Separation of sugars by chromatography
3. TLC of lipids
4. column chromatography for proteins, pigments
5. paper electrophoresis
6. agarose electrophoresis
7. PAGE & determination of molecular weight
8. Cell disintegration
9. Cell fractionation & assay for marker enzyme
10. Friske Dosimetry

References

1. Williams B.L. & Wilson K - A biologist's guide to principles and techniques of practical Biochemistry .Edward Arnold Publishers
2. Chatwal and Anand: Instrumental methods of Chemical analysis Himalaya publishing house ,Mumbai
3. H.H. Willard, LL. Merritt Jr 1986 Instrumental Methods of Analysis . CBS Publishers & distributors.
4. B.B. Straughan & S. Walker. (ed) Spectroscopy, Chapman & Hall LTD
5. Hanes Gel Electrophoresis of Proteins _A Practical Approach , IRL Press.
6. James Miller Chromatography: Concepts & Contrasts, John Wiley & Sons, New York
7. E.D. Holme & H. Peck , Analytical Biochemistry, Longman
8. R.J. Hamilton and P.A. Sewell, Introduction to HPLC

9. G.M. Message Practical aspects of Gas Chromatography and mass Spectrophotometry, , John Wiley & Sons, New York
10. T. Kremmery Gel Chromatography, Wiley publications
11. 11. Upadhyaya Biophysical Chemistry Himalaya Publishing House , India.
12. J.M. Chapman and G. Ayrey The use of radioactive isotopes in the Life Sciences, George Allen & Unwin Ltd, London
13. C.C Thornburn Isotopes and Radiations in Biology, Butterworth & Co. Ltd, London

Paper V

MOLECULAR BIOLOGY

Unit I Genetic Material

Discovery of genetic material –Experimental evidences

Genome of bacteria, viruses and eukaryotic cell, C-value paradox, cot value, repetitive & non-repetitive DNA. Organelle genome, Topological manipulations of DNA

Chromosomes: Structure of typical chromosome, centromeres & telomeres, molecular nature and function, Giant Chromosomes.

Chromatin structure –Hetero & Euchromatin, Nucleosomes as subunits of chromatin, Organization of histone octamer.

Unit II Perpetuation :

Replication of DNA is Semiconservative, semidiscontinuous and primed by RNA, Direction of replication with experimental evidences.

Replication of bacteria and eukaryotes, DNA polymerases of E. coli & eukaryotes, & phages, Mechanism of replication, of Chromosomal DNA, circular plasmids, telomeres, and organelle genome.

Structure of Pol III holoenzyme and replication of leading and lagging strands.

Fidelity and catalytic efficiency of polymerases.

Unit III Mutation & Repair

Mutation: Spontaneous & Induced mutation: Types of mutations : point, frameshift, lethal, conditional lethal, inversion and deletions, null mutation, Reversion of mutations, Intra and intergenic suppressions. Scoring of mutations, Enrichment of mutants of single type. Physical and chemical mutagens
Repair of DNA-Excision, mismatch, SOS, photoreactivation, Recombination repair, Eukaryotic repair mechanisms, System to safeguard DNA.

Unit IV. TRANSCRIPTION

PROKARYOTIC RNA polymerases and its subunits, Sigma factor & specificity of binding to DNA, Structure of bacterial promoters and their consensus sequences
Initiation of transcription, elongation and termination, rho dependent and rho – independent termination of transcription, anti terminators, post transcriptional modifications.

Eukaryotic transcription: RNA polymerases, -types & subunits, promoter elements for the three polymerases, Transcriptional factors for the three polymerases, Initiation of transcription by the three polymerases, role of enhancers, GC box, Octamers, as upstream elements, elongation & termination of

transcription, Chromatin structure & its effect on transcription, transcription in organelles, post transcriptional modification of rRNA, tRNA and mRNA, capping, polyadenylation, intron splicing, role of snurps

Unit V. TRANSLATION

Direction of protein synthesis, RNA template, direction with experimental proof, tRNA as adapter, Ribosomes and their organization in prokaryotes and eukaryotes, polycistronic RNA in bacteria, Initiation of translation in bacteria small subunit, its accessory factors, SD sequences in bacteria, Assembly of ribosomes in eukaryotes, initiator tRNA, elongation of translation, translocation and termination mechanisms. Role of ribosomal RNA in protein synthesis, Summary of genetic code, Post translational modification of proteins, folding, membrane localization, localization in organelles, cotranslational transfer through ER, transport of proteins to nucleus, oligosaccharide addition to proteins.

Practicals

1. Spontaneous mutation in bacteria
2. Induced mutation using chemical and physical mutagens
3. Scoring and enrichment of mutants
4. Ampicillin enrichment of Auxotrophs
5. Isolation of different auxotrophic mutants by using selective plates
6. Chromosomal aberration due to radiations
7. Repair mechanisms in E.coli –dark, photoreactivation
8. Repair mechanisms in Yeast
9. Study of genotypes and its conformation

References:

1. Benjamin Lewin -Gene VI, Gene VII, Oxford University press
2. David Friefieder - Essentials of Molecular Biology, Jones & Barlett publications
3. J. Kendrew - Encyclopedia of Molecular Biology Blackwell Scientific publications.
4. Weaver - Molecular Biology
5. J.D. Watson, N.H. Hopkins, J.W. Roberts, et al - Molecular Biology of the Gene, Benjamin Cummings publ.co.inc., California
6. J. Darnell, et al - molecular biology of the cell (2nd edition) Garland Publishing Inc.
7. Meyers R.A (ed) ., Molecular biology and biotechnology. VCH publishers NY Inc.
8. Alberts B et al - Molecular biology of the cell. Garland Publishing Inc.
9. Watson J.D ., Recombinant DNA.
10. Malacinski; Essentials of Molecular Biology.
11. Stansfield; Molecular and cell biology.
12. Walker - Molecular biology and Biotechnology.
13. Brown T.A - Essential of Molecular biology Vol 1 and 2 each.
14. Dale - Molecular Genetics of Bacteria

Paper VI

Macromolecules and Molecular Enzymology

Unit I Proteins

Classification, structure, general reactions of amino acids, non- protein amino acids, primary, secondary, tertiary and quaternary structures of proteins, sequencing of proteins, protein folding, methods of purification (brief), allosteric proteins, metabolism, biosynthesis, regulation and metabolic disorders of amino acids.

Sources of organic Nitrogen, Flow of Nitrogen into the catabolism of amino acids, Urea cycle and excretion of nitrogen

Unit II Nucleic Acids

Biosynthesis and regulation of nucleic acids, purines and pyrimidines by denovo and salvage pathways, structure of DNA & RNA , different forms of DNA (A, B, Z etc.), structure of rRNA, tRNA, & ribosomes

Unit III Enzymology an Introduction:

Classification, and nomenclature of enzymes. Enzymes as biocatalysts, Theories & Mechanism of enzyme action, specificity of enzyme action, activation energy, , allosteric enzymes, multienzyme complex, isozymes,

Unit IV Activity of enzymes

Enzyme induction active site determination, enzyme kinetics, enzyme inhibitors, enzyme parameters, factors affecting enzyme activity and enzyme immobilization, by different methods and their application effects of organic solvents on enzyme catalysis, structural consequences, enzyme denaturation, purification strategies.

Unit V Applied Enzymology

Use of enzymes in industries, textile, leather, food, industries. Application of immobilized enzymes in the industries, Use of purified enzymes in biosensors Enzyme sensors for clinical diagnosis , environmental analysis, and other applications of biosensors

Practicals

1. Estimation of proteins by folin Lowry & biurets method
2. Determination of isoelectric pH of proteins and amino acids
3. Estimation of DNA
4. Determination of T_m of DNA
5. Denaturation & renaturation of DNA
6. Estimation of RNA
7. Isolation of proteins- casein from milk, haemoglobin from RBC
8. Enzyme production from microbes and seeds
9. Enzyme purification by salting out followed by a chromatographic technique
10. Enzyme kinetic analysis
11. Effect of inhibitors on enzyme activity
12. Immobilization of enzymes
13. Assembly of biosensor and determination of its activity

Reference Books

- 1 Cohn & Stump – Outline of Biochemistry Wiley Eastern Ltd.
- 2 Harpers Review of biochemistry – Prentice Hall
- 3 Cregnton – Protein Structure & Molecular Properties
- 4 A. L. Lehninger, D. L. Nelson & M M Cox – Principles of Biochemistry.
- 5 Lubert Stryer – Biochemistry
- 6 David Meltzer – Biochemistry : The Chemical Reactions of living Cells –Academic Press, New York
- 7 Dixon & Webb –Enzymes
- 8 J. Jayraman- Practical Biochemistry
- 9 Plummer. –Practical biochemistry
- 10 Switzer R.L. and Garuty L.F., Experimental Biochemistry
- 11 Calladine Understanding DNA: The Molecule & How it Works 20th edition,
- 12 Voet - Biochemistry
- 13 Voet,- Fundamentals of Biochemistry with CD
- 14 Zuby - Biochemistry 4th edition
- 15 Boyer- Concepts in Biochemistry
- 16 Cooper -The tools of Biochemistry
- 17 Adams- Biochemistry of Nucleic Acids
- 18 Branden –Introduction to Protein Structure 2nd ed
- 19 Cleveland- Protein Engineering :Principles and Practice

Paper VII

Cell Biology

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, Cellular Mechanisms of Development : Cell differentiation & cell memory, Morphogenesis & Cell differentiation in prokaryotic cells.

Unit III, Biomembranes :

Structure & function of biomembranes i.e. plasma membrane,E.R.membrane, mitochondrial & chloroplast membrane and membranes in Nitrobacter sp. Transport across membranes: Types of membrane transport, Role of carrier proteins , ion channels & membrane potential in membrane transport.Sodium & calcium pumps in prokaryotes & eukaryotes, Preparation & applications of liposomes.

Unit IV Cellular Interactions

Cell-cell interaction : Nerve cell –muscle cell interaction, Rhizobium –legume interaction, Cell- cell interaction observed in Myxobacteria & Bdellovibrio 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, function, adenylate cyclase system, cAmp, protein kinase & CREB proteins ,calcium channels, and second messengers.

Practicals

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

References

- 1 Alberts B et al Molecular biology of the cell. Garland Publishing Inc.
 - 2 Lodish et al., Molecular cell biology. Freeman & company ,New York 1999
 - 3 Gennis R.B Biomembranes- molecular structure and function. Springer.
 - 4 G.Posil ,S.T.Crooke (Eds) mechanism of rceptor regulation. Plenum press, 1985
 - 5 DM Prescott; Reproduction in Eukaryotic cells, Academic Press
 - 6 S.F Gilbert; Developmental Biology, Sinauer Associates inc
 - 7 Sheeler; cell and Molecular Biology.
 - 8 Sadava ; cell biology
Smith -cell Biology 2nd ed.
- ,

Paper VII

Biology of the Immune System

Unit I Basic concepts:

Basic concepts of immunity, Innate immunity its determinants and significance, phagocytosis, Acquired immunity, Humoral ,cellular, specificity of immune response, Active and passive immunity .
Cells and Organs of the immune system : Hematopoiesis, Surface markers on cells and their differentiation from pluripotent stem cell, primary and secondary lymphoid organs, Lymphatic system.

Unit II , Antigens and Antibodies

Immunogenicity and antigens : Immunogenicity and antigenicity of a compound, factors influencing antigenicity ,haptens , adjuvants, epitopes, linear and conformational epitopes, Chemical basis of antigen specificity,biological system and immunogenicity,
Antibodies : Basic structure,fine structure, classes of antibodies and their biological activities, antigenic determinants of antibodies, forces of antigen antibody interaction.

Unit III The recognition of Antigens

B –Cell receptors : Structure and organization, Ig super family, T cell Receptors : Structure and organization, TCR-CD3 complex, T cell accessory molecules, Alloreactivity of T cells, $\alpha\beta$ and $\gamma\delta$ T cells.
MHC : General organization and inheritance, haplotypes,
Structure and organization of class I and II MHC, polymorphism of MHC and its tissue distribution,its role in immune response, antigen processing, presentation of endogenous, exogenous antigens and non peptide bacterial antigens , self MHC restriction,

Unit IV Lymphocyte Activation and Regulation and Effector Mechanisms

T Cells : Maturation in thymus, positive and negative selection in thymus
Activation by interaction with an presenting cell, signal transduction, Accessory molecules ,their role in activation of T cells, differentiation and maturation of T cells superantigen mediated activation. Clonal anergy ,mechanism of tolerance.
B Cells : Maturation, T dependent and independent activation ,Germinal centers, Ag induced B cell differentiation. B cell tolerance.

Effector mechanisms : Cytokines as intracellular messengers, their properties, Receptors, Th1 & Th2 balance, its significance. Cell mediated effector mechanisms, CTL, NK cells, mechanism of cytolysis, Complements and their role in effector mechanisms. Regulation of Immune Response.

Unit V Techniques :

Antigen antibody Interactions : Precipitations, Double, Single radial immunoprecipitations agglutinations, measurement of immune complexes, Immunoelectrophoresis, Immunofluorescence, RIA, ELISA, Recent developments, Cellular techniques : Isolation of PBMC, purification of cells, Isolation of sub population, FACS, Lymphocyte responsiveness, MLR, Cytotoxicity reactions, Migration inhibition assays.

Practicals

- 1 Study of Immune cells TLC/DLC
- 2 Isolation of PBMC from heparinised blood
- 3 Enrichment of T&B cells
- 4 E-Rosetting for T-Cells
- 5 Reverse plaque assay for B Cells
- 6 Isolation of bacterial antigens
- 7 Isolation of protein A from Staphylococci
- 8 Immunoelectrophoresis
- 9 Antigen antibody interactions -Precipitations
- 10 Haemagglutininations
- 11 Complement activity on RBC
- 12 Bactericidal assays

References,

1. Roitt I M, Essential Immunology, Blackwell Scientific Publications, Oxford
2. Weissman I L Wood, Immunology, Benjamin Cummings
3. Kuby - Immunology, 4th ed Freeman press
4. Stites DP Basic & Clinical Immunology, Appleton & Lang press
5. Ellis, Vaccines, A new approach to Immunology
6. W E Paul, Fundamental Immunology, Raven Press
7. D M Weir Experimental Immunology 4 volumes
8. William Paul Fundamentals of Immunology
9. Abbas- Cellular and Molecular Immunology
10. Rose- Manual of Clinical and Laboratory immunology
11. Benjamini- Immunology :A short Course
12. Brooks – Medical Microbiology 21st ed
13. Joshi – Immunology
14. Janeway -Immunobiology

Paper IX

Immunotechnology and Applied Immunology

Unit I Immunogenetics

Genetic model of immunoglobulin structure, multigene organization, Variable gene rearrangement, molecular mechanism of recombination, generation of diversity, class switch, Expression of Ig genes and regulation of transcription. Rearrangement of TCR, and expression of TCR genes.

Unit II Inflammation and Infection

Inflammation its mediators and the process, Cell adhesion molecules and their role in inflammation, Lymphocyte homing, tissue injury and immune response leading to an inflammatory reaction, the steps involved, anaphylatoxins, role of granulocytes in the process

Viral Parasitic and Bacterial infections.: Immune response to infection and.

Unit III Inappropriate Immune Response :

Autoimmunity, its mechanisms, diagnosis, and control

Immunodeficiency diseases. Primary, secondary deficiencies, diagnosis, and treatment

Hypersensitivity types & significance

Unit IV Hybridoma Technology

Production of mouse monoclonal antibodies, myeloma

cells, immunization, preparation of cells, fusion, selection of hybrids, screening, cloning, ascites development in vivo,,

human hybridomas, production, problems, uses.,

man made antibodies tetradomas, hybrid antibodies,

Unit V Vaccines & Applied Immunology :

Strategies for the development of new generation vaccines, subunit vaccines, peptide vaccines, recombinant vaccines, DNA vaccines to common diseases

Transplantation and immune response, prevention of rejection of the transplant,

Tumour immunology, immune response to tumour, immunotherapy, Diagnosis of infectious Diseases, and Immunotherapy in health care.

Practicals

- a. 1 Purification of Immunoglobulins by precipitation
- b. Affinity purification of Immunoglobulins
- c. Preparation of Enzyme conjugated antibodies
- d. Diagnostic assays for typhoid using widal kit and purification of H & O antigens from S.typhi
- e. ELISA
- f. Diagnosis of RA by agglutination
- g. Western blotting

References,

- 1 Roitt I M, Essential Immunology , Blackwell Scientific Publications, Oxford
- 2 Weissman I L Wood, Immunology, Benjamin Cummings
- 3 Kuby Immunology , Freeman
- 4 Stites DP Basic & Clinical Immunology, Appleton & Lang press
- 5 Ellis, Vaccines, A new approach to Immunology
- 6 W E Paul, Fundamental Immunology, Raven Press
- 7 D M Weir Experimental Immunology 4 volumes .
- 8 S.H. Kaufman ,A Sher, and Ahmed -Immunology of infectious diseases ASM Press
- 9 PCR in Clinical Laboratory Medicine ASM Press
- 10 M.Cunningham, R.S. Fujinami Molecular mimicry, Microbes, and Autoimmunity
- 11 Benjamini- Immunology :A short Course
- 12 Brooks – Medical Microbiology 21st ed
- 13 Joshi – Immunology
- 14 Janeway -Immunobiology 4th ed
- 15 Travers Immunobiology: The Immune system in health and diseases 3rd ed
- 16 Zuby – Clinical Parasitology a practical approach

Paper X

Advanced Molecular Genetics & Genetic Engineering

Unit I 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. Mutations i.e deletions, inversions & frame shift due to transposition Mechanism of transposition, Controlling elements of maize- autonomous and nonautonomous elements. P- elements in Drosophila., Retro viruses as retroposons.

Unit II. GENE EXPRESSION :

Prokaryotic:

Operon concept, coordinated control of structural genes, lac, trp, ara operons, Repressor proteins and their functions. operators and other DNA elements of regulation, Positive & negative control of an operon, Catabolic repression, stringent response , Attenuation as control mechanism,

Eukaryotic :

Transcriptional activators as positive regulators of gene expression, Coordinated control of expression by different factors, Independent domains of proteins bind to DNA to activate transcription, Upstream factors, response elements identifying genes under common regulation. Zn fingers, leucine zippers, homeodomain helix loop helix are different domains present in transcription factors. Activating domains of transcriptional activators Gene expression & methylation Repression by inhibition of TAF binding, blocking of activation,, silencing, translational control.

Unit III Isolation, Identification & characterization of DNA fragments:

Restriction endonucleases-, Type I ,II & III, Recognition sequences, properties, nomenclature, classification of Type II Endonucleases, their activity .Restriction mapping, RFLP, RAPD, AFLP
DNA ligase: Properties & specificity.

Enzymes used in Genetic Engineering. – S1 Nuclease, Bal 31 nuclease., DNA Polymerase, Polynucleotide kinase, Phosphatase, Reverse Transcriptase its activity and mode of action

Chemical synthesis of DNA

DNA sequencing: Dideoxy method, Automated sequencing.

Unit IV Cloning vectors in E. coli.

Plasmids: Properties, Incompatibility, Transformation techniques, Isolation and, Purification techniques Plasmid vectors & their properties, PBR 322- its construction & derivatives, Single stranded plasmids, Promoter probe vectors, Runaway plasmid vectors.

Bacteriophage Lambda as a vector : Essential features, organization of λ genome general structure, Rationale for vector construction, Improved λ vectors, λ gt series, λ EMBL vectors, in vitro packaging, Cosmids, Phasmids, Filamentous phage vectors, λ Zap λ bluescript vectors,

Cloning Strategies : Genomic DNA libraries, Chromosome Walking and Jumping, cDNA libraries ,shotgun cloning ,directed cloning, Phage display

Unit V Cloning and Expression in other Organisms

E.coli expression vectors : Promoters,(B-gal,T7, Lambda), codon selection, Maximizing expression, Hybrid promoters, manipulation of cloned gene to achieve expression, stability of proteins, Fusion proteins and their applications.

Bacillus ; Transformation techniques, plasmids and vectors, expression vectors excretion vectors, Shuttle vectors, Phage vectors.

Streptomyces : Transformation, Plasmid and vectors, expression vectors and phage vectors.

Yeast : Genetic markers and selection system, yeast integrating, replicating , episomal vectors, yeast artificial chromosomes, expression vectors.

Broad host range vectors for cloning in gram negative organisms, P,W,Q. group of plasmids, transposons as broad host range vectors.

Practicals

1. Study of Conjugation in E.coli ,and score for a marker
2. Generalized Transduction in E coli using P1 phage
3. Transposition of tn family and insertional inactivation in E coli
4. Phage titration with p1 & phage
5. Phage induced recombination
6. Gene expression in E.coli & Yeast

7. Isolation of plasmids from E coli , Bacillus
8. Restriction fragment analysis
9. Transformation of E coli
10. Transformation of Bacilli
11. Transfection with phage DNA & isolation of lysogens
12. Isolation of RNA from Eukaryotic cells
13. Shot gun cloning in E.coli
14. Isolation of genomic DNA
15. Electrelution to purify the DNA fragments

References:

1. Benjamin Lewin -Gene VI, Gene VII, Oxford University press
2. David Friefieder Essentials of Molecular Biology, Jones & Barlett publications
3. J. Kendrew Encyclopedia of Molecular Biology Blackwell Scientific publications.
4. Weaver Molecular Biology
5. J.D.Watson, N.H.Hopkins ,J.W Roberts, et al Molecular Biology of the Gene, Benjamin Cummings publ.co.inc., California
6. J.Darnell., et al molecular biology of the cell(2nd edition) Garland Publishing Inc.
7. Meyers R.A (ed) ., Molecular biology and biotechnology.VCH publishers NY Inc.
8. Alberts B et al Molecular biology of the cell. Garland Publishing Inc.
9. Watson J.D ., recombinant DNA.
10. Joyner: gene targeting – a practical approach.
11. Nicoll; Genetic engineering.
12. Robertson; Manipulation and expression of recombinant DNA.
13. Brown D.A. Genetics : Molecular Approach
14. Primrose Molecular Biotechnology
15. Berry Yeast Biotechnology
16. Griffith Anthony, Miller J.F., Suzuki D, Lewontin R, and Gelbart W.M – An introduction to Genetic Analysis
17. Nancy Craig, Martin Gellert Allan Lambowitz Mobile DNA II
18. Helen Kreuzer Recombinant DNA & Biotechnology
19. Winnaker - From Genes to Clones
20. Old & Primrose – Principles of gene Manipulations

PAPER XI

Bioprocess Engineering

Unit I Bioreactors :

Design of a basic fermenter, Bioreactor configurations, design features, individual parts, baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices, probes for online monitoring, computer control of fermentation process, measurement and control of process

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,

Unit II Mass Transfer in reactors

Transport phenomenon in fermentation : Gas liquid exchange and mass transfer, O_2 transfer, critical oxygen concentration, determination of $K_L a$, heat transfer, Aeration / Agitation its importance.

Sterilization of Bioreactors., Nutrients, air supply, products and effluent. process variables, and control, Scale up of Bioreactors.

Unit III Fermentation process :

Growth of cultures in the fermenter : Kinetics of growth in Batch culture, continuous culture w.r.t. substrate utilization, specific growth rate, steady state in a chemostat, Fed batch fermentations, yield of biomass, product, calculations for productivity, substrate utilization kinetics.

Fermentation Process : inoculum development, storage of cultures for repeated fermentations, scaling up of process from shake flask to industrial fermentations

Unit IV Down stream Processing :

Biomass separation by centrifugation, filtration, flocculation, and other recent developments.

Cell disintegration : Physical, chemical and enzymatic methods.

Extraction : Solvent, two phase, liquid extraction, whole broth, Aqueous multiphase extraction.

Purification by different methods

Concentration by precipitation, ultrafiltration, reverse osmosis.

Drying and crystallization.

Unit V Isolation, Selection Improvement of cultures.

Screening and Isolation of microorganisms . Primary and Secondary metabolites, Enrichment ,Specific screening for the desired product.

Strain Improvement for the selected organisms : Mutation and screening,of improved cultures, Random & strategic screening methods ,Strategies of Strain Improvement for primary ,secondary metabolites with relevant examples.Use of recombinant DNA 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 product and its application n the industry,
Importance of media in fermentation ,media balancing after improvement
Preservation of cultures after SIP,

Practicals

1. Isolation of Industrially Important microbes from the environment
2. Determination of TDP & TDT of microorganism for a design of a sterilizer
3. Determination of Growth curve of a industrial organism and compute substrate degradation profile, specific growth rate & growth yield
4. Screening and enrichment for a primary /secondary metabolite from the environment
5. Strain improvement for higher yield of a product
6. Random and strategic screening for a metabolite
7. Media balancing experiments
8. Alcohol Fermentation using different substrates and its downstream process.

References:

1. Baily & Ollis Biochemical Engineering Fundamentals, 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. Battley, E.H. Energetics of Microbial Growth, John Wiley & Sons

10. Davies, J.E and Demain, A.L Manual of Industrial Microbiology and Biotechnology 2nd Edition, ASM, Publications
11. Nielsen, J & Villadsen, B. Bioreaction Engineering principles. Plenum Press, New York.
12. Roels, J.A. Energetics and Kinetics in Biotechnology, Elsevier Biomedical Press, Amsterdam
13. Stephanopoulos, G., Neilson, J., and Aristidou, A. Metabolic Engineering. Principles and Methodologies., Academic Press, San Diego
14. Chisti Y Encyclopedia of Bioprocess Technology : Fermentation, Biocatalysis, and Bioseparation., Vol 5 John Wiley and sons, New York
15. Doran Bioprocess Engineering Principles, Academic Press, London
16. Van't Riet, K. and Tramper, J. Basic Bioreactor Design. Marcel Dekker, New York
17. Asenjo, J.A., ed. Separation Process in Biotechnology, Marcel Dekker, New York
18. Belter, P.A, Cussler, E.L. and Hu, W-S. Bioseparations : Downstream Processing for Biotechnology., John Wiley and Sons, New York

Paper XII

Molecular & Clinical Virology

Unit I General Virology

Classification and Nomenclature of Viruses, their Properties, Morphology & Ultrastructure, types of envelopes, their composition, viroids and prions

Unit II Cultivation And Diagnosis

Cultivation of Viruses in embryonated eggs, experimental animals, Cell cultures, and in transgenic system Different methods of purification characterization and enumeration of viruses, (serological, physical and chemical methods & infectivity assays

Unit III Bacterial Viruses

Structure and organization of Bacteriophages, Lytic & Lysogenic Life Cycles, Genome Organization, Infection and multiplication, replication of T phages, Lambda phage, M13 Mu phage, Gene Expression and control of life cycle Phage- lytic & lysogeny, T4 and lambda phage, Antitermination and lambda-repressor control of lysogeny.

Unit IV Animal Viruses :

Classification of animal viruses, life cycle, and Pathogenicity of important viruses
Genome organization and replication of Arthropod viruses, Retroviruses, DNA Viruses (adeno, Pox, SV40, Vaccinia, Hepatitis) Clinical diagnosis and treatment of HIV, Hepatitis, Influenza and other emerging viral diseases

Unit V Plant viruses:

Classification of plant viruses, life cycle, and Pathogenicity of important viruses
Genome organization and replication of common plant viruses like TMV, cauliflower mosaic virus, potato virus, Gemini virus.

Transmission of plant viruses by vectors and other means. Diagnostic techniques in seeds, seed stocks and diseased plants, prevention of crop loss due to virus infection- virus free planting material; vector control.

PRACTICALS:

- 1 Titration of E.coli phages.
- 2 Determination of burst size of phages.
- 3 One step growth curve for determining virus titre.
- 4 Viral DNA extraction
- 5 SS DNA extraction from M13 phages.
- 6 Clinical Diagnosis of Viral Diseases by PCR ,ELISA
- 7 Isolation of plant viruses from diseased material

References:

- 1 Morag C and Timbury MC 1994 Medical Virology 10th edition Churchill Livingstone, London
- 2 Dimmock N J, Primrose S.B 1994 Introduction to modern Virology , 4th edition Blackwell Scientific Publications. Oxford.
- 3 Conrat H.F., Kimball PC and Levy J.A, 1994, Virology 3rd edition, Prentice Hall Englewood cliff NJ.
- 4 Topley and Wilsons 1995 text Book on the principles of bacteriology, virology and Immunology, Edward Arnold, London principles of Virology 2000.
- 5 S.J.Flint Molecular biology, pathogenesis and control ASM Press. Washington DC
- 6 Edonard Kurstak Applied Virology 1984, edited by Academic press Inc.
- 7 . Dimmock Introduction to modern virology
- 8 Steven Specter , Adinka R.L. Young S.A Clinical Virology manual
- 9 Guschup M.H. Prion Diseases

Paper XIII

Industrial & Environmental Biotechnology

Unit I Industrial fermentation and production :

General methods of production, SIP, purification, and applications of
Organic acids : Citric acid, lactic acid

Amino acids : Glutamic acid ,

Antibodies : Classification , antibiotic research, isolation of new antibiotics, hybrid
antibiotics, lactum, Aminoglycosides, peptides ,ansamycins, quinoses.

Unit II Industrial fermentation and production :

General methods of production, SIP, purification, and applications of

Enzymes : Amylases, proteases, pectinases, lipase, acylase

Polymers : Polysaccharide- Alginate, dextran, xanthan, pullulan

Lipids – PHB, PHA

Biomass: SCP and SCO

Solvents : Ethanol, acetone

Unit III Biotransformation –

Introduction, types of reactions involved, procedures and applications w., r.t.
steroids, antibiotics and pesticides.

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

Microbial Leaching : Chemistry, organisms used, and applications

Unit IV Environmental Biotechnology

Water, Air, pollution and its control by biotechnological means

Biotechnology and waste management Aerobic and anaerobic treatments

Degradation of Xenobiotics from the environment

Bioremediation

Effluent treatment : Types, microbes used, Types of ETP plants.

Microbial, biochips, bioplastics,

bioinsecticides and biofertilizers.

Microbial flavour, dyes, surfactants

Bio- terrorism.

Unit V Intellectual property and Ethical issues:

Intellectual property rights, (IPR), patents, trademarks, copy right, secrets, IPR and plant genetic resources (PGR), Patenting of biological materials, international conventions, International competition obligations with patent applications, Implication of patenting, current issues, hybridoma technology 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.

Practicals

1. Production of Organic acids by fermentation
2. Production of Amino acids by fermentation
3. Antibiotic fermentations Penicillin, rifamycin, tetracycline etc
4. Microbial Enzyme production and its characterization
5. Microbial polysaccharide production
6. Lipid productions from microbes
7. Biomass SCP from fungi algae
8. Organic solvent production
9. Biotransformations
10. Bioinsecticide isolation purification and assay
11. Biofertilizers production
12. Microbial leaching
13. Effluent treatment -Physical, chemical and biological treatments

References:

- 1 Baily & Ollis Biochemical Engineering Fundamentals, 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, Sinauer 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.

- 11 Alexander M. Biodegradation and Bioremediation. Academic Press, San Diego
- 12 Sayler, G.S., Sanseverino, J and Davis, K.L. Biotechnology in the Sustainable Environment. Plenum Press, New York.

Paper XIV

Recombinant DNA Technology & Bioinformatics

Unit I molecular tools for studying genes and their activities I

Recombinant selection & screening: direct, indirect and immunochemical methods, blotting techniques: Northern, Southern, Western blotting, Autoradiography & Phosphorimaging, Preparation of probe by radioactive & non radioactive methods, Differential screening, colony hybridization
Mapping & quantifying transcripts: S1 mapping, primer extension, runoff & run on transcription, Reporter gene expression, Hybrid release & arrest translation, Maxi, mini cells, exon cloning

Unit II Molecular tools for studying genes and their activities II

Dna protein interaction : filter binding assay, gel mobility shift, DNase footprinting, DMS footprinting
Polymerase Chain Reaction : procedure, Types and applications
DNA fingerprinting : application in Forensic medicine

Unit III Impact of Recombinant DNA Technology

In vitro Mutagenesis : Random and site directed mutagenesis mechanisms & application
Protein Engineering : Methods, application, Engineering of important Enzymes, and Antibodies
Metabolic Engineering : Basic Concepts, methods and applications with suitable and relevant examples .

Unit IV Bioinformatics

A brief idea about various biotechnological data banks : Protein sequence in data banks, nucleic acid sequence data banks, Gene bank, PDB Bio molecular structure data banks, cell information system, animal virus information system, searching sequence database, structural databases, motif databases, and other databases, Search engines –concept & uses., Accessing information (network, ExPASy, embnet, ICGEBnet) Genome analysis use of programs like BLASTA, FASTA, sequence analysis using EMBOSS, GCG, for sequence alignment, analysis of genome for repeats, ORF, RE sites and other applications, structure prediction motifs PROSITE

Unit V Protein & DNA Microarrays and Emerging areas

Protein structure prediction, Chou Frasnman, Jpred, tertiary structure prediction, Comparative modeling, Rasmol,
Dna microarray: printing oligonucleotides on glass slides, Nitrocellulose paper, applications of this micro arrays in diagnosis, whole genome analysis using labeled probes, analysis of single nucleotide polymorphism

Protein microarrays : proteome analysis by 2D electrophoresis, advantages ,uses of this technology Medical informatics, Comparative genomes
Antisense and Ribozyme Technology: Molecular mechanisms, Biochemistry of ribozymes ,strategies for designing ribozymes, Applications of ribozymes and antisense RNA technology.

Practicals

1. Demonstration of southern blotting
2. Demonstration of northern blotting
3. Demonstration of western blotting
4. Preparation of probe by Nick translation
5. Non radioactive labeling of oligonucleotides
6. Analysis of DNA ,protein sequences using databases available through INTERNET

REFERENCES :

1. Watson J.D. ,Recombinant DNA : A short Course, Scientific American.
2. Old R.W. & Primrose S.B., Principles of Gene manipulations, Blackwell Scientific publications
3. Ausbel S M, Brent R, Current Protocols in Molecular Biology., Wiley International New york
4. Maniatis I,Fritsch EF,& Sambrook J, Molecular cloning
5. Winnekar From Genes to clones
6. Setlow & Hollander A, Genetic Engineering : Principles & Methods, Plenum Press.
7. D,M Glover , DNA cloning , A practical approach
8. Methods in Enzymology series ,vol 152,185,,Academic Press inc,San diego
9. PeruskiJR and Peruski The Internet and New Biology: Tools for genomics and Molecular research ASM 1997
10. S.P.Hunt & R.Liveey (OUP) 2000 Functional genomics , a practical approach
11. Mark Schena eds DNA Microarrays , A practical approach
12. Baxevanis 1998 Bioinformatics
13. Higgins & Taylor Bioinformatics 2000
14. Primrose Molecular Biotechnology
15. Berry Yeast Biotechnology
16. Griffith Anthony,Miller J,F., Suzuki D,Lewontin R,and Gelbart W.M – An introduction to Genetic Analysis
17. Nancy Craig, martin Gellert allan Lambowitz Mobile DNA II
18. Helen Kreuzer Recombinant DNA &Biotechnology
19. Higgins -Bioinformatics : Sequence Structure and data banks

20. Baxevanis Bioinformatics : a practical guide to analysis of genes & proteins
21. Hunt: Functional Genomics
22. S .Sunderrajan & Balaji R - Introduction to Bioinformatics, Himalaya Publishing House
23. Creighton ; Proteins Structure and Function
24. Winnaker - From Genes to Clones
25. Old & Primrose – Principles of gene Manipulations, Blackwell Scientific publications, Oxford
- 26.** Stephanopoulos,G.,Neilson,J, and Aristodou,A . Metaboloic Engineering. Principles and Methodologies., Academic Press, San Diego

Paper XV

Plant Biotechnology

Unit I Introduction to tissue culture and its importance in Biotechnology,

Plant Tissue culture: Media compositions, phytohormones, and their selective usage, selection of media for specified 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 applications, Genome instability in reaction to morphogenesis, Somaclonal variation and its applications , micropropagation & its applications

Unit II Cell and Organ Culture

Plant organ culture: Shoot tip shoot apical meristem, root, leaf ,haploid culture with anthers & microspores with specific protocols, endosperm culture and its importance, Incompatibility in in vitro cultures, applications of in vitro fertilization ,flower, and ovary culture, embryo rescue, Somatic embryogenesis, factors influencing embryogenesis ,synthetic seeds, 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 III Plant Genetic Engineering: Vectors

Gene constructs, Promoters, Reporter genes.

Vectors : Plasmid vectors, Agrobacterium 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

Unit IV Plant Genetic Engineering: Transformation techniques :

Agrobacterium mediated. coculture method, direct gene transfer

methods, chemical, electroporation, particle gun, lipofection, microinjection, fibre mediated, laser induced and other recent methods. transformation of monocots

Generation of Transgenes , inheritance of the transgene analysis and confirmation, stability and gene silencing, application of terminator genes.
Chloroplast transformation

V Applications of plant biotechnology:

Plant tissue culture and biosynthesis of secondary products.
Generation of virus free, Coat protein mediated, nucleocapsid gene insertions, insect resistant, bt, non bt like protease, amylase inhibitor
disease resistant ,Chitinase, gluconase, RIP, Antifungal proteins ,nematode resistant
herbicide resistant, phosphinothrin, glyphosate, sufonyl urea, atrazine
salt tolerant plants,
Generation of genetically modified food longer shelf life, improved quality .
Plant secondary metabolites manipulation of different pathways (Metabolic engineering) applications of suspension cultures, genetic stability, some of the important products from suspension cultures, Ethical issues and problems.

Practicals

1. Introduction to plant tissue culture
2. Media preparation, sterilization
3. Induction of Callus culture
4. Anther culture
5. Suspension culture
6. Micropropagation
7. Embryo Rescue
8. Plant regeneration from callus
9. Agrobacterium mediated transformation
10. Gene transfer in plant cells

* Most of the practicals will be demonstrations either in the Institute or at various other established labs

References:

1. R.J.Henry, Practical application of Plant Molecular Biology, Chapman & Hall
2. Kalyan Kumar DE Introduction to Plant Tissue culture
3. Bhojwani Plant Tissue Culture
4. Montells H, Mathews JA, Mckee RA Principles of plant Biotechnology
5. Biotechnology, Annual review, three volumes
6. Freshney R I Animal Cell Culture, A practical Approach, IRL press

- 7 Rehm & Reid Biotechnology , 7 volumes
- 11 J.Hamond P.McGaravey & V.Yusibov (Eds) plant Biotechnology Springer Verlag 2000
- 12 T.J Fu,G Singh,& W.R.Curtis (Eds) Plant cell and tissue culture for the production of food ingredients, Kluwer Academic press 1999
- 13 J.Reinert and Yps Bajaj Plant Cell, Tissue and Organ Culture, Narosa Publishing House
- 14 Dixon Plant Cell Culture
- 15 Srivastava Plant Tissue culture and Molecular Biology

Paper XVI

Animal Cell Science And Technology

Unit I Introduction to tissue culture and its importance in Biotechnology

Animal tissue culture : ,Natural and artificial Media, Serum and its importance, Serum free media, Chemically defined media, Protein free media, sterilization of glasswares and media.

Initiation of cell culture : Primary cultures , disaggregation of tissues 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 II Cell and Organ Culture

Animal Organ cultures, various cells used in tissue culture and their uses, cell synchronization, cell cloning & micromanipulations Artificial skin, Large scale culturing of animal cells : Monolayer cultures in roux bottles, roller bottle, multitrays, synthetic hollow fibre, bead bed reactors, microcarrier cultures, heterogenous reactors. Suspension cultures in stirred tank reactors, continuous flow cultures, airlift fermenters, Immobilised cultures of animal cells

Unit III Animal Genetic Engineering : Vectors

Gene constructs, Promoters and Enhancers used for expression, Reporter and Marker genes, their assay.

Plasmid Vectors: SV40 based vectors, binary vectors, BPV based vectors, polyoma viral vectors, retroviral plasmid constructs,

Viral vectors : SV40 replacement vectors, Retroviral vectors, Vaccinia viral vectors , P element vectors, baculoviral vectors.

Unit IV Animal Genetic Engineering : Transfection

Transfection methods: Calcium phosphate precipitation, DEAE dextran method, lipofection, electroporation, Microinjection, retroviral infections., Biolistics, polybrene

Generation of transgenes , integration and inheritance of the transferred gene., Stable and transient gene expression, identification of transgene, detection of mRNA and proteins.

Unit V Application of animal technology

Animal cell culture products : Vaccines, interferons, Recombinant proteins, Antibodies,

Embryonic Stem cells: culture, gene transfer, targeted gene transfer

Gene therapy : Genetic diseases Somatic and Embryonic therapy

Generation of transgenic mice, cattles, sheep fish and their uses.

Cloning of animals, human cloning, Tissue engineering

Ethical issues, biosafety, problems and regulations

Practicals

- a. Preparation of Media & filter sterilization
- b. Introduction to Animal culture
- c. Establishment of primary culture, secondary culture
- d. preservation of cell lines
- e. Regeneration of frozen cells in vitro
- f. Marker gene assay
- g. Gene transfer into animal cells

References

- a. Freshney Culture of Animal cells (3rd Edition) Wiley liss
- b. J.R.W. Masters Animal Cell culture Practical approach Oxford
- c. R.Basega Cell growth and division A practical approach , IRL press
- d. M.Butler & M. Dawson, Cell culture, labfax Bios Scientific Publications Oxford
- e. Martin Animal cell culture techniques Springer
- f. Methods in Enzymology series
- g. Pinket :Transgenic animal technology –A lab hand book
- h. Marshers ,John R.W Animal Cell Culture
- i. Butler M (ed) Mammalian Cell Biotechnology. A practical Approach, Oxford University Press, New York
- j.** Spier, R.E. The encyclopedia of Cell Technology. John Wiley and Sons., New York.

