Syllabus for horizontal mobility

STRUCTURE OF M. Sc. DEGREE COURSE FOR BIOCHEMISTRY/ BIOTECHNOLOGY/MICROBIOLOGY/ENVIRONMENTAL BIOTECHNOLOGY

Two years M. Sc. program is formulated for developing competent biochemists/biotechnologist/microbiologist for which significant job opportunities exist in this country. The course is based on interdisciplinary nature of Biochemistry, Chemistry, Quantitative Biology, Genetics, Microbiology and Biophysics. The program obliges students to read original publications and envisages significant inputs in laboratory work, communication skill, creativity, planning, execution and critical evaluation of the studies undertaken. This program gives common basic knowledge (Biochemistry, Enzymology, Molecular Biology, Research Methodology, Biostatistics, Computer science and Bioinformatics) at first year level to become good biochemists/biotechnologist/microbiologist. The specializations introduced in the course at second year level are in the disciplines of Immunochemistry, Neurochemistry, Clinical Biochemistry, Environmental Biochemistry and Toxicology, General Biotechnology, Plant Biotechnology, Microbiology and Microbial Technology.

SEMESTER- I

LS 141: Cell Biology, Microbiology and Virology
(Prerequisite: B. Sc. Life Science/Chemistry)
BC 141: Proteins – Structure and Functions
(Prerequisite: B. Sc. Life Science/Chemistry)
BC 142: Biomolecules
(Prerequisite: B. Sc. Life Science/Chemistry)
BSI 141: Biostatistics and Bioinformatics with Computer Orientation
(Prerequisite: B. Sc. Life Science/Chemistry)

LC BC 141: Laboratory Course I
(Prerequisite: B. Sc. Life Science)
LC BC 142: Laboratory Course II
(Prerequisite: B. Sc. Life Science)

600 marks

SEMESTER-II

BC 241: Enzymology
(Prerequisite: BC 141, BC 142)
MB 241: Molecular Biology
(Prerequisite: BC 141, BC 142)
BC 242: Bioenergetics
(Prerequisite: BC 141, BC 142)

TB 241: Tools and Techniques in Bioscience
(Prerequisite: BC 141, BC 142)

LC BC 241: Laboratory Course III
(Prerequisite: LC BC 141, LC BC 142)
LC BC 242: Laboratory Course IV
(Prerequisite: LC BC 141, LC BC 142)

600 marks

Semester III

GE 341: Genetic Engineering
(Prerequisite: MB 241)
FT 341: Fermentation Technology-I
(Prerequisite: LS 141, TB 241, GE 341)
MIC 341: Microbial Diversity and Extremophiles
(Prerequisite: LS 141, TB 241, GE 341)
IM 341: Immunology
(Prerequisite: BC141, BC 241)

LC MIC 341: Laboratory Course V
(Prerequisite: LC BC 141, LC BC 142)

LC MIC 342: Laboratory Course VI
(Prerequisite: LC MIC 341, LC BC 141)

600 marks

Semester IV

MIC 441: Food and Dairy Microbiology
(Prerequisite: B. Sc. Microbiology or LS 141)
BI 441: Bioinformatics
(Prerequisite: BC 141, BSI 141, MB 241)
MFT 441: Microbial fermentation Technology
(Prerequisite: FT 341)
MIC 442: Medical Microbiology
(Prerequisite: B. Sc. Microbiology or LS 141)

LC MIC 441: Laboratory Course VII
(Prerequisite: LC MIC 341, LC MIC 342)

LC BC 442: Laboratory Course VIII (Project work)
(Prerequisite: LC MIC 341, LC MIC 441, LC BC 142)

600 marks

Work load for M. Sc I & II

M. Sc. I (Sem. I and II)	Theory	Practicals
	16 hrs	16 hrs
Seminars	2 hrs	(for 1 batch)
Oral Exam	2 hrs	
	20 hrs	

Credit system

Admission:
Intake capacity:
1. 25 students every year on the basis of entrance examination
2. 10 % students from other Universities.

Eligibility for Admission:
A) A candidate possessing B. Sc. Degree with minimum 50% marks with chemistry/ biochemistry/ microbiology/ botany/zoology/biotechnology/life sciences as principal subject with chemistry at B. Sc. I, and B. Pharm who have passed the entrance examination conducted by the Shivaji University shall be held eligible for admission to M. Sc. Course Microbiology. Students from other Universities with B. Sc. General Degree and who have passed the entrance examination conducted by the University are also eligible.
B) Candidate should have microbiology at subsidiary level or he should pass bridge course "Basics of Microbiology" for admission to M. Sc. Microbiology course.
C] Candidate has to pass entrance examination conducted by Department of Microbiology.

Course Work:
1. Student has to complete 96 credits
   Theory courses: 64 credits
   Practical/Project/ Seminar/ Scientific Paper Writing: 32 credits
   (Seminar: 1, Scientific Paper Writing: 1, Project at any University/ Industry/ Institution: 4, Practical course at the Department: 4 or 2)
2. Each Semester student can opt for 1 credit to 32 credits
3. There will be 2 semester in each year and course will be of 4 semesters.
4. Time course: 2 yrs minimum or as and when completes 96 credits.

Class capacity:
Theory: 60 students maximum/per class
Practical courses: 10 students/batch

Examination:
Theory Exam:
External marks: 80 per theory paper (examination at the end of semester)
Internal marks: 20 per theory paper (examination "objective type" to be conducted by

respective teacher)

This activity will be coordinated by one of the teacher from the Department.
Nature of question paper: objective/multiple choice/one line answer/true or false.
It will be Surprise test during the theory lecture of respective teacher.
Examination will be conducted twice in the semester having 10 marks for each test.
There is no reexamination

Tentative schedule of the examination:

4th Week of July- Paper-I
1st Week of August- Paper-II
2nd Week of August- Paper-III
3rd Week of August- Paper-IV

1st Week of September- Paper-I
2nd Week of September- Paper-II
3rd Week of September - Paper-III
4th Week of September - Paper-IV

Practical Exam:

1. Continuous evaluation for 100 marks for each Practical courses by respective teacher. Senior teacher will be deputed for each course.
   (Experimental performance will be graded immediately after completion of experiment)

4th Week of August- Mid term Practical examination
Duration: 1 day (10.30 am to 05.30 pm)
Nature of examination: Principle writing (10 marks)
Two Experiments (20 marks each)
Viva-voce (10 marks)

1st Week of October- Final Practical examination
Duration: 1 day (10.30 am to 05.30 pm)
Nature of examination: Principle writing (10 marks)
Two Experiments (20 marks each)
Viva-voce (10 marks)
Duly completed Journal (10 marks)
Attendance and practical record notebook submission duly signed by in charge teacher (60 marks)

Seminar:
Duration: 2 days (10.30 am to 05.30 pm)
After final practical examination (10 marks)

Appointment of examiners for internal theory and practical examinations will be done by University authorities or Head of the Department.
Examiners will be paid remuneration as per University rules.

Project evaluation:

By internal and external examiner at the end of Fourth Semester for (100 marks).

Course required for M. Sc. Degree in Microbiology:

Core Theory courses: 12 x 4 = 48 credits
Core Laboratory courses: 6 x 4 = 24 credits

Courses available in the Department:

Theory courses:
Compulsory courses for M. Sc. Degree in Microbiology: BC 141, BC 142, BSI 141, BC 241, MB 241, TB 241, GE 341, FT 341, MIC 341, MIC 441, BI 441, MFT 441)

Laboratory courses:
(Compulsory Lab courses for M. Sc. Degree in Microbiology: LC BC 141, LC BC 142, LC BC 241, LC BC 242, LC MIC 341, and LC MIC 342)

(LS141 represents: **LS:** Course name, **1**: Semester, **4**: credit allotted to the course, **1**: Chronological order within that category)

Core Theory courses: 12 x 4 = 48 credits
Core Practical courses: 6 x 4 = 24 credits

Rest credits can be obtained by doing courses at different Departments of the University, or from any other University or within the department.

It is also suggested that every student undertake two hours library work under the supervision of faculty members. It is envisaged that the research projects (dissertation) and specializations will inculcate aptitude for research and practical applications. The students will also have basic inputs on communications skills and computers knowledge (information technology) and learn the basics of scientific writing and presentation.

Course: A course means a semester course.
Credit: One clock hour theory lecture per week per semester (15 weeks) is equivalent to one credit. (15 hours = 1 credit)
Semester: Each semester consists of 15 weeks.

SEMESTER – I

LS 141: Cell Biology, Microbiology and Virology (60)
(Prerequisite: B. Sc. Life Science/Chemistry)

UNIT I (15)

CELL BIOLOGY:

Cell as a basic unit of life. Cell organization of prokaryotic and eukaryotic cells. Structural and functional capitalization of cell –mitochondria, chloroplast, lysosomes, golgi bodies, plasma membrane and cytoskeleton, cell wall, nucleus.

UNIT II (15)

Cell cycle, cell division - mitosis and meiosis.

Chromosome structure, gene, gene number, gene clusters and Pseudogene. Polytene and lampbrush chromosomes. Packing of DNA, supercoiled DNA, nucleosome, Inverted repeats, repetitive DNA sequence, satellite DNA.

Cell trafficing.

UNIT III (15)

MICROBIOLOGY:

Structure, classification and general characteristics of Bacteria (including ribotyping), Micoplasma, Protozoa, archea and yeast, fungi. Association of bacteria.

Methods in microbiology: Pure culture techniques, principles of microbial nutrition, construction of culture media, enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Sterilization-Application of sterilization methods in biotechnology, Various sterilization methods, Microbial contamination control and Sterility testing.

Microbial growth: The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yield, synchronous growth, continuous culture.

UNIT IV (15)

VIROLOGY:

Classification and General properties of plant, animal and bacterial viruses, Bacteriophages - lytic cycle & lysogeny. Structure of viruses, assembly of viral membrane.

Life cycle and replication of viruses:

RNA-negetive strand (VSV), positive strand (Polio), segmented [Influenza]

Retrovirus- RSV and HIV

DNA- adenovirus and SV-40

Cultivation in cell culture, chick embryo and animal inoculation.

Persistent chronic and acute viral infections.

Mechanism of interferon and antiviral therapy.

Host virus interactions; plant and animal.

Suggested readings:

1. Clark M S & Wall W. J. (1996) Chromosomes, Chapman & Hall, London.
2. Textbook of Medical Physiology by A.C. Guyton and J. E. Hall, W.B. Saunders Publication, 9th Edition , 1996
3. Physiology Illustrated by Lipfold and Cogdell
4. Cells by David Prescott
5. Cell Structure and Function by Loewy and Gallant
6. Essential Cell Biology by Albert Bray et al, Garland Publication New York 1997
7. Introduction to Modern Virology by Dimmock and Primrose
8. Molecular Virology by Alan Cann
9. Madigam M.T., Martinko J.M and Parker J. (2001) Biology of Microorganisms 9th ed. Prentice Hall Int. (U.K.) Ltd, London.
10. General Microbiology by Stanier, Adelberg and Ingraham, The Macmillan Press Ltd, Hong Kong.

BC 141: Proteins – Structure and Functions (60)

(Prerequisite: B. Sc. Life Science/Chemistry)

UNIT I (15)

AMINO ACIDS:

Chemical structure and general properties, pI of amino acids, acid base concepts. Henderson and Hasselbaclh equation. General metabolism scheme of amino acids and Urea cycle.

PROTEINS:

Classification- size, shape, degree of association, complexity.

Classification of proteins according to biological functions (Enzymes, transport, storage, contractile, structural, defense and regulatory)

Structure of peptide bond - restricted rotation, cis - trans bending, Ramchandran plot. Peptides.

UNIT II (15)

Secondary structure - alpha helix and beta pleated structure, triple helix (collagen) and supersecondary structures.

Tertiary structure - forces stabilising tertiary structure, unfolding/refolding experiment, prediction of secondary and tertiary structure. Dynamics of protein folding, role of molecular chaperones in protein folding, Lysosomal and membrane proteins.

Quaternary structure - forces stabilising quaternary structure. Structure function relationship - myoglobin and hemoglobin.

Techniques for studying primary sequence of proteins, experimental methods, end group analysis, finger printing and sequenators.

UNIT III (15)

Chemical synthesis of peptides/ solid phase automated synthesis, prediction of conformation from amino acid sequence, zymogens and their conversion into active proteins
Protein evolution - phylogenic tree, convergent and divergent trees, sequence analysis, comparison matrix, Dot matrix and substitution matrix.
Protein turnover: Ubiquitination, proteasome and protein degradation.

UNIT IV **(15)**
Concept of prosthetic group, apoenzyme, holoenzyme, enzyme.
Coenzyme:
Vitamins as coenzymes: sources, requirements, functions and deficiency symptoms of water soluble vitamins. structure and biochemical role. Assay of vitamins.
Cofactors: Role of trace elements, their bound forms in biological systems and in enzyme structure and function.

Suggested Readings:

1) Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000
2) Biochemistry by Lubert Stryer, 4th Edition
3) Biochemistry by David Rawn
4) Principles of protein structure by Shulz and Schirmer
5) Fundamentals of Enzymology by Royer
6) Fundamentals of enzymology by Price and Steavens

BC 142: Biomolecules **(60)**
(Prerequisite: B. Sc. Life Science/Chemistry)

UNIT I **(15)**
CLASSIFCATION AND STRUCTURES:
Classification, characteristics and functions of monosaccharides, disaccharides - polysaccharides. Epimers, isomers, anomers, chiral carbon atom, chair and boat form, glucopyranose and fructopyranose.
CARBOHYDRATE METABOLISM:
General scheme of metabolism, historical and experimental details in derivation of a metabolic pathway. Glycolysis - aerobic and anaerobic, regulation of glycolysis. Krebs cycle and its regulation; Hexose monophosphate shunt,

UNIT II **(15)**
OTHER PATHWAYS OF CARBOHYDRATE METABOLISM
phosphoketolase pathway, Entner Dudroff pathway, glyoxylate and glucuronate pathways, Cori cycle. Interconversion of sugars, gluconeogenesis , synthesis of disaccharides and polysaccharides. Regulation of blood glucose and homeostasis. Glycogenesis and glycogenolysis and their regulation.
COMPLEX CARBOHYDRATES:
Types and general functions, amino sugars, sialic acid and mucopolysaccharides. Structure and functions of glycoproteins and proteoglycans. Blood group sugar

compounds, sugar nucleotides, bacterial cell wall components. Lectins - specificity, characteristics and uses, pectin, xylans.

UNIT III **(15)**

LIPIDS:

Definition and classification of lipids. Fatty acids - general formula, nomenclature and chemical properties Structure, function and properties of simple, complex, acylglycerols, phosphoglycerides, sphingolipids, waxes, terpenes, steroids and prostaglandins.
Beta oxidation - pathway and regulation.
Role of acyl carnitine in fatty acyl transport. Synthesis of fatty acid - structure and composition of fatty acid synthetase complex, pathway and regulation. synthesis of triacyl glycerides.
Ketone bodies - formation and utilisation.

UNIT IV **(15)**

NUCLEIC ACIDS:

Structure of nucleoside, nucleotide. De novo and salvage pathways of nucleotide synthesis. Experimental evidence for nucleic acids as genetic material. Secondary structure of DNA, Watson and Crick model of DNA. A, B and Z forms of DNA, Tm and its relation to GC content Chemical and enzymatic degradation of nucleic acids.

Suggeted Readings :

1) Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000
2) Biochemistry by Lubert Stryer, 4th Edition
3) Biochemistry by Zubay
4) Biochemistry By Garrett and Grisham
5) Complex Carbohydrate by Nathan Sharon

BSI 141: Biostatistics and Bioinformatics with Computer Orientation (60)
(Prerequisite: B. Sc. Life Science/Chemistry)

UNIT I **(15)**

BASIC TERMS, MEASURES OF CENTRAL TENDENCY AND DISPERSION*:*

Population, Sample, variable, parameter, primary and secondary data, screening and representation of data. Frequency distribution, tabulation, bar diagram, histograms, pie diagram, cumulative frequency curves. Mean median, mode, quartiles and percentiles, measures of dispersion: range, variance, standard deviation, coefficient of variation, symmetry: measures of skewness and kurtosis

PROBABILITY AND DISTRIBUTIONS:

Sample space, events, equally likely events. Definition of probability (frequency approach), independent events. Addition and multiplication rules, conditional probability, Examples Bernoulli, Binomial, Poisson and Normal distributions. Mean and variance of these distributions (without proof). Sketching of p.m.f. and p.d.f, Use of these distributions to describe in biological models. Model sampling and Simulation study.

UNIT II **(15)**

BIVARIATE DATA:

Scatter plot, correlation coefficient (r), properties (without proof), Interpretation of r, linear regression. Fitting of lines of regression, regression coefficient, coefficient of determination.

METHODS OF SAMPLING:

Use of random numbers to generate simple random samples with replacement and without replacement. Sampling distribution and standard deviation of sample mean. Stratified sampling and its advantages.

HYPOTHESIS TESTING:

Hypothesis, critical region, and error probabilities. Tests for proportion, equality of proportions, equality of means of normal populations when variance known and when variances are unknown. Chi-square test for independence. P-value of the statistic. Confidence limits, Introduction to one way and two-way analysis of variance.

UNIT III **(15)**

COMPUTER RELATED INTRODUCTORY TOPICS:

History of development of computers, Basic components of computers, Hardware; CPU, input, output, storage devices. Software; operating systems, Programming languages (Machine, Assembly and Higher level)

APPLICATION SOFTWARE:

Introduction to MSEXCEL-Use of worksheet to enter data, edit data, copy data, move data. Use of in-built statistical functions for computations of Mean, S.D., Correlation, regression coefficients etc. Use of bar diagram, histogram, scatter plots, etc. graphical tools in EXCEL for presentation of data. Introduction to MSWORD word processor-editing, copying, moving, formatting, Table insertion, drawing flow charts etc.

UNIT IV **(15)**

BIOINFORMATICS :

Introduction to Internet and use of the same for communication, searching of database, literature, references etc. Introduction to Bioinformatics, Databank search- Data mining, Data management and interpretation, BLAST, Multiple sequence alignment, Protein Modeling, Protein structure Analysis, Docking, Ligplot interactions, Genes, Primer designing, Phylogenetic Analysis, Genomics and Proteomics.

Suggeted Readings :

1. Biostatistics : A foundation for Analysis in the Health Sciences 7/E Wayne W. Daniel, Wiley Series in Probability and Statistics.
2. Introductory Statistics. Fifth Edition. (2004) Prem S. Mann. John Wiley and Sons (ASIA) Pte Ltd.
3. Basic Statistics-Aprimer for Biomedical Sciences- (Olive Jean Dunn).

4. Biostatistics-An introductory text - (Auram Gold Stein).
5. Statistics : An Introductory Analysis (Taro Yamane) Harper and Row Publisher 1964,67,73
6. Computational Biochemistry, By: C. Stan Tsai, A John Wiley & Sons, Inc., publication.

LC BC 141: Laboratory Course I (60)

(Prerequisite: B. Sc. Life Science)

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-H_2SO4 method ii) Anthrone method
7) Estimation of glucose concentration by
   a) Glucose oxidase method
8) Determination of fructose concentration by resorcinol method.
9) Estimation of DNA and RNA
   a] Estimation of DNA by diphenyl amine method.
   b] Estimation of DNA by Spectrophotometric method.
   c] Estimation of RNA by orcinol method
10) Estimation of Cholesterol
11) Estimation of Inorganic phosphate by Fiske & Subbarow Method
12) Estimation of Vit. C concentration by DCPIP method
13) Isolation of Characterization of casein from milk.
14) Isolation and characterization of starch from potato.
15) Isolation of DNA and RNA.
16) Isolation of cholesterol and lecithin from egg yolk.
17) Determination of hyperchromicity and study of melting curves.

LC BC 142: Laboratory Course II (60)

(Prerequisite: B. Sc. Life Science)

Biostatistics and bioinformatics:

1] Measures of Central Tendency and Dispersion
2]Statistical Analysis using EXCEL. (Descriptive statistics and graphical presentation.)
3] Sketching of pmf/pdf of Binomial, Poisson and Normal distributions.
4] Correlation and Regression Analysis

5] Simple random sampling and stratified sampling.
6] Hypotheses testing and confidence intervals.
7] Analysis of Variance.
8] Word processing.
9] Getting an amino acid sequence, nucleotide sequence and blasting.
10] Multiple sequence alignment
11] Homology modeling
12] Structure analysis: secondary, tertiary and Quaternary structure, bond angle, bond length, different interactions.
13] Searching for possible ligand, ligand protein interactions.
14] Primer designing.
15] Phylogenetic studies.

Suggested Readings :

1) Practical Biochemistry : An Introductory Course by Fiona Frais.
2) Methods in Enzymology Vol. I by S.P.Colowick and N.O.Kaplan eds.
3) Basic Biochemical Methods 2nd ed by R.R.Alexander and J.M.Griffith
4) Biochemical Methods 2nd ed. by S.Sadasivam and A. Manickam.
5) Hawk's Physiological Chemistry ed. by Bernard L Oser.
6) A Textbook of Practical Biochemistry by David Plummer.
7) Laboratory Mannual in Biochemistry by S. Jayaraman.

SEMESTER- II

BC 241: Enzymology (60)
(Prerequisite: BC 141, BC 142)

UNIT I (15)

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 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 II (15)

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, non-competitive and uncompetitive, their mode of action and experimental determination.
Enzyme activity, international units, specific activity, turnover number, end point kinetic assay

UNIT III **(15)**

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 **(15)**

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.

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

Suggested Readings :

1) Fundamentals of Enzymology Price and Stevens
2) Enzymes Dixon and Webb
3) Isoenzymes By D. W. Moss
4) Immobilized Biocatalysts W. Hartneir
5) Selected papers Allosteric Regulation M. Tokushige

MB 241: Molecular Biology **(60)**

(Prerequisite: BC 141, BC 142)

UNIT-I **(15)**

Genome organization

Organization of bacterial genome, Structure of eucaryotic chromosomes; role of nuclear matrix in chromosome organization and function, matrix binding proteins, heterochromatin and euchromatin, molecular components, DNA reassociation kinetics (Cot curve analysis), repetitive and unique sequences, kinetics and sequence complexities, satellite DNA, DNA melting and buoyant density, packing and organization of chromatin, nucleosome phasing, DNase I hypersensitive regions, DNA methylation & Imprinting

Mutation

Nonsense, missense and point mutations, intragenic and intergenic suppression, frameshift mutations, physical, chemical and biological mutagens.

UNIT-II **(15)**

DNA Replication, Repair & Recombination

Concepts of replication initiation, elongation and termination in prokaryotes and eukaryotes, enzymes and accessory proteins involved in DNA replication, Fidelity in replication, replication of single stranded circular DNA. Gene stability and DNA repair, DNA repair enzymes, photoreactivation, nucleotide excision repair, mismatch correction, SOS repair. Recombination: homologous and non-homologous recombination, site specific recombination, Holliday structure, resolution, chi sequences in prokaryotes, gene targeting, gene disruption, FLP/FRT and Cre/Lox recombination RecA and other recombinases.

UNIT-III **(15)**

Prokaryotic & Eukaryotic Transcription

Prokaryotic Transcription & Regulation: Promoters, Regulatory elements, Transcription unit, constitutive and inducible promoter, operators, Initiation, Attenuation, Termination, Rho-dependent and independent termination, Anti-termination, Transcriptional regulation, positive and negative regulation, operon concept, Regulation of transcription of lac, trp, ara, his, and gal operons, transcriptional control in lambda phage, Transcript processing, Processing of tRNA and rRNA

Eucaryotic transcription and regulation: RNA polymerase structure and assembly, RNA polymerase I, II, III, Eukaryotic promoters and enhancers, General Transcription factors, TATA binding proteins (TBP) and TBP associated factors (TAF), Activators and repressors, transcription initiation, elongation and termination, activation and repression, Transcriptional and post-transcriptional gene silencing, expression and processing of heterogeneous nuclear RNA, tRNA, rRNA, 5'-Cap formation,3'-end processing and polyadenylation, Splicing, RNA editing, Nuclear export of mRNA, mRNA stability, catalytic RNA.

UNIT-IV **(15)**

Translation & Transport

The translation machinery, ribosomes, composition and assembly, Universal genetic code, degeneracy of codons, termination codons, isoaccepting tRNA, wobble hypothesis. Mechanism of initiation, elongation and termination, Co- and post-translational modifications, genetic code in mitochondria. Protein synthesis, Transport of proteins and molecular chaperones, protein stability, protein turnover and degradation

Suggested reading:

1.Stryer L (1995) Biochemistry, 4 th edition, W. H. Freeman & company, New York.
2. Watson J. D., Hopkins, N. H., Roberts, J. W., Steitz, J. A. and Weiner, A. M. (1988) Molecular biology of the gene, 4 th edition, The Benjamin/Cummings publishing companies, inc, California.
3. Benjamin Lewin (1999) Genes VII, oxford University Press, Oxford.

4. Weaver R. F. (1999) Molecular biology, WCB McGraw-Hill companies, Inc, New York.
5. Brown T A (1995) Essential molecular biology, vol. I, A practical approach, IRL press, Oxford.
6. Genes and Genomes Maxine Singer and Paul Berg

BC 242: Bioenergetics **(60)**

(Prerequisite: BC 141, BC 142)

UNIT I **(15)**

FREE ENERGY CONCEPT:

Molecular basis of entropy, concept of free energy, standard free energy and measurement of free energy, significance in metabolism. Application of first and second law of thermodynamics to biological systems. Energy rich bonds - ATP and interconversions of nucleotide phosphates. Phosphorylation potential

NITROGEN FIXATION:

Biological fixation of nitrogen, symbiotic and non-symbiotic nitrogen fixation.
Nitrogenase enzyme complex - azoferredoxin and molybdoferrodoxin. Physiological electron donors and mechanism of nitrogen reduction, assimilation of ammonia, nitrogen cycle. Nif genes and its regulation.

UNIT II **(15)**

MITOCHONDRIA:

Architecture, chemical activity of mitochondria. Sequence of electron carriers and sites of oxidative phosphorylation, ATP generation, heme and non- heme iron proteins. Thermodynamic considerations, oxidation - reduction electrodes, standard electrode potential, redox couples, phosphate group transfer potential. Respiratory controls. Theories of oxidative phosphorylation, uncouplers and inhibitors of energy transfer. ATP synthetase complex.

UNIT III **(15)**

CHLOROPLAST:

Architecture, - light harvesting complexes, bacteriorhodopsin, plastocyanin, carotenoids and other pigments. Hill reaction, photosystem I and II - location and mechanism of energy transfer, photophosphorylation and reduction of carbon dioxide. Calvin cycle , quantitative efficiency, photorespiration, C4 - metabolism.
Chemiosmotic theory and evidence for its occurance, ion transport through membranes, proton circuit and electro-chemical gradient, ionophores, Q cycle and stoichiometry of proton extrusion and uptake, P/O and H/P ratios, reverse electron transfer.
Fractionation and reconstitution of respiratory chain complexes.

UNIT IV **(15)**

HORMONES :

General classification of hormones - synthesis, structure, secretion, transport, metabolism and mechanism of action of pancreatic, thyroid, parathyroid, hypothalamus, pituitary, adrenal and prostaglandins. Hormonal control of spermatogenesis, menstrual cycle, pregnancy and lactation . Cell membrane and intracellular receptors for hormones. Secondary messengers

Plant growth hormones - auxins, gibberllins, abscessic acid, cytokinins.

Phenoromones

Suggested Readings :

1.Biochemistry by Lubert Stryer 4th Edition
2. Biochemistry by Mathew VanHolde
3. Lehningers Principles of Biochemistry by Nelson and Cox
4. Hormones by Norman Litwack
5. Basic and Clinical Endocrinology Greenspan and Baster
6. Biochemistry and Physiology of Plant Hormones, Thomas Moore
7. Annual Review of Biochemistry 1977
8. Thermodynamics for Biological Systems Baine

TB 241: Tools and Techniques in Bioscience **(60)**

(Prerequisite: BC 141, BC 142)

UNIT I **(15)**

TECHNOLOGY FUNDAMENTALS (Life Science):

General scheme for purification of bio-components. Methods for studying cells and organelles. Sub-cellular fractionation and marker enzymes. Methods for lysis of plant, animal and microbial cell. Ultrafiltration, freeze drying and fractional precipitation. Use of detergents in isolation of membrane proteins.

UNIT II **(15)**

CHROMATOGRAPHY:

Basic principles and applications of ion-exchange, gel filtration, partition, affinity, HPLC and reverse phase chromatography, gas chromatography, TLC, Paper chromatography. Chromatofocussing.

CENTRIFUGATION:

Ultracentrifugation - velocity and buoyant density determination. Density gradient centrifugation, molecular weight determination.

UNIT III **(15)**

ELECTROPHORESIS:

Basic techniques, poly acrylamide/ starch/ agarose gel electrophoresis, use of SDS/urea, isoelectric focusing, capillary electrophoresis. Pulse field gel electrophoresis.

TRACER TECHNIQUES:
Principles and applications of tracer techniques in biology, Measurement of alpha, beta and gamma radiations. Radiation dosimetry, Radioactive isotopes and half life of isotopes, Autoradiography, Cerenkov radiation, Liquid Scintillation spectrometry.

UNIT IV (15)

DETERMINATION OF BIOPOLYMER STRUCTURE (Principles and applications):
X-ray diffraction, fluorescence, UV, visible, CD/ORD, ESR, NMR and Mass spectroscopy, atomic absorption spectroscopy. plasma emission spectroscopy.

MICROSCOPY:
Principles and application of light phase contrast, fluorescence, scanning and transmission electron microscopy,

Suggested Readings:

1) Protein Purification by Robert Scopes, Springer Verlag Publication, 1982
2) Tools in Biochemistry David Cooper
3) Methods of Protein and Nucleic acid Research, Osterman Vol I – III
4) Centrifugation D. Rickwood
5) Practical Biochemistry, V th edition, Keth, Wilson and Walker.

LC BC 241: Laboratory Course III (60)
(Prerequisite: LC BC 141, LC BC 142)

1] Separation and identification of amino acid mixture by
i] Paper chromatography technique.
ii]Paper electrophoresis technique
2] Thin layer chromatographic separation of sugars and membrane lipids.
3] Separation and identification of serum proteins by polyacrylamide/agarose gel electrophoresis. (BSA/Hb).
4] Separation of DNA by agarose gel electrophoresis.
5] Separation of proteins (hemoglobin & cytochrome c) using molecular sieve chromatography.
6] Determination of capacity of ion exchange resin [Dowex- 50]
7] Purification of protein by ion exchange chromatography.
[DEAE cellulose chromatography]
8] Determination of activity of invertase from immobilized cells of *Saccharomyces cerevisiae*

LC BC 242: Laboratory Course IV (60)
(Prerequisite: LC BC 141, LC BC 142)

1] Identification and quantitation of activity of α amylase/ β amylase /cellulase/amyloglucosidase/invertase/alkaline phosphatase (salivary/microbial/animal/plant source].
2] Determination of specific activity.

3] Determination of activity in presence of activators.
4] Determination of activity in presence of inhibitors.
5] Determination of optimum pH
6] Determination of optimum temperature
7] Determination of Km
8] Determination 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

SEMSTER III

GE 341: Genetic Engineering (60)
(Prerequisite: MB 241)

UNIT I: (15)

DNA & Basics of Recombinant DNA Technology

Structure of DNA: A-,B-,Z-, and triplex DNA, measurement of properties, spectrophotometric, CD, AFM, and electron microscope analysis of DNA structure. Restriction analysis: Types of restriction enzyme, Type I, II and III, restriction modification systems, type II restriction endonucleases and properties, isoschizomers and neoschizomers, mcr/mrr genotypes, Cohesive and blunt end ligation, linkers, adaptors, homopolymeric tailing. Labeling of DNA: Nick translation, random priming, radioactive and non-radioactive probes, use of Klenow enzyme, T4 DNA polymerase, bacterial alkaline phosphatase, polynucleotide kinase. Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence *in situ* hybridization Restriction maps and mapping techniques, DNA fingerprinting, chromosome walking & chromosome jumping

DNA-Protein Interactions: Electro mobility shift assay, DNase I footprinting, methyl interference assay

UNIT II: **(15)**

Cloning Vectors

Gene Cloning Vectors: Plasmids, bacteriophages, Cloning in M13 mp vectors, phagemids, Lambda vectors; insertion and replacement vectors, EMBL, λDASH, λgt10/11, λZAP etc. Cosmid vectors. Artificial chromosome vectors (YACs, BACs), Animal Virus derived vectors- SV-40, vaccinia/bacculo & retroviral vectors. Expression vectors; pMal, GST, pET-based vectors. Protein purification; His-tag, GST-tag, MBP-tag etc. Restriction proteases, intein-based vectors. Inclusion bodies, methodologies to reduce formation of inclusion bodies. Baculovirus and pichia vectors system

UNIT III: **(15)**

Cloning Methodologies

Insertion of Foreign DNA into Host Cells: Transformation, Transfection: Chemical and physical methods, liposomes, microinjection, macroinjection, electroporation, biolistics, somatic cell fusion, gene transfer by pronuclear microinjection, Plant transformation technology: Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence genes, use of Ti and Ri as vectors. Cloning and expression in yeasts (Saccharomyces, Pichia etc.), animal and plants cells, methods of selection and screening, cDNA and genomic cloning, expression cloning, jumping and hopping libraries, southwestern and far western cloning, yeast two hybrid system, phage display, Construction of cDNA libraries in plasmids and screening methodologies, Construction of cDNA and genomic DNA libraries in lambda vector. Principles in maximizing gene expression, Site-directed mutagenesis.

UNIT IV: **(15)**

PCR and Its Applications

Primer design, Fidelity of thermostable enzymes, DNA polymerases, multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products, T-vectors, proof reading enzymes, PCR in gene recombination, deletion, addition, overlap extension, and SOEing, site specific mutagenesis, PCR in molecular diagnostics, viral and bacterial detection, PCR based mutagenesis.

Applications

Sequencing methods: Enzymatic DNA sequencing, Chemical sequencing of DNA, principle of automated DNA sequencing, RNA sequencing.

Chemical Synthesis of oligonucleotides. Gene silencing techniques: Introduction to siRNA and siRNA technology, micro RNA, construction of siRNA vectors, principle and application of gene silencing. Gene knockouts and Gene Therapy: Creation of knock out mice, disease model, somatic and germ-line therapy in vivo and ex-vivo, suicide gene therapy, gene replacement, gene targeting

Other applications: Transgenics, Genome projects and their implications, application in global gene expression analysis. Applications of recombinant DNA technology in medicine, agriculture, veterinary sciences.

Suggested readings:

1. Sambrook J, Fritsch E. F. and Maniatis (1989) Molecular cloning, vol. I, II, III, II nd edition, Cold spring harbor laboratory press, New York.
2. DNA Cloning : A practical approach D.M. Glover and D.B. Hames, RL Press, Oxford, 1995
3. Molecular and cellular methods in Biology and Medicine, P.B. Kaufman, W. Wu , D. Kim and L.J. Cseke, CRC Press Florida 1995
4. Methods in Enzymology Guide to Molecular Cloning Techniques, Vol. 152 S.L. Berger and A. R. Kimmel, Academic Press Inc, San Diego, 1996
5. Methods in Enzymology Gene Expression Technology, Vol. 185D. V. Goedel, Academic Press Inc, San Diego, 1990
6. DNA Science: A First Course in Recombinant Technology, D. A. Mickloss and G. A Freyer, Cold Spring Harbor Laboratory Press, New York, 1990
7. Molecular Biotechnology, 2nd Ed. S. B. Primrose, Blackwell Scientific publishers, Oxford, 1994
8. Milestones in Biotechnology, Classic Papers on Genetic Engineering, J. A. Davis and W. S. Reznikoff, Butterworth-Heinemann Boston 1992
9. Route Maps in Gene Technology, M. R. Walker, and R. Rapley, Blakwell Science, Oxford, 1997
10. Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eukaryotes, S. M. Kingsman, Blackwell Scientific Publications, Oxford, 1998

FT 341: Fermentation Technology-I (60)
(Prerequisite: LS 141, TB 241, GE 341)

UNIT I (15)

Upstream Processing

Microbial cell growth, kinetics and Stoichiometry, various Methods for growth measurement, Strain improvement by mutation, genetic engineering, etc. Overproduction of metabolites, alternative carbon and nitrogen sources and their composition. Development of innocula for industrial fermentation, design of industrial production media. Alternate metabolic routines for utilization of carbon sources with their regulation and inter-linkage especially for glucose and hydrocarbons, preservation and maintenance of microbes.

UNIT II (15)

Fermentation

Design of fermenter, construction materials, various sterilization techniques for solid, liquid and gases, aeration and agitation, foam, auxillary equipments. Control of various parameters – online and offline monitoring, rheological properties of fermenter, role of computer in fementer operation,

UNIT III **(15)**

Batch, fed-batch and continuous fermentation.
Effluent treatment, scale up and scale down. Types of fermenters, solid state fermentation, process economics, fermentation economics.

UNIT IV **(15)**

Downstream Processing

Principle, methodology, instrumentation an applications of cell homogenization techniques liquid-liquid extraction centrifugation, filtration, , distillation, ultrafiltration, precipitation, adsorption chromatography, ion exchange chromatography, gel filtration and affinity chromatography in clarification, concentration, isolation and purification of various metabolites from fermented media

Suggested Readings :

1) Moo-Young M. ed. (1985) Comprehensive Biotechnology vol: I & II, Pergamon Press N.Y.
2) Ratledge C and Kristiansen B. eds. (2001) Basic Biotechnology 2nd ed. Cambridge Univ Press Cambridge.
3) Old R.W and Primose S.D (1995) Principles of Gene Manipulation 5th ed. Blackwell Scientific Pub. Oxford.
4) Bailey J.E and Ollis D.F. (1986) Biochemical Engineering Fundamentals 2nd ed. McGraw Hill Book Company, N. Delhi.
5) Aiba S, Humphrey A. E. and N. F. Millis (1973) Biochemical Engineering, 2nd Edition University of Tokyo Press, Tokyo, Japan.
6) Stanbury P.F., Whitaker A, and Hall S.J. (1997) Principles of Fermentation Technology 2 nd ed.Aditya Books Pvt. Ltd, N.Delhi.
7) Mukhopadhaya S.N. (2001) Process Biotechnology Fundamentals.Viva Books Pvt. Ltd. N.Delhi.
8) Rehm H.J and Reed G. (1985) Biotechnology vol. I & II. VCH, Basel.
9) Stainer R. Y. Ingrahm J. L., Wheelis M. L. and Painter P. R. (1987) General Microbiology 5th Edition, Macmillan Press Ltd. London.

MIC 341: Microbial diversity and extremophiles **60**
(Prerequisite: LS 141, TB 241, GE 341)

UNIT I **(15)**

Microbial Ecology: Basic ecological principles, Ecosystems, Habitats, Ecological niches, microbial community, Population dynamics and ecosystem management, mathematical definitions and suitable examples of microbe-microbe interactions, microbe-plant interactions and microbe – animal interactions.

Unit II **(15)**

Microbial taxonomy: Brief study on: Algae: Classification, distribution, structure, nutrition and metabolism, reproduction, importance of Algae. Fungi; Classification, distribution, structure, nutrition and metabolism, reproduction, importance of Fungi.

Protozoa ; Classification, nutrition, morphology, reproduction, of protozoa. Viruses; .General properties, classification and reproduction of viruses. Viroids and virusoids, Prions.

Unit III **(15)**

Study of types of Microbes with examples: Concept of autotrophy, Photosynthetic bacteria, Methanogens and methanotrophs, Nitrogen fixing bacteria, Acidophilic bacteria, Halophilic bacteria and Thermophilic bacteria.

Unit IV **(15)**

Other microbial interactions and its controls, with certain abiotic components of environment like wood, plastic, paints, rubber, pesticides, toxic heavy metals, etc.: Biodeteriorations, Bioremediations, Biotransformations and Biomagnifications and their significance with respect to environment and biodiversity. Role of microbes in secondary and tertiary recovery of petroleum.

Suggested readings:

Extremophiles (2000) By B.N.Johari, Springer Verlag
Microbial Diversity (1999) By D. Colwd, Academic press
Microbial Ecology (1979) By J.M. Lynch and N.J.Poole, Blackwell Scientific Publications, Oxford.
Introduction to Modern Virology (2001) eds.: N.J.Dimmock and K.N.Leppard, Blackwell Scientific Publications, Oxford.

IM 341: Immunology **(60)**

(Prerequisite: BC 141, BC 241)

Unit I **(15)**

Immunology – fundamentals and anatomy of immune system

A) Immunity – Innate and acquired immunity. Components of innate and acquired immunity.
B) Antigen, Haptens, adjuvants, mitogens. Antibodies – structure, functions.
C) The anatomy of the immune response: - Cells and organs of immune system. Regulation of immune response – Humoral and Cell mediated response.

Unit II **(15)**

Immunity to infection

A) Antigen processing and presentation, MHC, complement system.
B) Bacterial, viral, protozoal and parasitic infections with reference to (Diphtheria, influenza virus, malaria and helminthes) with specific representative examples of each group.
C) Vaccines – Active and passive immunization, DNA vaccines, multivalent subunit vaccines, synthetic peptide vaccines.

Unit III **(15)**

Clinical Immunology

A) Hypersensitivity: - Type I, II, III, and IV reactions.
Autoimmunity – organ specific and systemic autoimmune diseases. Treatment of autoimmune diseases.

B) Transplantation and tumor immunology: - Graft rejection, tissue typing, immunosuppressive therapy and clinical transplantation.
Tumor antigens,cancer immunotherapy.

C) Immunodeficiency diseases - Phagocytic, humoral, cell mediated deficiencies and SCID. AIDS- causes, syndrome, diagnostic tools, treatment and development of vaccine

Unit IV **(15)**

Immunotechnology

A) Antigen antibody interactions – Principles, types and applications of agglutination, precipitation, complement fixation, viral neutralization, immunodiffusion, immunoelectrophoresis, ELISA and RIA.

B) Monoclonal antibodies – Hybridoma technology and various cellular technologies.

C) Automation in immunological techniques – auto analyzers used in immunology, FACS etc.

Suggested readings:

1. Kuby : Immunology; RA Goldsby, Thomas J. Kindt, Barbara A. Osborne.
2. Immunology by Roitt I. M., Brostoff J. and Male D. Gower medical publishing London.
3. Fundamentals of immunology 4th ed., Paul 1999, Lippencott Raven.

LC MIC-341 Laboratory Course-V **(60)**

(Prerequisite: LC BC 141, LC BC 142)

1. Screening of antibiotic producers- crowded plate technique
2. screening of organic acid producers & amine producers
3. Screening of Amylase, Protease & Lipase producers
4. Screening of Vitamin producers
5. Enrichment and isolation of pesticide resistant bacteria from soil
6. Isolation of thermophilic bacteria from soil
7. isolation of acidophilic and alkalophilic bacteria from soil
8. Isolation of psychrophilic bacteria from soil
9. Isolation of halophilic and halotolerant bacteria
10. Determination of effective dilution of the given disinfectant to disinfect tables & vessels
11. Determination of effective dilution of the given disinfectant for effective disinfection of skin.
12. Determination of preservative effect of the given preservative
13. Determination of potability of the given water sample f from microbiological point of view.

14. Estimation of heterotrophic bacterial count of the given sample.
15. Isolation of lysozyme from egg.

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LC MIC 342: Laboratory Course VI (60)
(Prerequisite: LC MIC 141, LC BC 141)

1. determination of protein content by Robinson- Hogden biurret methode
2. determination of carbohydrate content from given sample
3. production of citric acid by Aspergillus niger
4. determination of lipid content of given bacteria
5. Transformation
6. Conjugation
7. ELISA
8. Western blot.
9. Transduction
10. Protoplast fusion
11. Gene expresion
12. Preparation of plant tissue culture, formulation of media.
13. Isolation of cell wall and study of cell wall polysaccharide by chromatographic technique.
14. Laboratory Production of Bacillus thuringinesis insecticide and testing of its efficiency.
15. Production of biomass Azotobacter, Rhizobium, Azolla and preparation of biofertilizer from it.

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SEMESTER- IV

MIC- 441: Food and Dairy Microbiology 60
(Prerequisite: B. Sc. Microbiology or LS 141)

Unit I (15)

Contamination, Preservation and Spoilage of different kinds of foods:
Cereal products, Sugar products, Vegetables and fruits, Meat and Meat products, Fish, Eggs, Milk and Milk products, Heated canned foods and other Miscellaneous foods.
Fermented Foods: Pickles, Fermented soya products, Fermented products like Idli, Dhokla etc. Fermented vegetables -sauerkraut fermentation.Fermented bakery products.

Unit II (15)

Food poisoning: Staphylococal poisoning, botulinal poisoning, Salmonella, Vibrio, Bacillus cereus poisoning. Mycotoxins: Patulin, Aflatoxin, Ochratoxin, Luteoskyrin, Sterigmatocystin, ATA etc.

Food borne infections: Study of food borne diseases Sterptococcal infections, Tuberculosis, Shigellosis, Brucellosis, Enteropathogenic viral infections, preventive measures.

Unit III **(15)**

Dairy Microbiology: Cheese fermentation, Fermented Milks, Butter, and other milk products. Indicator organisms. Spoilage and defects of fermented dairy products.

Unit IV **(15)**

Microbiological quality control of milk and milk products: ISI standards, FAO/WHO regulations, FDA regulations and APHA/IDF regulations.
Principles of HACCP in Food industries, Quality Manuals and documentations for different products, Basic GMP in the industry.

Suggested readings:

Food Science (1996) Fifth Edition by Norman and Potter
Food Microbiology Frazier
Dairy Microbiology by J.S.Yadav, S. Grover, and V.K. Batish

BI 441: Bioinformatics **(60)**
(Prerequisite: BC 141, BSI 141, MB 241)

UNIT I **(15)**

PROTEOMICS: PROTEIN SEQUENCE DATABASES AND ANALYSIS:
Protein sequence information, composition and properties, physicochemical properties based on sequence, sequence comparison, Primary databases, Secondary databases. Pair-wise sequence alignment, gaps, gap-penalties, scoring matrices, PAM250, BLOSUM62, local and global sequence alignment, multiple sequence alignment, useful programs, ClustalW, BLASTp.

PROTEOMICS; STRUTURAL DATABASES, PROTEIN STRUCTURE PREDICTION:
Structural databases; Protein Data bank (PDB), Nucleic Acid Data Bank (NDB), Molecular modeling Data Bank (MMDB). Homology modeling, prediction of protein structure from sequences, Secondary structure, three-dimensional structure prediction, protein folding and functional sites, protein folding classes.

UNIT II **(15)**

GENOMICS: NUCLEOTIDE SEQUENCE DATABASES AND ANALYSIS:
Human Genome project; rough and final draft of HGP, goals of the HGP, Genes, genomes, nucleotides, DNA sequences. Sequence databases: GeneBank, EMBL Nucleotide sequence databank, DNA Data Bank of Japan (DDBJ), database formats. Recombinant DNA technology, restriction enzymes, resource for restriction enzyme (REBASE), similarity search. Polymerase chain reaction, primer selection for PCR, BLASTn, application of BioEdit.

GENOMICS: GENE IDENTIFICATION:
Genome information and special features, coding sequences (CDS), untranslated regions (UTR's), cDNA library, expressed sequence tags (EST). Approach to gene identification; masking repetitive DNA, database search, codon-bias detection, detecting functional sites in the DNA. Internet resources for gene identification, detection of functional sites, gene expression. Construction of maps, genetic map, physical map.

UNIT III **(15)**

STRUCTURAL BIOLOGY:
Nucleic acids, ribose-ring puckering, RNA folding, conformational study, amino acids, proteins, Ramachandran plot, α-helix, β-sheets, 3_{10}-helix, loops, membrane proteins, protein-ligand interactions, biophysical aspects of proteins and nucleic acids.

MOLECULAR MODELING:
Introduction, molecular mechanics, force field, potential energy functions, energy minimization, single point calculations, full-geometry optimization, conformational search, docking, molecular dynamics simulations, molecular modeling packages.

UNIT IV **(15)**

MICROARRAYS:
Concept of microarrays; spotted arrays, oligonucleotide arrays, designing the experiment, Microarray design, microarray experimentation, Applications of microarray technology. Mass spectroscopy for protein analysis, MALDI-TOF, Electrospray ionization (EST), Tandem mass spectroscopy (MS/MS) analysis; tryptic digestion and peptide fingerprinting (PMF), Protein Micro array in protein expression, profiling and diagnostics, drug target discovery

PHYLOGENETIC ANALYSIS:
Evolution, elements of phylogeny, methods of phylogenetic analysis, Phylogenetic tree of life, comparison of genetic sequence of organisms, phylogenetic analysis tools- Phylip, ClustalW.

Suggested Readings:

1. Introduction to Bioinformatics, (Atwood, T. K. and Parry-Smith, D. J).
2. An introduction to Computational Biochemistry. (C. Stain Tsai, A John Wiley and Sons, Inc., publications).
3. Developing Bioinformatics Computer Skills. (Cynthia Gibas and Per Jambeck).
4. Bioinformatics Methods and Applications Genomics, Proteomics and Drug Discovery. (Rastogi S. C. Mendiratta, and Rastogi P.)
5. NCBI Web site: http://www.ncbi.nlm.nih.gov

MFT 441: Microbial fermentation Technology (60)

(Prerequisite: FT 341)

Unit I (15)

Basic design of fermenter: Fermenter Body, Aeration and Agitation, Baffles and Spargers.

Fermentation media: Functions of media components, media rheology and Newton's law of viscosity, Optimization of medium.

Unit II (15)

Gas diffusion: Oxygen and Mass Balance Transfer relationship, Factors affecting gas diffusion.

Different types of fermentors: Airlift, tower, double cone, Waldhof type, Acetator and cavitators.

Types of fermentations: Solid Surface culture type, Liquid surface culture, submerged fermentations. Batch, Continuous and Fed Batch fermentations.

Unit III (15)

Cultures: Isolation, Screening, Yield improvement by changing culture techniques, Strain improvement and preservation. Growth kinetics and yield kinetics.

Controls of fermentation: Principles of control system design, Flux control analysis, Command controls, Biosensors. Fermentation control options- Knowledge based system (KBS), Artificial neural networks (ANN) and Genetic algorithm (GA).

Unit IV (15)

Modelling of fermentation processes: Modelling bioprocesses, Approaches and techniques of mathematical modeling. Upstream processing and Down stream processing.

Process validation and quality assurance.

Suggested readings:

Fermentation Microbiology and Biotechnology by M. El-Mansi and C. Bryce

Principles of Fermentation technology by Whitekar, Stanbury and Hall Modelling and Control of fermentation processes by J.R. Leigh

MIC 442: Medical microbiology 60

(Prerequisite: B. Sc. Microbiology or LS 141)

Unit I (15)

Virulence: Invasion of pathogens through the different immunological barriers of human body. Establishment of infection. Role of portal of entry of the pathogen. Antigenic variations and virulence. Microbial toxins and super antigens. Carriers of infections. Epidemiology of certain diseases like urino-genital infections, upper respiratory tract infections, dermatological infections and gastero intestinal tract infections. Loss of virulence by many pathogens on subculturing on artificial media.

Unit II **(15)**

Epidemiology: Spread of certain infections in a population. Concept of epidemic, endemic and pandemic spread. Role of socioeconomic conditions in spread of disease. Epidemiological methods- descriptive, analytical and experimental epidemiology. Measurement of infection rate.

Unit III **(15)**

Chemotherapy: Development of drug resistance amongst pathogens – antibiotic resistance mechanisms. Disease management methods. Different prophylactic and therapeutic methods in control of infections.

Unit IV **(15)**

Clinical Microbiology: Collection and transportation of pathological samples with special reference to samples like Cerebro Spinal Fluid (CSF), Sputum samples, Urine samples and swabs. Certain cultural techniques for pathogens like Dermatophytes, Salmonella, Meningococcus, Leptospira, Mycobacterium, Vibrio, Plasmodium spp, Wucheria bancriofti, and Ascaris lumbricoides.

Rapid methods of identification of infection like ELISA, FAT, RIA and Western Blot techniques.

Suggested reading:

Medical Microbiology by Ananthanaryan

Medical Microbiology by Dey and Dey

LC MIC 441: Laboratory Course VII **(60)**

(Prerequisite: LC MIC 341, LC MIC 342)

1. Fermentative production of gluconic acid.
2. Bioassay of streptomycin.
3. Fermentative production of wine.
4. Detection of adulteration in common food.
5. Detection of afla toxin in food and feed.
6. Chemical analysis of food – pH, benzoate, sorbate and colour.
7. Microbiological –MPN, Resazurin. Chemical – pH, fat, protein, sugar and ash, Physical – sp. gravity, different solid, test for grading of milk.
8. Platform test in dairy industry – COB, alcohol precipitation, titrable acidity test, quantitative phosphatase test.
9. Using RasMol through command line.
10. Pair-wise sequence alignment.
11. Multiple sequence alignment.
12. Introduction of BioEdit.
13. Construction of three-dimensional model by using SPARTAN.

14. Model Building and Energy minimization.

15. Molecular Docking and Drug designing.

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LC MIC 442: Laboratory Course VIII (Project work) (60)
(Prerequisite: LC MIC 341, LC MIC 441, LC BC 142)

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