DEVI AHILYA VISHWAVIDYALAYA, INDORE

School of Biotechnology

1.1.1
Syllabus of all programs

School of Biotechnology

Devi Ahilya University, Indore

Syllabus

M. Sc. General Biotechnology

Revised Course Structure

Choice Based Credit System (CBCS)

2015-2017

The School of Biotechnology has choice based credit system (CBCS) in M.Sc. Biotechnology, students has to earn 93 actual credits and 16 virtual credits in total 04 semesters (two year duration). Maximum duration for completion of the course may be up to 04 years as per ordinance no. 31.

If the student desires, credits for Generic elective papers can be earned in any other school/department.

Out of 93 actual credits, 36 credits must be accrued from core papers, 06 credits from Discipline Centric electives papers, 06 in Generic Electives credits, 08 from soft skill development, 03 credits from Skill Enhancement Courses paper, 22 credits from Practical's and 12 credits from project/ dissertation work. The 16 Virtual Credits have to be earned through Comprehensive Viva Voce examination conducted at the end of every semester (each of 04 credits). From these 109 credits, the credit for each subhead is as under:

S. No.	Type of Subject/Activity	Number of Subjects	Credit/Subject	Total Credit
01.	Core	12	03	36
02.	Discipline Centric Electives	04	1.5	06
03.	Generic Electives	02	03	06
04.	Soft Skill	04	(01*01 + 02*03 + 01*01)	08
05.	Skill Enhancement Courses	01	03	03
06.	Practical	03	(01*06+02*08)	22
07.	Project Work	01	12	12
08.	Comprehensive Viva Voce	1/ Semester	04	16
Total				109

S. No.	Core Subjects (03*12 = 36 Credit)	Elective (Generic) (03*02 = 06 Credit)	Elective (Discipline Centric) Any 04 (1.5*04 = 06 Credit)	Soft Skills and Skill Enhancement (33 Credit)	Project (12 Credit)
01.	Biochemistry	Environmental Biotechnology	Genomics & Proteomics	Seminar (Soft Skills) (01*01 + 02*03 = 07 Credit)	Project Work of 12 Credits. (In-house for M.Sc. Biotechnology (admitted through JNU)
02.	Cell & Developmental Biology	IPR & Biosafety	Protein Engineering	Practical (In every Semester except last semester)	
03.	Molecular Biology		Cancer Genetics	Metabolic Engineering (Skill Enhancement = 03)	
04.	Analytical Techniques		Animal Tissue Culture	Research Proposal Writing Skills (Soft Skills) (01 Credit)	
05.	Computer Application, Bioinformatics & Biostatistics		Stem Cell Biology		
06.	Immunology		Pharmacogenomics		
	Genetics				
07.	Genetic Engineering				
08.	Enzyme & Enzyme Technology				
09.	Bioprocess Engineering & Technology				
10.	Plant Biotechnology				
11.	Microbiology and Industrial Applications				
Total Credits: 109					

M.Sc. General Biotechnology Syllabus

CONTENTS

SEMESTER – I

Course Code	Title	Credits
BT MB 501	Biochemistry **(Core)**	03
BT MB 511	Cell & Developmental Biology **(Core)**	03
BT MB 521	Molecular Biology **(Core)**	03
BT MB 531	Analytical Techniques **(Core)**	03
BT MB 541	Computer Application, Bioinformatics & Biostatistics **(Core)**	03
BT MB 551	Seminar & Communication Skills **(Soft Skill Development)**	01
BT MB 561	Practical	06
	Comprehensive Viva-Voce	04
Total		26

SEMESTER – II

Course Code	Title	Credits
BT MB 502	Immunology **(Core)**	03
BT MB 512	Genetics **(Core)**	03
BT MB 522	Genetic Engineering **(Core)**	03
BT MB 532	Enzyme & Enzyme Technology **(Core)**	03
BT MB 542	Environmental Biotechnology **(Generic Elective)**	03
BT MB 552	Genomics & Proteomics **(Discipline Centric Elective)**	1.5
BT MB 562	Protein Engineering **(Discipline Centric Elective)**	1.5
BT MB 572	Cancer Genetics **(Discipline Centric Elective)**	1.5
BT MB 582	Seminar/ Research Skill Development **(Soft Skills)**	02
BT MB 592	Practical	08
	Comprehensive Viva - Voce	04
	Total	32

Any 02 out of 03 Discipline Specific electives can be opted by the students from SBT. One Generic Elective of 03 credits can be opted by the students from SBT itself or from any other department (UTD).

SEMESTER – III

Course Code	Title	Credits
BT MB 601	Bioprocess Engineering & Technology **(Core)**	03
BT MB 611	Plant Biotechnology **(Core)**	03
BT MB 621	Microbiology and Industrial Applications **(Core)**	03
BT MB 631	IPR & Biosafety **(Generic Elective)**	03
BT MB 641	Metabolic Engineering **(Skill Enhancement)**	03
BT MB 651	Animal Tissue Culture **(Discipline Centric Elective)**	1.5
BT MB 661a	Stem Cell Biology **(Discipline Centric Elective)**	1.5
BT MB 661b	Pharmacogenomics **(Discipline Centric Elective)**	1.5
BT MB 671	Seminar **(Soft Skills)**	02
BT MB 681	Research Proposal Writing Skills **(Soft Skills)**	01
BT MB 691	Practical	08
	Comprehensive Viva - Voce	04
Total		33

Any 02 out of 03 Discipline Specific electives can be opted by the students from SBT. One Generic Elective of 03 credits can be opted by the students from SBT itself or from any other department (UTD).

SEMESTER – IV

Course Code	Title	Credits
BT MB 602	**Project Work**	12
BT MB 612	Seminar (Topic other then the dissertation work)	02
	Comprehensive viva-voce	04
Total		18

Total Credits.....109

M.Sc. Biotechnology

SEMESTER – I

Course Code	Title	Credits
BT MB 501	Biochemistry **(Core)**	03
BT MB 511	Cell & Developmental Biology **(Core)**	03
BT MB 521	Molecular Biology **(Core)**	03
BT MB 531	Analytical Techniques **(Core)**	03
BT MB 541	Computer Application, Bioinformatics & Biostatistics **(Core)**	03
BT MB 551	Seminar & Communication Skills **(Soft Skill Development)**	01
BT MB 561	Practical	06
	Comprehensive Viva-Voce	04
Total		26

Biochemistry - 3 Credits

Unit - I

Amino acids:

Structure and functional group properties; Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Evolution of protein structure; Structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc.; Tools to characterize expressed proteins.

Proteins - classification and separation, purification and criteria of homogeneity, end group analysis, hierarchy in structure, Ramachandran maps.

Unit – II

Sugars (Carbohydrates):

Mono, di, and polysaccharides; Suitability in the context of their different functions- cellular structure, energy storage, signaling; Glycosylation of other biomolecules - glycoproteins and glycolipids; Lipids - structure and properties of important members of storage and membrane lipids; lipoproteins.

Unit - III

Lipids – Structure and Classification of fatty acids; Structure of triglycerides and phospholipids, Chemical Reactions; structure and properties of important members of storage and membrane lipids; lipoproteins, Glycolipids, Sphingolipids, terpenes and steroids.

Unit - IV

Heterocyclic compounds and secondary metabolites in living systems - nucleotides, pigments, isoprenoids; classifications; functions and their properties in the body.

Principles of thermodynamics:

Classes of organic compounds and functional groups - atomic and molecular dimensions, space filling and ball and stick models.

Unit - V

Bioenergetics:

Basic principles; Equilibria and concept of free energy; Coupled processes; Glycolytic pathway; Kreb's cycle; Oxidative phosphorylation; Photosynthesis.

Texts/References

1. **V.Voet and J.G.Voet**, ***Biochemistry***, 4th edition, John Wiley, New York, 2010.

2. **A.L. Lehninger**, ***Principles of Biochemistry***, 4th edition, W.H Freeman and Company, 2005.

3. **L. Stryer**, ***Biochemistry***, 5th edition, W.H. Freeman and Company, 2002.

Cell & Developmental Biology - 3 Credits

Unit - I

Cell Theory & Methods of Study:

Microscope and its modifications – Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM), Electron tunneling and Atomic Force Microscopy, etc.

Membrane Structure and Function

Structural models; Composition and dynamics; Transport of ions and macromolecules; Pumps, carriers and channels; Endo- and Exocytosis; Membrane carbohydrates and their significance in cellular recognition; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata.

Unit - II

Organelles

Nucleus – Structure and function of nuclear envelope, lamina and nucleolus; Macromolecular trafficking; Chromatin organization and packaging; Cell cycle and control mechanisms; Mitochondria – structure, organization of respiratory chain complexes, ATP synthase, Structure- function relationship; Mitochondrial DNA and male sterility; Origin and evolution; Chloroplast– Structure-function relationship; Chloroplast DNA and its significance; Chloroplast biogenesis; Origin and evolution.

Endo-membrane System and Cellular Motility: Organization and role of microtubules and microfilaments; Cell shape and motility; Actin-binding proteins and their significance; Muscle organization and function; Molecular motors; Intermediate filaments; Extracellular matrix in plants and animals.

Unit – III

Cellular Movements and Pattern Formation

Laying of body axis planes; Differentiation of germ layers; Cellular polarity; Model plants like Fucus and Volvox; Maternal gene effects; Zygotic gene effects; Homeotic gene effects in Drosophila; Embryogenesis and early pattern formation in plants; Cell lineages and developmental control genes in Caenorhabditis.

Unit – IV

Cell cycle – Molecular events and model systems; Control mechanism; Apoptosis.

Cellular basis of differentiation and development - mitosis, gametogenesis and fertilization, development Arabidopsis; Spatial and temporal regulation of Gene Expression

Differentiation of Specialized Cells

Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Cellular basis of immunity; Differentiation of cancerous cells and role of proto-oncogenes; Phase changes in Salmonella; Mating cell types in yeast; Surface antigen changes in Trypanosomes; Heterocyst differentiation in Anabaena; Sex determination in Drosophila.

Unit - V

Cancer: Biology of cancer; properties and features of cancer cells; oncogenes; tumor suppresser genes; mechanism of cancer; metagenesis; types of cancer

Genes, Mutation and Mutagenesis: UV and chemical mutagens; Types of mutation; Ames test for mutagenesis; Methods of genetic analysis.

Genetic Systems of Yeast and Neurospora.

Extra-Chromosomal Inheritance.

Texts/References

1. **Lodish et al., *Molecular cell Biology***, 4th Edition, W.H. Freeman & Company, 2000.

2. **Smith & Wood**, ***Cell Biology***, 2nd Edition, Chapman & Hall, London, 1996.

3. **Watson et al., *Molecular Biology of the gene***, 5th Edition, Pearson Prentice Hall. USA, 2003.

4. **B. M. Turner**, ***Chromatin & Gene regulation***, 1st Edition, Wiley-Blackwell, 2002.

5. **Benjamin Lewin**, ***Gene IX***, 9th Edition, Jones and Barlett Publishers, 2007.

Molecular Biology - 3 Credits

Unit I

Nucleotides: Structure; classification; Biosynthesis of purine and pyrimidine nucleotides from ribose including regulation, salvage pathways.

Genome organization

Organization of bacterial genome; Structure of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA re-association kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome phasing; DNase I hypersensitive regions; DNA methylation & Imprinting.

Unit II

DNA Structure; Replication; Repair & Recombination

Structure of DNA - A-,B-, Z- and triplex DNA; Measurement of properties-Spectrophotometric, CD, AFM and Electron microscope analysis of DNA structure; Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single strandedcircular DNA; Gene stability and DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination.

Unit III

Prokaryotic & Eukaryotic Transcription

Prokaryotic Transcription; Transcription unit; Promoters- Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Anti-termination; Transcriptional regulation-Positive and negative; Operon concept-lac, trp, ara, his, and gal operons; Transcriptional control in lambda phage; Transcript processing; Processing of tRNA and rRNA Eukaryotic 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; Transcriptional and post-transcriptional gene silencing

Post Transcriptional Modifications

Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA.

RNA splicing: Nuclear splicing, spliceosome and small nuclear RNAs, group I and group II introns, Cis- and Trans-splicing reactions, tRNA splicing, alternate splicing.

Unit IV

Translation & Transport

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; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation

Unit V

Antisense and Ribozyme Technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyrne; hammer- head, hairpin and other ribozymes, strategies for designing ribozymes, Applications of antisense and ribozyme technologies. RNA interference.

Molecular Mapping of Genome: Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, Simple sequence repeat loci, Southern and fluorescence in situ hybridization for genome analysis, Chromosome micro dissection and micro cloning, Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, Molecular markers linked to disease resistance genes.

Text/References

1. **Benjamin Lewin, Gene IX**, 9th Edition, Jones and Barlett Publishers, 2007.

2. **J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner**; **Molecular Biology of the Gene**,6th Edition, Benjamin Cummings Publishing Company Inc, 2007.

3. **Alberts et al**; **Molecular Biology of the Cell**, 4th edition, Garland, 2002.

Analytical Techniques - 3 Credits

Unit I

Spectroscopy Techniques

UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy

Unit II

Chromatography Techniques

TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity

Unit III

Centrifugation

Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge -Micro centrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods

Electrophoretic techniques

Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis

Unit IV

Radioactivity

Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method; Applications of isotopes in biochemistry; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay

Unit V

Microscopy: phase contrast, fluorescence microscopy, Electron microscopy and scanning tunneling microscopy. Characterization of macromolecules using X-ray diffraction analysis.

Texts/References

1. **Freifelder D.,** ***Physical Biochemistry, Application to Biochemistry and Molecular Biology***, 2nd Edition, W.H. Freeman & Company, San Fransisco, 1982.
2. **Keith Wilson and John Walker**, ***Principles and Techniques of Practical Biochemistry***, 5th Edition, Cambridge University Press, 2000.
3. **D. Holme & H. Peck,** ***Analytical Biochemistry***, 3rd Edition, Longman, 1998.
4. **R. Scopes,** ***Protein Purification - Principles & Practices***, 3rd Edition, Springer Verlag, 1994.
5. Selected readings from ***Methods in Enzymology***, Academic Press.

Computer Application, Bioinformatics & Biostatistics - 3 Credits

(*Interdisciplinary Subject/Elective)

Unit I

Computer Organization: Block diagram of computer, Memory devices; Advantages and Limitations of Computers; Comparison of different operating systems DOS, Windows, Linux.

Number System: Binary, Hexadecimal, Octadecimal.

Internet Technologies: Web Services – WWW; URL; Servers: Client/ Server essentials - Domain Name Server; FTP server; E-mail server; WEB servers; Web publishing-Browsers-IP Addressing.

Database: Database concept; Database management system; Database browsing and Data retrieval; Data structures and Databases.

Sequence and Genome Databases: Databases such as GenBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; TAIR; PlasmoDB; ECDC, Human Genome Project

Sequence file formats: GenBank, FASTA, PIR, ALN/ClustalW2, GCG/MSF, and PDB.

Unit II

Probability: Fundamental concepts of probability; sample space and events; independent events; mutually exclusive events; axioms of probability; conditional probability; additional and multiplication theorem of probability. Probability and analysis of one & two way samples;

Statistics: Central Limit theorem; Inference; Hypothesis; Critical region and error probabilities; Tests for proportion; Equality of proportions; Equality of means of normal populations (Variance known, Variance unknown)

Unit III

Measure of Central tendency and Dispersion; P-Value of the statistic; Confidence limit; T-Square Test; Chi-square test for independence; Introduction to one way & Two way ANOVA; Regression and Correlation coefficient; Use of statistical tools; preparation of graphs; histograms; charts and diagrams; Data Transofrmation.

Unit IV

Pair-wise Sequence Alignment: BLAST and its variants; FASTA.

Multiple sequence alignment: introduction

Phylogenetic Analysis: Introduction; Molecular Evolution; Cluster Analysis; Phylogenetic clustering by simple matching coefficients; Sequence comparison; Sequence pattern; : Tools used; Phylip and MEGA.

Unit V

Microarray: Goals of a Microarray experiment; Normalization of Microarray data; Detecting differential gene expression; Principal component analysis; Clustering of microarray data;

Structure Determination by X-ray crystallography; NMR spectroscopy

Structure Databases: The primary structure databases (PDB, NDB, and MMDB); secondary structure databases (SCOP, CATH, and Families of Structurally Similar Proteins). File formats for storage and dissemination of molecular structure.

***In-silico* Structure Prediction:** Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure-Structure comparison of macromolecules with reference to proteins.

Texts/References

1. **Wayne W. Daniel**, ***Biostatistics: A foundation for Analysis in the Health Sciences***, 8th Edition, Wiley, 2004.

2. **Prem S. Mann**, ***Introductory Statistics***, 6th Edition, Wiley, 2006.

3. **John A. Rice**, ***Mathematical Statistics and Data Analysis***, 3rd Edition, John A. Rice, Duxbury Press, 2006.

4. **Campbell and Heyer**, ***Discovering Genomics, Proteomics, & Bioinformatics***, 2nd Edition, Benjamin Cummings, 2002.

5. **Cynthia Gibas and Per Jambeck**, ***Developing Bioinformatics Computer Skill***, 1st Edition, O'Reilly Publication, 2001.

6. **Mount D.,** ***Bioinformatics: Sequence and Genome Analysis*****,** Cold Spring Harbor Laboratory Press, New York. 2004

7. **C.R. Kothari,** ***Research Methodology: Methods and Techniques***

PRACTICAL [Total 06 Credits]

Lab on Biochemistry and Analytical Techniques

1. To prepare an Acetic-Na Acetate Buffer system and validate the Henderson-Hasselbach equation.

2. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.

3. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC.

4. AN ENZYME PURIFICATION THEME (such as E.Coli Alkaline phosphatase or any enzyme of the institutions choice).

   (a) Preparation of cell-free lysates

   (b) Ammonium Sulfate precipitation

   (c) Ion-exchange Chromatography

   (d) Gel Filtration

   (e) Affinity Chromatography

   (f) Generating a Purification Table

   (g) Assessing purity by SDS-PAGE Gel Electrophoresis

   (h) Assessing purity by 2-D gel Electrophoresis

   (i) Enzyme Kinetic Parameters: Km, Vmax and Kcat.

5. Biophysical methods (Circular dichroism spectroscopy, fluorescence spectroscopy).

6. Determination of mass of small molecules and fragmentation patterns by Mass Spectrometry

Lab on Molecular Biology

1. Plasmid DNA isolation and DNA quantitation: Plasmid minipreps

2. Restriction digestion

3. Preparation of competent cells.

4. Agarose gel electrophoresis

3. Restriction Enzyme digestion of DNA

4. Purification of DNA from an agarose gel

5. DNA Ligation

6. Transformation of E.coli with standard plasmids, Calculation of transformation efficiency

7. Cloning of genomic DNA in standard plasmid vectors

8. Confirmation of the insert, Miniprep of recombinant plasmid DNA, Restriction mapping

9. Polymerase Chain reaction, using standard 16srRNA eubacterial primers

10. RFLP analysis of the PCR product

11. Transformation of yeast Saccharomyces cerevisiae

Lab On Biostatistics and Computer Application

Introduction to MS EXCEL-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 SYSTAT package.

Searching PubMed , Introduction to NCBI, NCBI data bases, BLAST : BLASTn, BLASTp, PSI-BLAST, Sequence manipulation Suite, Multiple sequence alignment, Primer designing, Phylogenetic Analysis. Protein Modeling, Protein structure Analysis, Docking, Ligplot interactions.

SEMESTER – II

Course Code	Title	Credits
BT MB 502	Immunology **(Core)**	03
BT MB 512	Genetics **(Core)**	03
BT MB 522	Genetic Engineering **(Core)**	03
BT MB 532	Enzyme & Enzyme Technology **(Core)**	03
BT MB 542	Environmental Biotechnology **(Generic Elective)**	03
BT MB 552	Genomics & Proteomics **(Discipline Centric Elective)**	1.5
BT MB 562	Protein Engineering **(Discipline Centric Elective**	1.5
BT MB 572	Cancer Genetics **(Discipline Centric Elective)**	1.5
BT MB 582	Seminar/ Research Skill Development **(Soft Skills)**	02
BT MB 592	Practical	08
	Comprehensive Viva - Voce	04
	Total	32

Any 02 out of 03 Discipline Specific electives can be opted by the students from SBT. One Generic Elective of 03 credits can be opted by the students from SBT itself or from any other department (UTD).

Immunology - 3 Credits

Unit I

Immunology- fundamental concepts and anatomy of the immune system

Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Haematopoesis; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system; lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue.(MALT&CALT); Mucosal Immunity;

Immuno-chemistry of Antigens - immunogenecity, Antigenecity, haptens, Toxins-Toxiods, Hapten-carrier system; Genetic bases of immune response – Heterogenecity; Role and properties of adjuvants, Immune modulators; B cell epitopes; Hybridoma Rabbit, human; Antigens - immunogens, haptens; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing. Kinetics of immune response, memory; Principles of Immunization; Techniques for analysis of Immune response

Unit II

Immune responses generated by B and T lymphocytes

Immunoglobulins-basic structure, classes & subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Principles of cell signaling;Basis of self –non-self discrimination; Kinetics of immune response, memory; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Cytokines-properties, receptors and therapeutic uses; Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system

Unit III

Antigen-antibody interactions

Affinity, cross reactivity, specificity, epitope mapping Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy; Surface plasmon resonance, Biosenor assays for assessing ligand –receptor interaction, CMI techniques-lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis, Microarrays, Transgenic mice, Gene knock outs

Unit IV

Vaccinology

Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering-chimeric and hybrid monoclonal antibodies; Catalytic antibodies and generation of immunoglobulin gene libraries.

Unit V

Clinical Immunology

Immunity to Infection: Bacteria, viral, fungal and parasitic infections (with examples from each group); Hypersensitivity – Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Transplantation – Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy; Tumor immunology – Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy; Immunodeficiency-Primary immunodeficiencies, Acquired or secondary immunodeficiencies.

Texts/References

1**. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne *Immunology,*** 6th Edition, Freeman, 2002.

2. **Brostoff J, Seaddin JK, Male D, Roitt IM., *Clinical Immunology***, 6th Edition, Gower Medical Publishing, 2002.

3. **Janeway et al., *Immunobiology***, 4th Edition, Current Biology publications. 1999.

4. **Paul**, ***Fundamental of Immunology***, 4th edition, Lippencott Raven, 1999.

5. **Goding**, ***Monoclonal antibodies***, Academic Press. 1985.

Genetics - 3 Credits

Unit I

Bacterial mutants and mutations

Isolation; Useful phenotypes (auxotrophic, conditional, lethal, resistant); Mutation rate; Types of mutations(base pair changes; frameshift; insertions; deletions; tandem duplication); Reversion vs. suppression; Mutagenic agents; Mechanisms of mutagenesis; Assay of mutagenic agents (Ames test)

Gene transfer in bacteria

History; Transduction – generalized and specialized; Conjugation – F, F', Hfr; F transfer; Hfr-mediated chromosome transfer; Transformation – natural and artificial transformation; Merodiploid generation; Gene mapping; Transposable genetic elements; Insertion sequences; Composite and Complex transposons; Replicative and non-replicative transposition; Genetic analysis using transposons.

Unit II

Bacteriophages and Plasmids

Bacteriophage–structure; Assay; Lambda phage – genetic map, lysogenic and lytic cycles; Gene regulation; Filamentous phages such as M13; Plasmids – natural plasmids; their properties and phenotypes; Plasmid biology - copy number and its control; Incompatibility; Plasmid survival strategies; Antibiotic resistance markers on plasmids (mechanism of action and resistance); Genetic analysis using phage and plasmid Restriction-modification systems

History; Types of systems and their characteristics; Methylation-dependent restriction systems; applications.

Unit III

Mendelian Genetics

Introduction to human genetics; Background and history; Types of genetic diseases; Role of genetics in medicine; Human pedigrees; Patterns of single gene inheritance-autosomal recessive; Autosomal dominant; X linked inheritance; Complicating factors - incomplete penetrance; variable expression; Multiple alleles; Co dominance; Sex influenced expression; Hemoglobinopathies - Genetic disorders of hemoglobin and their diseases.

Non Mendelian inheritance patterns

Mitochondrial inheritance; Genomic imprinting; Lyon hypothesis; isodisomy; Complex inheritance-genetic and environmental variation; Heritability; Twin studies; Behavioral traits; Analysis of quantitative and qualitative traits

Unit IV

Cytogenetics

Cell division and errors in cell division; Non disjunction; Structural and numerical chromosomal abnormalities – deletion; duplication; translocation; Sex determination; Role of Y chromosome; Genetic recombination; Disorders of sex chromosomes and autosomes; Molecular cytogenetics – Fluorescence In Situ Hybridization (FISH); Comparative Genomic Hybridization (CGH).

Developmental genetics

Genes in early development; Maternal effect genes; Pattern formation genes; Homeotic genes; Signaling and adhesion molecules.

Immunogenetics

Major histocompatibility complex; Immunoglobulin genes - tissue antigen and organ transplantation; Single gene disorders of immune system.

Unit V

Genetic variation

Mutations; kinds of mutation; agents of mutation; genome polymorphism; uses of polymorphism.

Gene mapping and human genome project

Physical mapping; linkage and association

Population genetics and evolution

Phenotype; Genotype; Gene frequency; Hardy Weinberg law; Factors distinguishing Hardy Weinberg equilibrium; Mutation selection; Migration; Gene flow; Genetic drift; Human genetic diversity; Origin of major human groups.

Texts/References

1. **S.R. Maloy, J.E. Cronan, D. Friefelder*, Microbial Genetics***, 2nd Edition, Jones and Bartlett Publishers, 1994.

2. **N. Trun and J. Trempy*, Fundamental Bacterial Genetics***, Blackwell publishing, 2004.

3. **Strachan T and Read A P*, Human molecular genetics***, 3rd Edition Wiley Bios, 2006.

4**. Mange E J and Mange A. P., *Human genetics***, 2nd Edition, Sinauer Associates publications, 1999.

5. **Hartl L D and Jones B, *Analysis of genes and genomes***, 3rd Edition, Jones and Bartlett Publishers, 1999.

Genetic Engineering - 3 Credits

Unit I

Basics Concepts

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization,

Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNaseI footprinting; Methyl interference assay

Unit II

Cloning Vectors

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; 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.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors

Unit III

Cloning Methodologies

Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression

Unit IV

PCR and Its Applications

Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – 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, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)

Unit V

Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro-RNA (miRNA); Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knockout mice; Disease model; Somatic and germ-line therapy - in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

Text/References

1. **S.B. Primrose, R.M. Twyman and R.W.Old**; ***Principles of Gene Manipulation***. 6th Edition, S.B.University Press, 2001.
2**. J. Sambrook and D.W. Russel**; ***Molecular Cloning: A Laboratory Manual***, Vols 1- 3, CSHL, 2001.
3. **Brown TA**, ***Genomes***, 3rd ed. Garland Science 2006
4. Selected papers from scientific journals.
5. Technical Literature from ***Stratagene, Promega, Novagen, New England Biolab*** etc.

Enzyme & Enzyme Technology - 3 Credits

UNIT I

Discovery, classifications and nomenclature of enzymes;

Techniques of enzyme isolation; Techniques of enzyme assay

UNIT II

Intracellular localization of enzymes; Techniques used in the purification of enzymes. Criteria of enzyme homogeneity Techniques used for determination of native and sub-unit molecular weight of enzymes; Isoenzymes; Multienzyme complexes and multifunctional enzymes

UNIT III

Physico-chemical characterization of enzymes;

Enzyme kinetics: Enzyme catalysis in solution - kinetics and thermodynamic analysis, effects of organic solvents on enzyme catalysis and structural consequences. Kinetics of enzyme inhibition;

Allosterism including half of the site activity phenomena

UNIT IV

Enzyme memory and pnemonical enzymes;

Structure and activity of the enzymes;

Mechanism of action of chymotrypsin, glyceraldehyde 3 Phosphate dehydrogenase, lysoenzyme, carboxy peptidase, ribonuclease, aldolase etc.

UNIT V

Various techniques used for the immobilization of enzymes, Applications of immobilized enzyme in Biotechnology; Riboenzyme and catalytic antibodies- Functional proteins- structure and drug targets (enzymes and receptors)

Text/References:

1. **Martin F. Chaplin and Christopher Bucke; Enzyme Technology,** Cambridge, Univ Press
2. **Anil Kumar and Sarika Garg; Enzymes and Enzyme Technology,** Anshan Publishing; 1st edition

Environmental Biotechnology – 3 Credits

UNIT I

Environment: Basic concepts and issues

Environmental Pollution: types of pollution, Methods for the measurement of pollution; Methodology of environmental management - the problem solving approach, its limitations.

UNIT II

Air pollution and its control through Biotechnology.

Water Pollution and Its Control: Water as a scarce natural resource, Need for water management, Measurement of water pollution, sources of water pollution, Waste water collection, Waste water treatment -physical, chemical and biological treatment processes.

UNIT III

Microbiology of WasteWater Treatments: Aerobic Process: Activated sludge, Oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds. Anaerobic Processes: Anaerobic digestion, anaerobic filters. Upflow anaerobic sludge blanket reactors.

Treatment schemes for waste waters of dairy, distillery, tannery, Sugar, antibiotic industries,

UNIT IV

Microbiology of degradation of Xenobiotics in Environment . Ecological considerations, decay behaviour & degradative plasmids; Hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides.

Bioremediation of contaminated soils and waste land.

Biopesticides in integrated pest management.

UNIT V

Solid wastes: sources and management (composting, wormiculture and methane production).

Global Environmental Problems: Ozone depletion, UV-B, green -house effect and acid rain, their impact and biotechnological approaches for management.

Genomics and Proteomics -1.5 Credits

Unit I

Introduction

Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

Unit II

Genome sequencing projects

Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.

Unit III

Proteomics

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.

Unit IV

Pharmacogenetics

High throughput screening in genome for drug discovery- identification of gene targets, Pharmacogenetics and drug development

Unit V

Functional genomics and proteomics

Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays; Structural proteomics

Texts/References

1. **Voet D, Voet JG & Pratt CW**, ***Fundamentals of Biochemistry***, 2nd Edition. Wiley 2006

2**. Brown TA, *Genomes***, 3rd Edition. Garland Science 2006

3. **Campbell AM & Heyer LJ**, ***Discovering Genomics, Proteomics and Bioinformatics,*** 2nd Edition. Benjamin Cummings 2007

4. **Primrose S & Twyman R**, ***Principles of Gene Manipulation and Genomics***, 7th Edition, Blackwell, 2006.

5. **Glick BR & Pasternak JJ**, ***Molecular Biotechnology***, 3rd Edition, ASM Press, 1998.

Protein Engineering– 1.5 Credits

Unit I

Protein Engineering – Introduction, Tools, Protein Structures- Sequence Identification, Sequence Determination and Modeling, Sequence Modification - Site-directed Mutagenesis Methods, Non-PCR Methods and PCR-based Methods, Molecular Evolution – modifying activity, substrate specificity, cofactor requirement, increasing stability, pH and temperature optima, de novo-Sequence Design, Expression, Analysis and detection, applications, future perspectives.

UNIT II

Computational approaches to protein engineering: sequence and 3D strucuture analysis, Data Mining, Ramachandran map, Mechanism of stabilization of proteins from psychrophiles and thermophiles vis-à-vis those from mesophiles; Protein design.

Applications **-** Point Mutations: Betaseron/Betaferon (Interferon /3- 16), Humalog (Lispro Insulin) and Novel Vaccine Adjuvants, Domain Shuffling (Linking, Swapping and Deleting) Linking – DomainFusions for Cell Targeting, Fused Cytokines and Fusions to Stabilize DimericProteins; Swapping Protein Domains –Chimaeric Mouse-Human Antibodies and Polyketide Synthases (PJCSs); Deleting Domains, Whole Protein Shuffling, Protein-Ligand Interactions -Enzyme Modifications, Hormone Agonists and Substitution of Binding Specificities, de novoDesign, future

Unit III

Detection and analysis of GMOs and GMO products: modified gene copy number determination, detection of chromosomal changes, toxicological studies, residual DNA analysis, product analysis – microbial, biochemical and molecular, toxicological evaluation

Unit IV

Case studies

Texts/References

1. Edited by **T E Creighton**, ***Protein Structure: A practical approach***, 2nd Edition, Oxford University Press, 1997.
2. Edited by **T E Creighton**, ***Protein Function: A practical approach***, Oxford University Press, 2004.
3. **Cleland and Craik**, ***Protein Engineering, Principles and Practice***, Vol 7, Springer Netherlands 1998.
4. **Muller and Arndt**., ***Protein Engineering protocols***, 1st Edition, Humana Press, 2006
5. **Ed. Robertson DE, Noel JP,** ***Protein Engineering Methods in Enzymology***, 388, Elsevier Academic Press, 2004
6. **J Kyte,** ***Structure in protein Chemistry***, 2nd Edition, Garland Publishers, 2006

Cancer Genetics – 1.5 Credits

UNIT I

Introduction:

Types and general characteristics of tumors; Chromosomal aberrations in neoplasia; Cell cycle point and cancer

Unit II

Cell Transformation and tumorigenesis:

Oncogenes; Tumour Suppressor genes; DNA repair genes and genetic instability; Epigenetic modifications, telomerase activity, centrosome malfunction; Genetic heterogeneity and clonal evolution

Unit III

Familial Cancers:

Retinoblastoma, Wilm's Tumour, Li-Fraumeni syndrome, colorectal cancer, breast cancer, Genetic predisposition to sporadic cancer

Unit IV

Tumour progression:

Angiogenesis and metastasis; Tumour specific markers

Unit V

Cancer and environment: physical, chemical and biological carcinogenesis; Cancer risk assessment, gene therapy and counseling

Texts/References

1. **Alberts et al., *The Science of Genetics*,** saunders, 1999
2. **Alberts et al., *Molecular biology of the cell*,** Garland 2008.
3. **Benjamin, *Genetics: A Conceptual Approach*,** 3rd Edition, Freeman, 2007.
4. **Berg and Singer, *Genes and Genome***, 1998.
5. **Black, *Microbiology: Principles and Explorations***, 6th Edition Wiley, 2004
6. **Cowell, *Molecular Genetics of Cancer*,** 2nd Revised Edition, Bios, 2001

PRACTICAL [Total 08 Credits]

Lab on Immunology

1. Preparation of antigens, Serum separation, Storage.
2. Antibody titre by ELISA method.
3. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
4. Complement fixation test.
5. Isolation and purification of IgG from serum or IgY from chicken egg.
6. SDS-PAGE, Immunoblotting, Dot blot assays
7. Blood smear identification of leucocytes by Giemsa stain
8. Separation of leucocytes by dextran method
9. Demonstration of Phagocytosis of latex beads
10. Separation of mononuclear cells by Ficoll-Hypaque
11. Flowcytometry, identification of T cells and their subsets
12. Lymphoproliferation by mitogen / antigen induced
13. Lymphnode Immunohistochemistry (direct and indirect peroxidase assay)
14. Hybridoma technology and monoclonal antibody production.

15. Immunodiagnostics using commercial kits

Lab on Microbiology

1. Sterilization, disinfection, safety in microbiological laboratory.
2. Preparation of media for growth of various microorganisms.
3. Identification and culturing of various microorganisms.
4. Staining and enumeration of microorganisms.
5. Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen.
6. Assay of antibiotics production and demonstration of antibiotic resistance.
7. Isolation and screening of industrially important microorganisms.
8. Determination of thermal death point and thermal death time of microorganisms.

Lab on Genetic Engineering

1. Isolation of genomic DNA from Bacillus subtilis* genome.
2. PCR amplification of scoC gene and analysis by agarose gel electrophoresis
3. Preparation of plasmid, pET-28a from E.coli DH5 and gel analy sis.
4. Restriction digestion of vector (gel analysis) and insert with NcoI and XhoI
5. a. Vector and Insert ligation
b. Transformation in E.coli DH5 .
6. Plasmid isolation and confirming recombinant by PCR and RE digestion.
7. Transformation of recombinant plasmid in E.coli BL21 (DE3) strain.
8. Induction of ScoC protein with IPTG and analysis on SDS-PAGE
9. Purification of protein on Ni-NTA column and analysis of purification by SDS-PAGE
10. a. Random Primer labeling of scoC with Dig-11-dUTP
    b. Southern hybridization of B. subtilis genome with probe and non-radioactive detection.

*Any other bacterial strain can be used.

SEMESTER – III

Course Code	Title	Credits
BT MB 601	Bioprocess Engineering & Technology **(Core)**	03
BT MB 611	Plant Biotechnology **(Core)**	03
BT MB 621	Microbiology and Industrial Applications **(Core)**	03
BT MB 631	IPR & Biosafety **(Generic Elective)**	03
BT MB 641	Metabolic Engineering **(Skill Enhancement)**	03
BT MB 651	Animal Tissue Culture **(Discipline Centric Elective)**	1.5
BT MB 661a	Stem Cell Biology **(Discipline Centric Elective)**	1.5
BT MB 661b	Pharmacogenomics **(Discipline Centric Elective)**	1.5
BT MB 671	Seminar **(Soft Skills)**	02
BT MB 681	Research Proposal Writing Skills (Soft Skills)	01
BT MB 691	Practical	08
	Comprehensive Viva - Voce	04
Total		33

Any 02 out of 03 Discipline Specific electives can be opted by the students from SBT. One Generic Elective of 03 credits can be opted by the students from SBT itself or from any other department (UTD).

Bioprocess Engineering and Technology - 3 Credits

Unit I

Basic principle of Biochemical engineering

Isolation, screening and maintenance of industrially important microbes; Microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); Strain improvement for increased yield and other desirable characteristics.

Unit II

Concepts of basic mode of fermentation processes

Bioreactor designs; Types of fermentation and fermenters; Concepts of basic modes of fermentation - Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation economics; Fermentation media; Fermenter design – mechanically agitated; Pneumatic and hydrodynamic fermenters; Large scale animal and plant cell cultivation and air sterilization; Upstream processing: Media formulation; Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process.

Unit III

Downstream processing

Bioseparation - filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra filtration; Drying; Crystallization; Storage and packaging; Treatment of effluent and its disposal.

Unit IV

Applications of enzymes in food processing

Mechanism of enzyme function and reactions in process techniques; Enzymic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Interesterified fat; Hydrolyzed protein etc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.

Applications of Microbes in food process operations and production

Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins from lactic acid bacteria – Production and applications in food preservation.

Unit V

Enzyme kinetics; Two-substrate kinetics and pre-steady state kinetics; Allosteric enzymes; Enzyme mechanism; Enzyme inhibitors and active site determination Production, recovery and scaling up of

enzymes and their role in food and other industries; Immobilization of enzymes and their industrial applications.

Texts/References

1. **Jackson AT.,** Bioprocess in Biotechnology, Prentice Hall, Engelwood cliffs, 1991
2. **Shufler ML and Kargi F.,** Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
3. **Stanburry RF and Whitaker A.,** Principles of Fermentation Technology, Pergamon press, Oxford, 1977
4. **Baily JE and Ollis DF**., Biochemical Engineering fu8ndamentals, 2nd edition, McGraw-Hill Book Co., New York, 1986.
5. **Aiba S, Humphrey AE and Millis NF**, Biochemical Engineering, 2nd Edition, University of Tokyo Press, Tokyo 1973.
6. **Young M.M.**, Comprehensive Biotechnology: The Principles, applications and regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Reed Elsevier India Private Ltd, India, 2004.
7. **Mansi EMTEL, Bryle CFA**, Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd. UK, 2007

Plant Biotechnology - 3 Credits

Unit I

Plant Tissue Culture

Historical perspective; Totipotency; Organogenesis; Somatic embryogenesis; Regulation and applications; Artificial seed production; Micropropagation; Somaclonal variation; Androgenesis and its applications in genetics and plant breeding; Germplasm conservation and cryopreservation.

Protoplast Culture and Somatic Hybridization

Protoplast isolation; Culture and usage; Somatic hybridization – methods and applications; Cybrids and somatic cell genetics.

Unit II

Agrobiology

Agrobacterium-plant interaction; Virulence; Ti and Ri plasmids; Opines and their significance; T-DNA transfer; Disarming the Ti plasmid.

Genetic Transformation

Agrobacterium-mediated gene delivery; Co integrate and binary vectors and their utility; Direct gene transfer-PEG-mediated, electroporation, particle bombardment and alternative methods; Screen able and selectable markers; Characterization of transgenics; Chloroplast transformation; Marker-free methodologies; Gene targeting.

Unit III

Molecular Mapping & Marker Assisted Selection (MAS)

Quantitative and qualitative traits; MAS for genes of agronomic importance, e.g. insert resistance, grain quality and grain yield; Molecular polymorphism, RFLP, RAPD, STS AFLP, SNP markers; Construction of genetic and physical map; Gene mapping and cloning; QTL mapping and cloning.

Strategies for Introducing Biotic and Abiotic Stress Resistance/Tolerance

Bacterial resistance; Viral resistance; Fungal resistance; Insects and pathogens resistance; Herbicide resistance; Drought, salinity, thermal stress, flooding and submergence tolerance.

Unit IV

Genetic Engineering for Plant Architecture and Metabolism

Seed storage proteins; Proteins engineering; Vitamins and other value addition compounds; Source-sink relationships for yield increase; Post-harvest bioengineering; Plant architecture; Flowering behavior.

Plants as Biofactories

Concept of biofactories; Fermentation and production of industrial enzymes, vitamins and antibiotics and other biomolecules; Cell cultures for secondary metabolite production; Production of pharmaceutically important compounds; Bioenergy generation.

Unit V

Plant Genomics

Identification of candidate genes using genetic information (positional cloning), using biochemical and expression analysis(microarray analysis, proteomics, metabolomics); Characterization and functional analysis of candidate genes: transformation, mutant populations, knockout system; Heterologous expression systems; Protein analysis; Bioinformatics and database; Genoinformatics. Eco-biotechnology

Biosensors; Biofuels; Marine biofarming ; Plant genetic resources; Patenting of biological material; Plant breeders rights(PBRs) and farmers right; Biosafety and containment practices.

Texts/References

1. **Adrian Slater, Nigel Scott and Mark Fowler**, ***Plant Biotechnology: The genetic manipulation of plant***, 1st Edition, Oxford University Press, 2003.

2. **Edited by BR Jorden**, 2nd Edition, ***The Molecular Biology and Biotechnology of Flowering***, CABI, 2006.

3. **Neil Wille**, ***Phytoremediation: Methods and Reviews***, 1st Edition, Humana Press, 2007.

4. **Denis Murphy**, ***Plant Breeding and Biotechnology: Societal Context and the Future of Agriculture***, Cambridge University Press, 2007.

Microbiology & Industrial Applications - 3 Credits

Unit I

Microbial Diversity & Systematic

Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergey's manual; Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.

Unit II

Microbial Growth & Physiology

Ultrastructure of Archaea (Methanococcus); Eubacteria (E.coli); Unicellular Eukaryotes (Yeast) and viruses (Bacterial, Plant, Animal and Tumor viruses); Microbial growth: Batch, fed-batch, continuous kinetics, synchronous growth, yield constants, methods of growth estimation, stringent response, death of a bacterial cell.

Microbial physiology: Physiological adoption and life style of Prokaryotes; Unicellular Eukaryotes and the Extremophiles (with classical example from each group)

Unit III

Microbial Interactions and Infection

Host–Pathogen interactions; Microbes infecting humans, veterinary animals and plants; Pathogenicity islands and their role in bacterial virulence

Unit IV

Microbes and Environment

Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth's Environment and Inhabitants; Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing; Microbial fuel cells; Prebiotics and Probiotics; Vaccines.

Unit V

Industrial Applications

Basic principles in bioprocess technology; Media Formulation; Sterilization; Thermal death kinetics; Batch and continuous sterilization systems; Primary and secondary metabolites; Extracellular enzymes; Biotechnologically important intracellular products; exopolymers; Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH

Microbial processes-production, optimization, screening, strain improvement, factors affecting downstream processing and recovery; Representative examples of ethanol, organic acids, antibiotics etc.

Enzyme Technology-production, recovery, stability and formulation of bacterial and fungal enzymes-amylase, protease, penicillin acylase, glucose isomerase; Immobilised Enzyme and Cell based biotransformations - steroids, antibiotics, alkaloids, enzyme/cell electrodes.

Texts/References

1**. Pelczar MJ Jr., Chan ECS and Kreig NR.,** ***Microbiology,*** 5th Edition, Tata McGraw Hill, 1993.

2. **Maloy SR, Cronan JE Jr., and Freifelder D,** ***Microbial Genetics***, Jones Bartlett Publishers, Sudbury, Massachusetts, 2006.

3. **Crueger and A Crueger,** ***Biotechnology: A textbook of Industrial Microbiology,*** Sinaeur Associates, 1990. (English Ed., TDW Brock);

4. **G Reed, Prescott and Dunn's,** ***Industrial Microbiology***, 4 th Edition, CBS Publishers, 1987.

5**. M.T. Madigan and J.M. Martinko**, ***Biology of Microorganisms***, 11th Edition, Pearson Prentice Hall, USA, 2006.

IPR & Bio-safety- 3 Credits

Unit I

Introduction to Intellectual Property

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP, IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS.

Unit II

Concept of 'prior art'

Invention in context of "prior art"; Patent databases; Searching International Databases; Country –wise patent searches (USPTO, EPO, India etc.); Analysis and report formation.

Unit III

Basics of Patents

Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application

Unit IV

Patent filing and Infringement

Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs; Financial assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US

Patenting by research students, lecturers and scientists-University/organizational rules in India and abroad, credit sharing by workers, financial incentives Patent infringement- meaning, scope, litigation, case studies and examples.

Unit V

Biosafety

Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment;

Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

Important Links

- http://www.w3.org/IPR/
- http://www.wipo.int/portal/index.html.en
- http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html www.patentoffice.nic.in
- www.iprlawindia.org/ - 31k - Cached - Similar page
- http://www.cbd.int/biosafety/background.shtml
- http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm

  http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html

Metabolic Engineering - 3 Credits

Unit I

Elements of Metabolic Engineering

Historical perspective and introduction; Importance of metabolic engineering; Paradigm shift; Information resources; Scope and future of metabolic engineering; Building blocks of cellular components; Polymeric biomolecules; Protein structure and function; Biological information storage – DNA and RNA.

Unit II

Review of cellular metabolism

Transport mechanisms and their models; Enzyme kinetics; Mechanisms and their dynamic representation; Regulation of enzyme activity versus regulation of enzyme concentration; Regulation of metabolic networks; Regulation of at the whole cell level; Example of important pathways; Case studies and analytical type problem.

Unit III

Material and Energy Balances

Stoichiometric models and matrix representation; the chemical reaction vector and energetic; Material and energy balances revisited; Basis for simplification of reaction; Elemental balances Component

balances and the link with macroscopic measurements; Examples of construction of elemental and component balances.

Unit IV

Metabolic Flux Analysis and control theory

The theory of flux balances; Derivation of the fundamental principle; Degree of freedom and solution methods; Moore-Penrose inverse and Tsai-lee matrix construction; Examples of applications of flux analysis introduction Metabolic Control Theory; Control coefficients; Elasticity Coefficients; Summation and connectivity theorems; Case Studies and examples.

Unit V

Metabolic Engineering Practice

The concept of metabolic pathway synthesis; Need for pathways synthesis, Examples for illustration; Overall perspective of MFA, MCA and MPA and their application; Three success case studies.

Texts/References

1. **Gregory N. Stephanopoulos, Aristos A. Aristidou**, ***Metabolic engineering – Principles and Methodologies***, 1st Edition, Jens Nielsen Academic Press, 1998.

2***. Relevant research papers***

3. **Gerhard Gottschalk,** ***Bacterial Metabolism***, 2nd Edition, Springer Verlag, 1986

4. **S.A. Teukolsky, W.T.Vellerling, B.P. Flannery**, ***Numerical Recipes in C***, Cambridge University Press, W.H. Press, 1993.

Animal Tissue Culture – 1.5 Credits

UNIT I

Structure and organization of animal cell
Equipments and materials for animal cell culture technology
Primary and established cell line cultures

UNIT II

Introduction to the balanced salt solutions and simple growth medium, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serurn and supplements.

Serum & protein free defined media and their application.

UNIT III

Measurement of viability and cytotoxicity.
Biology and characterization of the cultured cells, measuring parameters of growth.
Basic techniques of mammalian cell culture in vitro; culture, maintenance of cell culture; cell separation.
Disaggregation of tissue and primary culture, maintenance of cell culture; cell separation.
Scaling-up of animal cell culture.

UNIT IV

Cell synchronization.
Cell cloning and micro manipulation.
Cell transformation.

UNIT V

Application of animal cell culture; Stem cell cultures, embryonic stem cells and their applications
Cell culture based vaccines
Somatic cell genetics
Organ and histotypic cultures
Measurement of cell death; Apoptosis
Three dimensional culture and tissue engineering

Texts/References

1. **Ed. John R.W. Masters**, Animal Cell Culture – Practical Approach, 3rd Edition, Oxford university Press, 2000
2. **Ed. Martin,** Clynes Animal Cell Culture Techniques, Springer, 1998
3. **A. Puller** (ed), Genetic Engineering in Animals, VCH Publishers.

Stem Cell Biology - 1.5 Credits

Unit I

Introduction to Stem Cells

Definition, Classification and Sources.

Unit II

Embryonic Stem Cells

Blastocyst and inner cell mass cells; Organogenesis; Mammalian Nuclear Transfer Technology; Stem cell differentiation; stem cells cryopreservation.

Unit III

Application of stem Cells

Overview of embryonic and adult stem cells for therapy Neurodegenerative diseases; Parkinson's, Alzheimer, Spinal Code Injuries and other brain Syndromes; Tissue system Failures; Diabetes; Cardiomyopathy; Kidney failure; Liver failure; Cancer; Hemophilia etc.

Unit IV

Human Embryonic Stem Cells and Society

Human stem cells research: Ethical consideration; Stem cell religion consideration; Stem cell based therapies: Pre clinical regulatory consideration and Patient advocacy.

Texts/References

1. **Ann A.Kiessling,** ***Human Embryonic Stem Cells: An Introduction to the Science and Therapeutic Potential,*** Jones and Bartett, 2003.

2. **Peter J.Quesenberry**, ***Stem Cell Biology and Gene Therapy***, 1st Edition, Willy-Less, 1998.

3. **Robert Lanja**, ***Essential of Stem Cell Biology***, 2nd Edition, academic Press, 2006.

4. **A.D.Ho., R.Hoffiman**, ***Stem cell Transplantation Biology Processes Therapy***, Willy-VCH, 2006.

5**. C.S.Potten**, ***Stem Cells***, Elsevier,2006.

Phamacogenomics -1.5 Credits

Unit I

Pharmagogenomics, benefits, practical applications, the promise of Pharmagogenomics today leading to personalized medicines, human genetic variation-example of CYP gene variation leading to variable metabolism of drugs, distribution of variation, mutation and its kinds, natural selection, variation in ethnic groups races.

Unit II

Pharmacology, clinical pharmacology, drugs, drugs legislation and safety, types of drugs-example of latest drugs, drug potency and efficacy and toxicity, ADME of drug-drug absorption, drug distribution, drug metabolism and drug excretion, drug therapeutic levels, therapeutic index, drug abuse, drug response in patients by correlating gene expression, regulation of gene expression, polymorphism, alleles, single nucleotide polymorphism, genotyping.

Unit III

Genetic biomarkers- biomarkers on drug development, biomarkers in clinical development, biomarkers for molecular diagnostics-example of cancer biomarkers, pharmacogenetics and drug development

Texts/References

1. **Wu R and Lin M**, ***Statistical & Computational Pharmacogenomics***, CRC Press, 2008
2. **Yan Q*, Pharmacogenomics in Drug Discovery and Development***, Springer-Verlag New York, LLC, 2008
3. **Meyer UA and Tyndale RF**, ***Pharmacogenomics***, 2nd Edition, CRC Press, 2005.
4. **Innocenti F, *Pharmacogenomics: Methods and Applications***, Springer-verlag New York, LLC, 2005
5. **Rothstein MA and Collins FS**, ***Pharmacogenomics: Social, Ethical and Clinical Dimensions***, Wiley John & Sons, Inc., 2003

PRACTICAL (Total Credit 08)

Lab on Bioprocess Engineering & Technology

1. Determination of oxygen transfer rate and volumetric oxygen mass transfer coefficient (KLa) under variety of operating conditions in shake flask and bioreactor.

2. Determination of mixing time and fluid flow behavior in bioreactor under variety of operating conditions.

3. Rheology of microbial cultures and biopolymers and determination of various rheological constants.

4. Production of microbial products in bioreactors.

5. Studying the kinetics of enzymatic reaction by microorganisms.

6. Production and purification of various enzymes from microbes.

7. Comparative studies of Ethanol production using different substrates.

8. Microbial production and downstream processing of an enzyme, e.g. amylase.

9. Various immobilization techniques of cells/enzymes, use of alginate for cell immobilization.

Lab on Plant Biotechnology

1. Aseptic culture techniques for establishment and maintenance of cultures
2. Preparation of stock solutions of MS basal medium and plant growth regulator stocks.
3. Micropropagation of Tobacco plant by leaf disc culture
4. Micropropagation of Rice by indirect organogenesis from embryo
5. Preparation of competent cells of E. coli for harvesting plant transformation vector
6. Transformation of competent cells of E. coli with plant transformation vectors.
7. Small scale plasmid preparation from E. coli.
8. DNA check run by Agarose Electrophoresis
9. Restriction digestion of insert plasmid) and binary vector.
10. Electroelution of insert DNA from agarose gel slice.
11. Mobilization of recombinant Ti plasmid from common laboratory host (E. coli) to an Agrobacterium tumefaciens strain
12. Agrobacterium tumefaciens-mediated plant transformation
13. Direct DNA delivery to plant by Particle Bombardment.
14. Isolation of plant genomic DNA by modified CTAB method
15. Molecular analysis of putative transformed plants by Polymerase Chain Reaction

SEMESTER – IV

Course Code	Title	Credits
BT MB 602	Project Work	12
BT MB 612	Seminar (Topic other then the dissertation work)	02
	Comprehensive viva-voce	04
Total		18

Project

The course is required satisfactory completion and defense of the Masters dissertation.

This process includes

a) Conceptualization of the independent research

b) Collection, analysis, and interpretation of data,

c) Thesis writing

d) Oral presentation of findings

e) Viva-Voce.

NOTE: Dissertation activity must be completed within prescribed time frame for the semester.

School of Biotechnology

Devi Ahilya University, Indore

Syllabus

M. Sc. Genetic Engineering

Revised Course Structure

Choice Based Credit System (CBCS)

2015-2017

The School of Biotechnology has choice based credit system (CBCS) in M.Sc. Genetic Engineering, students has to earn 90 actual credits and 16 virtual credits in total 04 semesters (two year duration). Maximum duration for completion of the course may be up to 04 years as per ordinance no. 31(revised).

If the student desires, credits for Generic elective papers can be earned in any school/department.

Out of 90 actual credits, 36 credits must be accrued from core papers, 06 credits from Discipline Centric electives papers, 06 in Generic Electives credits, 05 from soft skill development, 03 credits from Skill Enhancement Courses paper, 22 credits from Practical's and 12 credits from project/ dissertation work. The 16 Virtual Credits have to be earned through Comprehensive Viva Voce examination conducted at the end of every semester (each of 04 credits). From these 106 credits, the credit for each subhead is as under:

S. No.	Type of Subject/Activity	Number of Subjects	Credit/Subject	Total Credit
01.	Core	12	03	36
02.	Discipline Centric Electives	04	1.5	06
03.	Generic Electives	02	03	06
04.	Soft Skill	04	(01*01 + 02*02)	05
05.	Skill Enhancement Courses	01	03	03
06.	Practical	03	(01*06+02*08)	22
07.	Project Work	01	12	12
08.	Comprehensive Viva Voce	1/ Semester	04	16
Total				**106**

S. No.	Core Subjects (Mandatory) (09*03 = 27 Credit)	Elective (Generic) Any Two (03*02 = 06 Credit)	Elective (Discipline Centric)	Soft Skills and Skill Enhancement (13 Credit)	Project (12 Credit)
01.	Biomolecules	Environmental Biotechnology	Bio-informatics	Seminar & Communication Skills	Project Work of 12 Credits.
02.	Cell Biology & Genetics	Biosafety, Bioethics and IPR	Genomics & Proteomics	Enzyme Technology (03 Credit)	
03.	Molecular Biology		Protein Engineering	Practical's (In Each Semester except last semester)	
04.	Analytical Techniques		Animal Tissue Culture		
05.	Computer Applications in Biology & Bio-statistics		Pharmacogenomics		
06.	Immunology		Stem Cell Biology		
07.	Genetics				
08.	Recombinant DNA Technology				
09.	Metabolic Engineering				
10.	Bioprocess Technology				
11.	Microbial Technology				
12.	Agriculture Biotechnology				
Total = 106 Credits					

M.Sc. Genetic Engineering Syllabus

CONTENTS

Semester I

Course Code	Title	Credits
BT GE 501	Biomolecules(Core)	03
BT GE 511	Cell Biology & Genetics(Core)	03
BT GE 521	Molecular Biology (Core)	03
BT G 531	Analytical Techniques(Core)	03
BT GE 541	Computer Applications in Biology & Bio-statistics (Core)	03
BT GE 551	Seminar & Communication Skills (Soft Skill Development)	01
BT GE 561	Practical	06
	Comprehensive viva-voce	04
Total		26

Semester II

Course Code	Title	Credits
BT GE 502	Immunology (Core)	03
BT GE 512	Genetics (Core)	03
BT GE 522	Enzyme Technology (Skill Enhancement Course)	03
BT GE 532	Recombinant DNA Technology (Core)	03
BT GE 542	Bio-informatics (Discipline Centric Elective)	03
BT GE 552	Genomics & Proteomics (Discipline Centric Elective)	1.5
BT GE 562	Protein Engineering (Discipline Centric Elective)	1.5
BT GE 572	Environmental Biotechnology (Generic Elective)	03
BT GE 582	Seminar/ Research Skill Development (Soft Skills)	02
BT GE 592	Practical	08
BT GE 510	Comprehensive viva-voce	04
Total		32

*03 Credits has to be earned from Discipline Centric electives by the students from SBT. One Generic Elective of 03 credits can be opted by the students from SBT itself or from any other department (UTD).

Semester III

Course Code	Title	Credits
BT GE 601	Metabolic Engineering **(Core)**	03
BT GE 611	Bioprocess Technology **(Core)**	03
BT GE 621	Agriculture Biotechnology **(Core)**	03
BT GE 631	Microbial Technology**(Core)**	03
BT GE 641	Biosafety, Bioethics and IPR **(Generic Elective)**	03
BT GE 651	Animal Tissue Culture **(Discipline Centric Elective)**	1.5
BT GE 661	Pharmacogenomics **(Discipline Centric Elective)**	1.5
BT GE 671	Stem Cell Biology **(Discipline Centric Elective)**	1.5
BT GE 681	Seminar **(Soft Skills)**	02
BT GE 691	Practical	08
	Comprehensive viva-voce	04
Total		32

*Any 02 out of 03 Discipline Centric electives can be opted by the students from SBT. One Generic Elective of 03 credits can be opted by the students from SBT itself or from any other department (UTD).

Semester IV

Course Code	Title	Credits
BT GE 602	Project Work	12
BT GE 612	Comprehensive viva-voce	04
Total		16

Total Credits in 2 years.....106

M.Sc. Genetic Engineering

Semester – I

Course Code	Title	Credits
BT GE 501	Biomolecules **(Core)**	03
BT GE 511	Cell & Developmental Biology**(Core)**	03
BT GE 521	Molecular Biology **(Core)**	03
BT G 531	Analytical Techniques**(Core)**	03
BT GE 541	Computer Applications in Biology & Bio-statistics **(Core)**	03
BT GE 551	Seminar & Communication Skills **(Soft Skill Development)**	01
BT GE 561	Practical	06
	Comprehensive viva-voce	04
Total		26

Biomolecules - 3 Credits

Unit - I

Amino acids:

Structure and functional group properties; Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Evolution of protein structure; Structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc.; Tools to characterize expressed proteins.

Proteins - classification and separation, purification and criteria of homogeneity, end group analysis, hierarchy in structure, Ramachandran maps.

Unit – II

Sugars (Carbohydrates):

Mono, di, and polysaccharides; Suitability in the context of their different functions- cellular structure, energy storage, signaling; Glycosylation of other biomolecules - glycoproteins and glycolipids; Lipids -structure and properties of important members of storage and membrane lipids; lipoproteins.

Unit - III

Lipids –Structure and Classification of fatty acids; Structure of triglycerides and phospholipids, Chemical Reactions; structure and properties of important members of storage and membrane lipids; lipoproteins, Glycolipids, Sphingolipids, terpenes and steroids.

Unit - IV

Heterocyclic compounds and secondary metabolites in living systems - nucleotides, pigments, isoprenoids; classifications; functions and their properties in the body.

Principles of thermodynamics:

Classes of organic compounds and functional groups - atomic and molecular dimensions, space filling and ball and stick models.

Unit - V

Bioenergetics:

Basic principles; Equilibria and concept of free energy; Coupled processes; Glycolytic pathway; Kreb's cycle; Oxidative phosphorylation; Photosynthesis.

Texts/References

1. V.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.

2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Comp

3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.

Cell Biology & Genetics---------- 3 Credits

UNIT I

Cell Theory & Methods of Study:

Microscope and its modifications – Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM), Electron tunneling and Atomic Force Microscopy, etc.

Membrane Structure and Function

Structural models; Composition and dynamics; Transport of ions and macromolecules; Pumps, carriers and channels; Endo- and Exocytosis; Membrane carbohydrates and their significance in cellular recognition; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata.

Unit - II

Organelles

Nucleus – Structure and function of nuclear envelope, lamina and nucleolus; Macromolecular trafficking; Chromatin organization and packaging; Cell cycle and control mechanisms; Mitochondria – structure, organization of respiratory chain complexes, ATP synthase, Structure- function relationship; Mitochondrial DNA and male sterility; Origin and evolution; Chloroplast– Structure-function relationship; Chloroplast DNA and its significance; Chloroplast biogenesis; Origin and evolution.

Endo-membrane System and Cellular Motility: Organization and role of microtubules and microfilaments; Cell shape and motility; Actin-binding proteins and their significance; Muscle organization and function; Molecular motors; Intermediate filaments; Extracellular matrix in plants and animals.

Unit – III

Cellular Movements and Pattern Formation

Laying of body axis planes; Differentiation of germ layers; Cellular polarity; Model plants like Fucus and Volvox; Maternal gene effects; Zygotic gene effects; Homeotic gene effects in Drosophila; Embryogenesis and early pattern formation in plants; Cell lineages and developmental control genes in Caenorhabditis.

Unit – IV

Cell cycle – Molecular events and model systems; Control mechanism; Apoptosis.

Cellular basis of differentiation and development - mitosis, gametogenesis and fertilization, development Arabidopsis; Spatial and temporal regulation of Gene Expression

Differentiation of Specialized Cells

Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Cellular basis of immunity; Differentiation of cancerous cells and role of proto-oncogenes; Phase changes in Salmonella; Mating cell types in yeast; Surface antigen changes in Trypanosomes; Heterocyst differentiation in Anabaena; Sex determination in Drosophila.

Unit - V

Biology of cancer; properties and features of cancer cells; oncogenes; tumor suppresser genes; mechanism of cancer; metagenesis; types of cancer

Genes, Mutation and Mutagenesis: UV and chemical mutagens; Types of mutation; Ames test for mutagenesis; Methods of genetic analysis.

Genetic Systems of Yeast and Neurospora.

Extra-Chromosomal Inheritance.

Texts/References

1. Lodish et al., Molecular cell Biology, 4th Edition, W.H. Freeman & Compan

2. Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.

3. Watson et al., Molecular Biology of the gene, 5th Edition, Pearson Prentice H

4. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley-Blackwell,

5. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.

Molecular Biology ---------- 3 Credits

Unit I

Nucleotides: Structure; classification; Biosynthesis of purine and pyrimidine nucleotides from ribose including regulation, salvage pathways.

Genome organization

Organization of bacterial genome; Structure of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA

re-association kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome phasing; DNase I hypersensitive regions; DNA methylation & Imprinting.

Unit II

DNA Structure; Replication; Repair & Recombination

Structure of DNA - A-,B-, Z- and triplex DNA; Measurement of properties-Spectrophotometric, CD, AFM and Electron microscope analysis of DNA structure; Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single strandedcircular DNA; Gene stability and DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination.

Unit III

Prokaryotic & Eukaryotic Transcription

Prokaryotic Transcription; Transcription unit; Promoters- Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Anti-termination; Transcriptional regulation-Positive and negative; Operon concept-lac, trp, ara, his, and gal operons; Transcriptional control in lambda phage; Transcript processing; Processing of tRNA and rRNA Eukaryotic 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; Transcriptional and post-transcriptional gene silencing

Post Transcriptional Modifications

Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA.

RNA splicing: Nuclear splicing, spliceosome and small nuclear RNAs, group I and group II introns, Cis- and Trans-splicing reactions, tRNA splicing, alternate splicing.

Unit IV

Translation & Transport

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; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation

Unit V

Antisense and Ribozyme Technology Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyrne;

hammer- head, hairpin and other ribozymes, strategies for designing ribozymes, Applications of antisense and ribozyme technologies. RNA interference.

Molecular Mapping of Genome Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, Simple sequence repeat loci, Southern and fluorescence in situ hybridization for genome analysis, Chromosome microdissection and microcloning, Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, Molecular markers linked to disease resistance genes.

. Text/References

1. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.

2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Mol Benjamin Cummings Publishing Company Inc, 2007.

3. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002.

Analytical techniques - 3 Credits

Unit I

Spectroscopy Techniques

UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism(CD); Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy, Raman spectroscopy, API-electrospray and MALDI-TOF; Mass spectrometry

Unit II

Chromatography Techniques

TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity

Unit III

Centrifugation

Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge -Micro centrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods

Electrophoretic techniques

Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis

Unit IV

Radioactivity

Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method; Applications of isotopes in biochemistry; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay

Unit V

Microscopy phase contrast, fluorescence microscopy, Electron microscopy and scanning tunneling microscopy. Characterization of macromolecules using X-ray diffraction analysis.

X-Ray Diffraction: Characterization of macromolecules using X-ray diffraction analysis.

Texts/References

1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freeman & Company, San Fransisco, 1982.

2. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, 2000.

3. D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.

4. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.

5. Selected readings from Methods in Enzymology, Academic Press

Computer Applications in Biology & Biostatistics - 3 Credits

Unit I

Computer Organization: Block diagram of computer, Memory devices; Advantages and Limitations of Computers; Comparison of different operating systems DOS, Windows, Linux.

Number System: Binary, Hexadecimal, Octadecimal.

Internet Technologies: Web Services – WWW; URL; Servers: Client/ Server essentials - Domain Name Server; FTP server; E-mail server; WEB servers; Web publishing-Browsers-IP Addressing.

Database: Database concept; Database management system; Database browsing and Data retrieval; Data structures and Databases.

Sequence and Genome Databases: Databases such as GenBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; TAIR; PlasmoDB; ECDC, Human Genome Project

Sequence file formats: GenBank, FASTA, PIR, ALN/ClustalW2, GCG/MSF, and PDB.

Unit II

Probability: Fundamental concepts of probability; sample space and events; independent events; mutually exclusive events; axioms of probability; conditional probability; additional and multiplication theorem of probability. Probability and analysis of one & two way samples;

Statistics: Central Limit theorem; Inference; Hypothesis; Critical region and error probabilities; Tests for proportion; Equality of proportions; Equality of means of normal populations (Variance known, Variance unknown)

Unit III

Measure of Central tendency and Dispersion; P-Value of the statistic; Confidence limit; T-Square Test; Chi-square test for independence; Introduction to one way & Two way ANOVA; Regression and Correlation coefficient; Use of statistical tools; preparation of graphs; histograms; charts and diagrams; Data Transofrmation.

Unit IV

Pair-wise Sequence Alignment: BLAST and its variants; FASTA.

Multiple sequence alignment: introduction

Phylogenetic Analysis: Introduction; Molecular Evolution; Cluster Analysis; Phylogenetic clustering by simple matching coefficients; Sequence comparison; Sequence pattern; : Tools used; Phylip and MEGA.

Unit V

Microarray: Goals of a Microarray experiment; Normalization of Microarray data; Detecting differential gene expression; Principal component analysis; Clustering of microarray data;

Structure Determination by X-ray crystallography; NMR spectroscopy

Structure Databases: The primary structure databases (PDB, NDB, and MMDB); secondary structure databases (SCOP, CATH, and Families of Structurally Similar Proteins). File formats for storage and dissemination of molecular structure.

***In-silico* Structure Prediction:** Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure-Structure comparison of macromolecules with reference to proteins.

Texts/References

1. Wayne W. Daniel, *Biostatistics: A foundation for Analysis in the Health Sciences*, 8th Edition, Wiley, 2004.
2. Prem S. Mann, *Introductory Statistics*, 6th Edition, Wiley, 2006.
3. John A. Rice, *Mathematical Statistics and Data Analysis*, 3rd Edition, John A. Rice, Duxbury Press, 2006.
4. Campbell and Heyer, *Discovering Genomics, Proteomics, & Bioinformatics*, 2nd Edition, Benjamin Cummings, 2002.
5. Cynthia Gibas and Per Jambeck, *Developing Bioinformatics Computer Skill*, 1st Edition, O'Reilly Publication, 2001.
6. Mount D., *Bioinformatics: Sequence and Genome Analysis*, Cold Spring Harbor Laboratory Press, New York. 2004
7. C.R. Kothari, *Research Methodology: Methods and Techniques*

PRACTICAL [Total 6 Credits]

Lab on Biochemistry and Analytical Techniques

1. To prepare an Acetic-Na Acetate Buffer system and validate the Henderson-Hasselbach equation.

2. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.

3. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC.

4. AN ENZYME PURIFICATION THEME (such as E.coli Alkaline phosphatase or any enzyme of the institutions choice).

(a) Preparation of cell-free lysates

(b) Ammonium Sulfate precipitation

(c) Ion-exchange Chromatography

(d) Gel Filtration

(e) Affinity Chromatography

(f) Generating a Purification Table

(g) Assessing purity by SDS-PAGE Gel Electrophoresis

(h) Assessing purity by 2-D gel Electrophoresis

(i) Enzyme Kinetic Parameters: Km, Vmax and Kcat.

5. Biophysical methods (Circular dichroism spectroscopy, fluorescence spectroscopy).

6. Determination of mass of small molecules and fragmentation patterns by Mass Spectrometry

Lab on Molecular Biology

1. Plasmid DNA isolation and DNA quantitation: Plasmid minipreps

2. Restriction digestion

3. Preparation of competent cells.

4. Agarose gel electrophoresis

3. Restriction Enzyme digestion of DNA

4. Purification of DNA from an agarose gel

5. DNA Ligation

6. Transformation of E.coli with standard plasmids, Calculation of transformation efficiency

7. Cloning of genomic DNA in standard plasmid vectors

8. Confirmation of the insert, Miniprep of recombinant plasmid DNA, Restriction mapping

9. Polymerase Chain reaction, using standard 16srRNA eubacterial primers

10. RFLP analysis of the PCR product

11. Transformation of yeast Saccharomyces cerevisiae

Lab On Biostatistics and Computer Application

Introduction to MS EXCEL-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 SYSTAT package.

Searching PubMed , Introduction to NCBI, NCBI data bases, BLAST : BLASTn, BLASTp, PSI-BLAST, Sequence manipulation Suite, Multiple sequence alignment, Primer designing, Phylogenetic Analysis. Protein Modeling, Protein structure Analysis, Docking, Ligplot interactions.

Semester - II

Course Code	Title	Credits
BT GE 502	Immunology **(Core)**	03
BT GE 512	Genetics **(Core)**	03
BT GE 522	Enzyme Technology **(Skill Enhancement Course)**	03
BT GE 532	Recombinant DNA Technology **(Core)**	03
BT GE 542	Bio-informatics **(Discipline Centric Elective)**	03
BT GE 552	Genomics & Proteomics **(Discipline Centric Elective)**	1.5
BT GE 562	Protein Engineering **(Discipline Centric Elective)**	1.5
BT GE 572	Environmental Biotechnology **(Generic Elective)**	03
BT GE 582	Seminar/ Research Skill Development **(Soft Skills)**	02
BT GE 592	Practical	08
	Comprehensive viva-voce	04
Total		32

*03 Credits has to be earned from Discipline Centric electives by the students from SBT. One Generic Elective of 03 credits can be opted by the students from SBT itself or from any other department (UTD).

Immunology ---------- 3 Credits

Unit I

Immunology- fundamental concepts and anatomy of the immune system

Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Haematopoesis; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system; lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue.(MALT&CALT); Mucosal Immunity;

Immuno-chemistry of Antigens - immunogenecity, Antigenecity, haptens, Toxins-Toxiods, Hapten-carrier system; Genetic bases of immune response – Heterogenecity; Role and properties of adjuvants, Immune modulators; B cell epitopes; Hybridoma Rabbit, human; Antigens - immunogens, haptens; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing. Kinetics of immune response, memory; Principles of Immunization; Techniques for analysis of Immune response

Unit II

Immune responses generated by B and T lymphocytes

Immunoglobulins-basic structure, classes & subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Principles of cell signaling;Basis of self –non-self discrimination; Kinetics of immune response, memory; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Cytokines-properties, receptors and therapeutic uses; Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system

Unit III

Antigen-antibody interactions

Affinity, cross reactivity, specificity, epitope mapping Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy; Surface plasmon resonance, Biosenor assays for assessing ligand –receptor interaction, CMI techniques- lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis, Microarrays, Transgenic mice, Gene knock outs

Unit IV

Vaccinology

Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies; Catalytic antibodies and generation of immunoglobulin gene libraries.

Unit V

Clinical Immunology

Immunity to Infection: Bacteria, viral, fungal and parasitic infections (with examples from each group); Hypersensitivity – Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Transplantation – Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy; Tumor immunology – Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy; Immunodeficiency-Primary immunodeficiencies, Acquired or secondary immunodeficiencies.

Texts/References

1**. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne *Immunology,*** 6th Edition, Freeman, 2002.

2. **Brostoff J, Seaddin JK, Male D, Roitt IM., *Clinical Immunology***, 6th Edition, Gower Medical Publishing, 2002.

3. **Janeway et al., *Immunobiology***, 4th Edition, Current Biology publications. 1999.

4. **Paul**, ***Fundamental of Immunology***, 4th edition, Lippencott Raven, 1999.

5. **Goding**, ***Monoclonal antibodies***, Academic Press. 1985.

Genetics - 3 Credits

Unit I

Bacterial mutants and mutations

Isolation; Useful phenotypes (auxotrophic, conditional, lethal, resistant); Mutation rate; Types of mutations(base pair changes; frameshift; insertions; deletions; tandem duplication); Reversion vs. suppression; Mutagenic agents; Mechanisms of mutagenesis; Assay of mutagenic agents (Ames test)

Gene transfer in bacteria

History; Transduction – generalized and specialized; Conjugation – F, F', Hfr; F transfer; Hfr-mediated chromosome transfer; Transformation – natural and artificial transformation; Merodiploid generation; Gene mapping; Transposable genetic elements; Insertion sequences; Composite and Complex transposons; Replicative and non-replicative transposition; Genetic analysis using transposons.

Unit II

Bacteriophages and Plasmids

Bacteriophage–structure; Assay; Lambda phage – genetic map, lysogenic and lytic cycles; Gene regulation; Filamentous phages such as M13; Plasmids – natural plasmids; their properties and phenotypes; Plasmid biology - copy number and its control; Incompatibility; Plasmid survival strategies; Antibiotic resistance markers on plasmids (mechanism of action and resistance); Genetic analysis using phage and plasmid Restriction-modification systems

History; Types of systems and their characteristics; Methylation-dependent restriction systems; applications.

Unit III

Mendelian Genetics

Introduction to human genetics; Background and history; Types of genetic diseases; Role of genetics in medicine; Human pedigrees; Patterns of single gene inheritance-autosomal recessive; Autosomal dominant; X linked inheritance; Complicating factors - incomplete penetrance; variable expression; Multiple alleles; Co dominance; Sex influenced expression; Hemoglobinopathies - Genetic disorders of hemoglobin and their diseases.

Non Mendelian inheritance patterns

Mitochondrial inheritance; Genomic imprinting; Lyon hypothesis; isodisomy; Complex inheritance-genetic and environmental variation; Heritability; Twin studies; Behavioral traits; Analysis of quantitative and qualitative traits

Unit IV

Cytogenetics

Cell division and errors in cell division; Non disjunction; Structural and numerical chromosomal abnormalities – deletion; duplication; translocation; Sex determination; Role of Y chromosome; Genetic recombination; Disorders of sex chromosomes and autosomes; Molecular cytogenetics – Fluorescence In Situ Hybridization (FISH); Comparative Genomic Hybridization (CGH).

Developmental genetics

Genes in early development; Maternal effect genes; Pattern formation genes; Homeotic genes; Signaling and adhesion molecules.

Immunogenetics

Major histocompatibility complex; Immunoglobulin genes - tissue antigen and organ transplantation; Single gene disorders of immune system.

Unit V

Genetic variation

Mutations; kinds of mutation; agents of mutation; genome polymorphism; uses of polymorphism.

Gene mapping and human genome project

Physical mapping; linkage and association

Population genetics and evolution

Phenotype; Genotype; Gene frequency; Hardy Weinberg law; Factors distinguishing Hardy Weinberg equilibrium; Mutation selection; Migration; Gene flow; Genetic drift; Human genetic diversity; Origin of major human groups.

Texts/References

1. **S.R. Maloy, J.E. Cronan, D. Friefelder,** ***Microbial Genetics***, 2nd Edition, Jones and Bartlett Publishers, 1994.

2. **N. Trun and J. Trempy,** ***Fundamental Bacterial Genetics***, Blackwell publishing, 2004.

3. **Strachan T and Read A P,** ***Human molecular genetics***, 3rd Edition Wiley Bios, 2006.

4**. Mange E J and Mange A. P.,** ***Human genetics***, 2nd Edition, Sinauer Associates publications, 1999.

5. **Hartl L D and Jones B,** ***Analysis of genes and genomes***, 3rd Edition, Jones and Bartlett Publishers, 1999.

Enzyme Technology - 3 Credits

UNIT I

Discovery, classifications and nomenclature of enzymes;

Techniques of enzyme isolation; Techniques of enzyme assay

UNIT II

Intracellular localization of enzymes; Techniques used in the purification of enzymes. Criteria of enzyme homogeneity Techniques used for determination of native and sub-unit molecular weight of enzymes; Isoenzymes; Multienzyme complexes and multifunctional enzymes

UNIT III

Physico-chemical characterization of enzymes;

Enzyme kinetics: Enzyme catalysis in solution - kinetics and thermodynamic analysis, effects of organic solvents on enzyme catalysis and structural consequences. Kinetics of enzyme inhibition;

Allosterism including half of the site activity phenomena

UNIT IV

Enzyme memory and pnemonical enzymes;

Structure and activity of the enzymes;

Mechanism of action of chymotrypsin, glyceraldehyde 3 Phosphate dehydrogenase, lysoenzyme, carboxy peptidase, ribonuclease, aldolase etc.

UNIT V

Various techniques used for the immobilization of enzymes, Applications of immobilized enzyme in Biotechnology; Riboenzyme and catalytic antibodies- Functional proteins- structure and drug targets (enzymes and receptors)

Text/References:

1. **Martin F. Chaplin and Christopher Bucke; Enzyme Technology,** Cambridge, Univ Press
2. **Anil Kumar and Sarika Garg; Enzymes and Enzyme Technology,** Anshan Publishing; 1st edition

Recombinant DNA Technology - 3 Credits

Unit I

Scope of Recombinant DNA Technology, Milestones In Genetic Engineering, Isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separation, cloning, gene expression. Cloning and patenting of life forms. Genetic engineering guidelines.

Basics Concepts

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNaseI footprinting; Methyl interference assay

Nucleic Acid Purification, Yield Analysis

Unit II

Cloning Vectors

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; 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.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors

Unit III

Cloning Methodologies

Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression

Unit IV

PCR and Its Applications

Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – 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, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)

cDNA Synthesis and Cloning: mRNA enrichment, reverse transcription, DNA primers, Linkers, adaptors and their chemical synthesis, Library construction and screening.

Unit V

Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro-RNA (miRNA); Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knockout mice; Disease model; Somatic and germ-line therapy - in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

Text/References

1.S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.

2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1- 3, CSHL, 2001.

3. Brown TA, Genomes, 3rd ed. Garland Science 2006

4. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc

Bioinformatics - 3 Credits

UNIT I

Introduction and Bioinformatics Resources: Knowledge of various databases and bioinformatics tools available at these resources, the major content of the databases, Literature databases

Sequence analysis: Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues.

Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series.

UNIT II

Pair Wise Sequence Alignment:

1) **Dynamic Programming** – Smith and Waterman & Needlemen and Wunch Algorithm; Use of Pair-wise alignments for analysis of Nucleic acid and protein sequences and interpretation of results.
2) **Heuristic Based Methods:** BLAST and FASTA algorithms, various versions of basic BLAST and FASTA.

Multiple sequence alignments (MSA): The need for MSA, basic concepts of various approaches for MSA (e.g. progressive, hierarchical etc.). Algorithm of CLUSTALW and PileUp and their application for sequence analysis (including interpretation of results), concept of dendrogram and its interpretation, Use of HMM-based Algorithm for MSA (e.g. SAM method)

UNIT III

Phylogeny: Phylogenetic analysis, Definition and description of phylogenetic trees and various types of trees, Method of construction of Phylogenetic trees [distance based method (UPGMA, NJ), Maximum Parsimony and Maximum Likelihood method]. The Fitch/Margoliash method; Character-based Methods – maximum parsimony, maximum likelihood; Phylogenetic softwares – PAUP, PHYLIP, MacClade

UNIT IV

Sequence patterns and profiles: Basic concept and definition of sequence patterns, motifs and profiles, various types of pattern representations viz. consensus, regular expression (Prosite-type) and sequence

profiles; profile-based database searches using PSI-BLAST, analysis and interpretation of profile-based searches.

Algorithms for derivation and searching sequence patterns: MeMe, PHI-BLAST, SCanProsite and PRATT. Algorithms for generation of sequence profiles: Profile Analysis method of Gribskov, HMMer.

UNIT V

PROTEIN STRUCTURE PREDICTION: Prediction of protein secondary structure from the amino acid sequence – Chou-Fasman methods, Neural network models, nearest neighbor methods, Hidden markov model. Prediction of three dimensional protein structure-comparative modeling, threading and ab initio method, Homology modeling. Protein - Protein Interaction: Tools and Databases

TEXT REFRENCES:

1. Introduction to Bioinformatics by Aurther M lesk
2. Developing Bioinformatics Computer Skills By: Cynthia Gibas, Per Jambeck
3. Structural Bioinformatics
4. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory Press, New York. 2004
5. Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., Wiley India Pvt Ltd. 2009
6. Bioinformatics for Dummies by Jean-michel Claverie Cedric Notredame. Publisher: Dummies

Genomics and Proteomics -1.5 Credits

Unit I

Introduction

Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

Unit II

Genome sequencing projects

Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.

Unit III

Proteomics

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.

Unit IV

Pharmacogenetics

High throughput screening in genome for drug discovery- identification of gene targets, Pharmacogenetics and drug development

Unit V

Functional genomics and proteomics

Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays; Structural proteomics

Texts/References

1. **Voet D, Voet JG & Pratt CW**, ***Fundamentals of Biochemistry***, 2nd Edition. Wiley 2006

2**. Brown TA*, Genomes***, 3rd Edition. Garland Science 2006

3. **Campbell AM & Heyer LJ**, ***Discovering Genomics, Proteomics and Bioinformatics,*** 2nd Edition. Benjamin Cummings 2007

4. **Primrose S & Twyman R**, ***Principles of Gene Manipulation and Genomics***, 7th Edition, Blackwell, 2006.

5. **Glick BR & Pasternak JJ**, ***Molecular Biotechnology***, 3rd Edition, ASM Press, 1998.

Protein Engineering– 1.5 Credits

Unit I

Protein Engineering – Introduction, Tools, Protein Structures- Sequence Identification, Sequence Determination and Modeling, Sequence Modification - Site-directed Mutagenesis Methods, Non-PCR Methods and PCR-based Methods, Molecular Evolution – modifying activity, substrate specificity, cofactor

requirement, increasing stability, pH and temperature optima, de novo-Sequence Design, Expression, Analysis and detection, applications, future perspectives.

UNIT II

Computational approaches to protein engineering: sequence and 3D strucuture analysis, Data Mining, Ramachandran map, Mechanism of stabilization of proteins from psychrophiles and thermophiles vis-à-vis those from mesophiles; Protein design.

Applications - Point Mutations: Betaseron/Betaferon (Interferon /3- 16), Humalog (Lispro Insulin) and Novel Vaccine Adjuvants, Domain Shuffling (Linking, Swapping and Deleting) Linking – DomainFusions for Cell Targeting, Fused Cytokines and Fusions to Stabilize DimericProteins; Swapping Protein Domains –Chimaeric Mouse-Human Antibodies and Polyketide Synthases (PJCSs); Deleting Domains, Whole Protein Shuffling, Protein-Ligand Interactions -Enzyme Modifications, Hormone Agonists and Substitution of Binding Specificities, de novoDesign, future

Unit III

Detection and analysis of GMOs and GMO products: modified gene copy number determination, detection of chromosomal changes, toxicological studies, residual DNA analysis, product analysis – microbial, biochemical and molecular, toxicological evaluation

Unit IV

Case studies

Texts/References

1. Edited by **T E Creighton**, ***Protein Structure: A practical approach***, 2nd Edition, Oxford University Press, 1997.
2. Edited by **T E Creighton**, ***Protein Function: A practical approach***, Oxford University Press, 2004.
3. **Cleland and Craik**, ***Protein Engineering, Principles and Practice***, Vol 7, Springer Netherlands 1998.
4. **Muller and Arndt**., ***Protein Engineering protocols***, 1st Edition, Humana Press, 2006
5. **Ed. Robertson DE, Noel JP,** ***Protein Engineering Methods in Enzymology***, 388, Elsevier Academic Press, 2004
6. **J Kyte,** ***Structure in protein Chemistry***, 2nd Edition, Garland Publishers, 2006

Environmental Biotechnology: 03 Credits

UNIT I

Environment: Basic concepts and issues

Environmental Pollution: types of pollution, Methods for the measurement of pollution; Methodology of environmental management - the problem solving approach, its limitations.

UNIT II

Air pollution and its control through Biotechnology.

Water Pollution and Its Control: Water as a scarce natural resource, Need for water management, Measurement of water pollution, sources of water pollution, Waste water collection, Waste water treatment -physical, chemical and biological treatment processes.

UNIT III

Microbiology of WasteWater Treatments: Aerobic Process: Activated sludge, Oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds. Anaerobic Processes: Anaerobic digestion, anaerobic filters. Upflow anaerobic sludge blanket reactors.

Treatment schemes for waste waters of dairy, distillery, tannery, Sugar, antibiotic industries,

UNIT IV

Microbiology of degradation of Xenobiotics in Environment . Ecological considerations, decay behaviour & degradative plasmids; Hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides.

Bioremediation of contaminated soils and waste land.

Biopesticides in integrated pest management.

UNIT V

Solid wastes: sources and management (composting, wormiculture and methane production).

Global Environmental Problems: Ozone depletion, UV-B, green -house effect and acid rain, their impact and biotechnological approaches for management.

PRACTICAL [Total 08 Credits]

Lab on Immunology

1. Selection of animals, Preparation of antigens, Immunization and methods of bleeding, Serum separation, Storage.

2. Antibody titre by ELISA method.

3. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.

4. Complement fixation test.

5. Isolation and purification of IgG from serum or IgY from chicken egg.

6. SDS-PAGE, Immunoblotting, Dot blot assays

7. Blood smear identification of leucocytes by Giemsa stain

8. Separation of leucocytes by dextran method

9. Demonstration of Phagocytosis of latex beads

10. Separation of mononuclear cells by Ficoll-Hypaque

11. Flowcytometry, identification of T cells and their subsets

12. Lymphoproliferation by mitogen / antigen induced

13. Lymphnode Immunohistochemistry (direct and indirect peroxidase assay)

14. Hybridoma technology and monoclonal antibody production.

15. Immunodiagnostics using commercial kits

Lab on Microbial Technology

1. Sterilization, disinfection, safety in microbiological laboratory.

2. Preparation of media for growth of various microorganisms.

3. Identification and culturing of various microorganisms.

4. Staining and enumeration of microorganisms.

5. Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen.

6. Assay of antibiotics production and demonstration of antibiotic resistance.

7. Isolation and screening of industrially important microorganisms.

8. Determination of thermal death point and thermal death time of microorganisms.

Lab on Bioinformatics

1. Bioinformatics Resources : NCBI, EBI, DDBJ, RCSB, ExPASy
2. Open access bibliographic resources and literature databases
    a. PubMed
    b. BioMed Central
    c. Public Library of Sciences (PloS)
    d. CiteXplore.

3. Sequence and structure databases.
4. Sequence file formats: GenBank, FASTA, GCG, MSF.
5. Pair wise alignment: BLAST and FASTA
6. Multiple Sequence Alignment: Clustal W, Clustal X and T-Coffee
7. Protein Strucutre Prediction: Modeller
8. Protein strucuture Visualization: Rasmol and PYMOL

SEMESTER III

Course Code	Title	Credits
BT GE 601	Metabolic Engineering **(Core)**	03
BT GE 611	Bioprocess Technology **(Core)**	03
BT GE 621	Agriculture Biotechnology **(Core)**	03
BT GE 631	Microbial Technology**(Core)**	03
BT GE 641	Biosafety, Bioethics and IPR **(Generic Elective)**	03
BT GE 651	Animal Tissue Culture **(Discipline Centric Elective)**	1.5
BT GE 661	Pharmacogenomics **(Discipline Centric Elective)**	1.5
BT GE 671	Stem Cell Biology **(Discipline Centric Elective)**	1.5
BT GE 681	Seminar **(Soft Skills)**	02
BT GE 691	Practical	08
	Comprehensive viva-voce	04
Total		32

*Any 02 out of 03 Discipline Centric electives can be opted by the students from SBT. One Generic Elective of 03 credits can be opted by the students from SBT itself or from any other department (UTD).

Metabolic Engineering ---------- 3 Credits

UNIT I

The concept of Metabolic Engineering, Historical and current views,

Carbohydrate Metabolism : Regulation of Embden, Meyerhoff and Parnass (EMP) Pathway & its regulation, Krebs cycle and its regulation, Krebs Kornberg Cycle, Pentose Phosphate pathway and its regulation, Glucuronate- Xylulose pathway, Oxidative phosphorylation

UNIT II

Industrially important enzymes of carbohydrate metabolism viz. Cellulases, Xylanases, starch phosphorylase, pectinmethylesterase, pectinases, glucose isomerase, Glucose oxidase. Biosynthesis of glycogen in animals and its regulation.

UNIT III

Lipid Metabolism: Beta Oxidation of Fatty acids, fatty acid biosynthesis, Biosynthesis of simple fat, phospholipids, cholesterol , sulfolipids and their possible regulation.

UNIT IV

Biosynthesis and degradation of individual amino acids, Urea Cycle.

Inborn errors of metabolism.

UNIT V

Secondary metabolites: various pathways for secondary metabolites viz. Alkaloids, Phenolics, Lignins, Terpenoids Flavonoids , Porphyrins and their possible regulation.

Texts/References

1. Gregory N. Stephanopoulos, Aristos A. Aristidou, Metabolic engineering – Principles and Methodologies, 1st Edition, Jens Nielsen Academic Press, 1998.

2. Relevant research papers

3. Gerhard Gottschalk, Bacterial Metabolism, 2nd Edition, Springer Verlag, 1986

4. S.A. Teukolsky, W.T.Vellerling, B.P. Flannery, W.H. Press, Numerical Recipes in C, Cambridge University Press, 1993.

Bioprocess Technology --------- 3 Credits

UNIT I

Introduction to Bioprocess Engineering.

Isolation, Preservation and Maintenance of Industrial Microorganisms.

Kinetics of microbial growth and death.

UNIT II

Media for Industrial Fermentation; Air and Media Sterilization.

Types of fermentation processes: Analysis of batch, Fed-batch and continuous bioreactions, stability of microbial reactors, analysis of mixed microbial populations, Bioreactors, specialized bioreactors (pulsed, fluidized, photobioreactors etc.)

UNIT III

Measurement and control of bioprocess parameters.

Downstream Processing: Introduction, Removal of microbial cells and solid matter, foam reparation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, Membrane process, Drying and Crystallization.

UNIT IV

Industrial Production of Chemicals: Alcohol (ethanol), Acids (citric, acetic and gluconic), solvents (glycerol, acetone, butanol), Antibiotics (penicillin, streptomycin, tetracycline), Aminoacids (lysine, glutamic acid), Single Cell Protein.

UNIT V

Introduction to Food Technology

a. Elementary idea of canning and packing.

b. Sterilization and Pasteurization of food Products.

c. Technology of Typical Food/Food products (bread, cheese, idli)

d. Food Preservation.

Texts/ References

1. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.

2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.

3. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997.

4. Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co., New York, 1986.

5. Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, 2nd Edition, University of Tokyo press, Tokyo, 1973.

6. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Young M.M., Reed Elsevier India Private Ltd, India, 2004.

7. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK, 2007.

Agriculture Biotechnology - 3 Credits

UNIT I

Conventional Plant Breeding; Introduction to cell and Tissue Culture, tissue culture as a technique to produce novel plants and hybrids; Tissue culture media (composition and preparation).Initiation and maintenance of callus and suspension culture; single cell clones. Organogenesis: somatic embryogenesis: transfer and establishment of whole plants in soil.Shoot-tip culture: rapid clonal propagation and production of virus-free plants. Embryo culture and embryo rescue.

UNIT II

Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids. Anther, pollen and ovary culture for production of haploid plants and homozygous lines.. Cryopreservation, slow growth and DNA banking for germ plasm conservation. Basic Techniques in rDNA Technology.

UNIT III

Plant Transformation technology: basis of tumor formation, hairy root, features of TI and RI plasmids, mechanisms of DNA transfer, role of virulence genes, use of TI and RI as vectors, binary vectors, use of 35S and other promoters, genetic markers, use of reporter genes, reporter gene with introns, use of scaffold

attachment regions, methods of nuclear transformation, viral vectors and their applications, multiple gene transfers, Vectors- less or direct DNA transfer, particle bombardment, (electroporation, microinjection, transformation of monocots. Transgene stability and gene silencing.

Application of Plant Transformation for productivity and performance: herbicide resistance, phosphoinothricin, glyphosate, sufonyl urea, atrazine, insect resistance, Bt genes, Non-Bt like protease inhibitors, alpha amylase inhibitor, virus resistance, coat protein mediated, nucleocapsid gene, disease resistance, chitinase, 1-3 beta glucanase, RIP, antifungal proteins, thionins, PR proteins, nematode resistance, abiotic stress, post- harvest losses, long shelf life of fruits and flowers, use of ACC synthase, polygalacturanase, ACC oxidase, male sterile lines, bar and barnase systems, carbohydrate composition and storage, ADP glucose pyrophosphatase.

UNIT IV

Chloroplast Transformation: advantages, vectors. success with tobacco and potato.

Metabolic Engineering and Industrial Products: plant secondary metabolities, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway; alkaloids, industrial enzymes, biodegradable plastics, polyhydroxybutyrate. therapeutic proteins, lysosomal enzymes, antibodies, edible vaccines, purification strategies, oleosin partitioning technology.

UNIT V

Molecular Marker-aided Breeding: RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (sequence characterized amplified regions), SSCP (single strand conformational polymorphism), AFLP, QTL, map based cloning, molecular marker assisted selection.

Arid and semi-arid plant biotechnology.

Green House and Green-Home technology.

Texts/References

1. Adrian Slater, Nigel Scott and Mark Fowler, Plant Biotechnology: The genetic manipulation of plant, 1st Edition, Oxford University Press, 2003.

2. Edited by BR Jorden, 2nd Edition, the Molecular Biology and Biotechnology of Flowering, CABI, 2006.

3. Neil Wille, Phytoremediation: Methods and Reviews, 1st Edition, Humana Press, 2007.

4. Denis Murphy, Plant Breeding and Biotechnology: Societal Context and the Future of Agriculture, Cambridge University Press, 2007.

Microbial Technology - 3 Credits

UNIT I

General concept of microbial technology

Isolation and Screening of industrially important microbes; Large scale culitivation of industrial microbes; Strain impriovement to improve yield of selected compounds e.g. antibiotics, enzyme of recombinant proteins.

Principles of exploitation of microorganism, primary and secondary metabolism, regulation of metabolism

UNIT II

Biofertilizers and Biopesticides; Biopolymers and bioplastics

Mushroom cultivation; Single Cell Protein; Biocatalyst selection, immobilization and performance;. Microbial production of nucleosides, nucleotides and pigments

UNIT III

Beverages: Wine, Beer, Microbial lipids, Microbial transformation of antibiotics and steroids

UNIT IV

Environmental application of microbes; Ore leaching; Toxic waste removal; Soil remediation.

Use of microbes in mineral beneficiation and oil recovery; Synthesis of commercial products by recombinant microorganisms (RE, antibiotics, biopolymers etc.)

UNIT V

Microbial application in food and healthcare industries; Food processing and food preservation; Large scale production of proteins from recombinant microorganisms; Extremophiles and their applications.

TEXT REFRENCES

1. Pelczar MJ Jr., Chan ECS and Kreig NR., *Microbiology,* 5th Edition, Tata McGraw Hill, 1993.

2. Maloy SR, Cronan JE Jr., and Freifelder D, *Microbial Genetics*, Jones Bartlett Publishers, Sudbury, Massachuse

3. Prescott and Dunn. *Industrial Microbiology*. 4th Ed, 1992

4. Watson, JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AM. *Molecular Biology of the Gene*. The Benjamin Cummings, 1987.

5. Principles of Fermentation Technology

6. Journal: (A) Nature Biotechnology (B) Trends ion microbiology (C) Current opinion in Microbiology.

Biosafety, Bioethics and Intellectual Property Rights – 03 Credits

UNIT I

Bioethics: Legality, morality and ethics, the principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity etc.

Transgenics and Bioethics: The expanding scope of ethics from biomedical practice to biotechnology, ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, bioethics vs. business ethics, ethical dimensions of IPR, technology transfer and other global biotech issues.

UNIT II

Biosafety in the laboratory institution: Laboratory associated infections and otherhazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory/ institution

Biosafety regulations in the handling of recombinant DNA processes and products in institutions and industries, biosafety assessment procedures in India and abroad.

UNIT III

Biotechnology and food safety: The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance.

Ecological safety assessment of recombinant organisms and transgenic crops, case studies of relevance (Eg. Bt cotton).

Biosafety assessment of biotech pharmaceutical products such as drugs /vaccines etc.

International dimensions in biosafety: Catagena protocol on biosafety, bioterrorism and convention on biological weapons

UNIT IV

Ethical issues in biotechnology. Biosafety and Risk assessment of GMOs. Public perception. IPR and Trade related aspects. Methods for producing transgenic plants and animals. Important genes of agronomic interest. Current trends in finding useful genes. GMO Act 2004. Traceability. Legislative aspects.

Bioethics & Animal Experimentation: Chronology of Biotechnological studies on animals – Law & legislation on animal experimentation in India and world – Moral status of animals as objects of experiments – Contemporary view on animal experiments – Moral responsibility of scientists over animal experiments.

Bioethics & Human Person: Personhood – Abortion – Bioethical issues in reproduction, population explosion and control – Assisted reproduction – AIDS – Egg donation – Prenatal screening & sex selection – Cloning - Ethical issues on life & death – Brain Vs Cortical death – Persistent vegetative state – Voluntary euthanasia & physician assisted suicide – Organ donation & Transplantation.

UNIT V

Bioethics & Society (Indian context): Ethical issues on New Genetics –Human Genome Project – Gene therapy – Genetic screening – Experimentation with human subjects - National Practice of health care – Public & Private medical practice – National resource allocations.

Intellectual property rights (IPR), sovereignty rights, CBD, bioethics and patenting; General agreement on trade and tariffs Indian sui-generis system for animal variety and farmer's rights protection act. WTO with reference to biotechnological affairs, TRIPs.; General Introduction: Patent claims, the legal decision – making process, ownership of tangible and intellectual property, Patent litigation.

Basic Requirements of Patentability: Patentable subject matter, novelty and the public domain, non obviousness

Special issues in Biotechnology Patents: Disclosure requirements, Collaborative research, Competitive research

Plant biotechnology Indian patents and Foreign patents, Plant variety protection act, The strategy of protecting plants.

Recent Developments in Patent System and Patentability of biotechnological inventions.

IPR issues in Indian Context Role of patent in pharmaceutical industry, computer related innovations. Case studies Rice, Haldi, neem, etc. and challenges ahead.

Important Links

http://www.w3.org/IPR/

http://www.wipo.int/portal/index.html.en

http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html www.patentoffice.nic.in

www.iprlawindia.org/ - 31k - Cached - Similar page

http://www.cbd.int/biosafety/background.shtml

http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm

http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html

Animal Tissue Culture - 1.5 Credits

UNIT I

Structure and organization of animal cell

Equipments and materials for animal cell culture technology

Primary and established cell line cultures

UNIT II

Introduction to the balanced salt solutions and simple growth medium, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serurn and supplements.

Serum & protein free defined media and their application.

UNIT III

Measurement of viability and cytotoxicity.

Biology and characterization of the cultured cells, measuring parameters of growth.

Basic techniques of mammalian cell culture in vitro; disaggregation of tissue and primary culture.,maintenance of cell culture; cell separation.

Scaling-up of animal cell culture.

UNIT IV

Cell synchronization.
Cell cloning and micromanipulation.
Cell transformation.

UNIT V

Application of animal cell culture; Stem cell cultures, embryonic stem cells and their applications
Cell culture based vaccines
Somatic cell genetics.
Organ and histotypic cultures.
Measurement of cell death; Apoptosis
Three dimensional culture and tissue engineering

Texts/References

1. Ed. John R.W. Masters, Animal Cell Culture – Practical Approach, 3rd Edition, Oxford university Press, 2000
2. Ed. Martin, Clynes Animal Cell Culture Techniques, Springer, 1998
3. A. Puller (ed), Genetic Engineering in Animals, VCH Publishers.

Pharmacogenomics: 1.5 Credits

1. Pharmagogenomics, benefits, practical applications, the promise of Pharmagogenomics today leading to personalized medicines, human genetic variation-example of CYP gene variation leading to variable metabolism of drugs, distribution of variation, mutation and its kinds, natural selection, variation in ethnic groups races.

2. Pharmacology, clinical pharmacology, drugs, drugs legislation and safety, types of drugs-example of latest drugs, drug potency and efficacy and toxicity, ADME of drug-drug absorption, drug distribution, drug metabolism and drug excretion, drug therapeutic levels, therapeutic index, drug abuse, drug response in patients by correlating gene expression, regulation of gene expression, polymorphism, alleles, single nucleotide polymorphism, genotyping.

3. Genetic biomarkers- biomarkers on drug development, biomarkers in clinical development, biomarkers for molecular diagnostics-example of cancer biomarkers, pharmacogenetics and drug development.

Texts/References

1. Wu R and Lin M, *Statistical & Computational Pharmacogenomics*, CRC Press, 2008
2. Yan Q, *Pharmacogenomics in Drug Discovery and Development*, Springer-Verlag New York, LLC, 2008
3. Meyer UA and Tyndale RF, *Pharmacogenomics*, 2nd Edition, CRC Press, 2005.
4. Innocenti F, *Pharmacogenomics: Methods and Applications*, Springer-verlag New York, LLC, 2005
5. Rothstein MA and Collins FS, *Pharmacogenomics: Social, Ethical and Clinical Dimensions*, Wiley John & Sons, Inc., 2003

Stem Cell Biology - 1.5 Credits

Unit I

Introduction to Stem Cells

Definition, Classification and Sources.

Unit II

Embryonic Stem Cells

Blastocyst and inner cell mass cells; Organogenesis; Mammalian Nuclear Transfer Technology; Stem cell differentiation; stem cells cryopreservation.

Unit III

Application of stem Cells

Overview of embryonic and adult stem cells for therapy Neurodegenerative diseases; Parkinson's, Alzheimer, Spinal Code Injuries and other brain Syndromes; Tissue system Failures; Diabetes; Cardiomyopathy; Kidney failure; Liver failure; Cancer; Hemophilia etc.

Unit IV

Human Embryonic Stem Cells and Society

Human stem cells research: Ethical consideration; Stem cell religion consideration; Stem cell based therapies: Pre clinical regulatory consideration and Patient advocacy.

Texts/References

1. Ann A.Kiessling, *Human Embryonic Stem Cells: An Introduction to the Science and Therapeutic Potential,* Jones and Bartett, 2003.

2. Peter J.Quesenberry, *Stem Cell Biology and Gene Therapy*, 1st Edition, Willy-Less, 1998.

3. Robert Lanja, *Essential of Stem Cell Biology*, 2nd Edition, academic Press, 2006.

4. A.D.Ho., R.Hoffiman, *Stem cell Transplantation Biology Processes Therapy*, Willy-VCH, 2006.

5. C.S.Potten, *Stem Cells*, Elsevier,2006.

PRACTICAL [Total 08 Credits]

Lab on Bioprocess Technology

1. Determination of oxygen transfer rate and volumetric oxygen mass transfer coefficient (KLa) under variety of operating conditions in shake flask and bioreactor.
2. Determination of mixing time and fluid flow behaviour in bioreactor under variety of operating conditions.
3. Rheology of microbial cultures and biopolymers and determination of various rheological constants.

4. Production of microbial products in bioreactors.
5. Studying the kinetics of enzymatic reaction by microorganisms.
6. Production and purification of various enzymes from microbes.
7. Comparative studies of Ethanol production using different substrates.
8. Microbial production and downstream processing of an enzyme, e.g. amylase.
9. Various immobilization techniques of cells/enzymes, use of alginate for cell immobilization.

Lab on Recombinant DNA Technology

1. Isolation of genomic DNA from Bacillus subtilis* genome.
2. PCR amplification of scoC gene and analysis by agarose gel electrophoresis
3. Preparation of plasmid, pET-28a from E.coli DH5 and gel analy sis.
4. Restriction digestion of vector (gel analysis) and insert with NcoI and XhoI
5. a. Vector and Insert ligation

b. Transformation in E.coli DH5 .

6. Plasmid isolation and confirming recombinant by PCR and RE digestion.
7. Transformation of recombinant plasmid in E.coli BL21 (DE3) strain.
8. Induction of ScoC protein with IPTG and analysis on SDS-PAGE
9. Purification of protein on Ni-NTA column and analysis of purification by SDS-PAGE
10. a. Random Primer labeling of scoC with Dig-11-dUTP

b. Southern hybridization of B. subtilis genome with probe and non-radioactive detection.

*Any other bacterial strain can be used.

Lab on Agriculture Biotechnology

1. Preparation of plant tissue culture media.
2. Callus Culture, Pollen Culture, Ovary Culture
3. Invitro root and shoot regeneration
4. Somatic embryo formation
5. Artificial Seed Generation
6. Pigment Production from Callus
7. Cell fusion with PEG.
8. Protoplast isolation and culture.

SEMESTER – IV

Course Code	Title	Credits
BT GE 602	Project Work	12
BT GE 612	Comprehensive viva-voce	04
Total		16

Project Work (Credit: 12)

The course is required satisfactory completion and defense of the Masters dissertation.

This process includes

a) Conceptualization of the independent research

b) Collection, analysis, and interpretation of data,

c) Thesis writing

d) Oral presentation of findings

e) Viva-Voce.

NOTE: Dissertation activity must be completed within prescribed time frame for the semester.

School of Biotechnology

Devi Ahilya University, Indore

Syllabus

M. Sc. Bioinformatics

Revised Course Structure

Choice Based Credit System (CBCS)

2015-2017

The School of Biotechnology has choice based credit system (CBCS) in M.Sc. Biotechnology, students has to earn 87 actual credits and 16 virtual credits in total 04 semesters (two year duration). Maximum duration for completion of the course may be up to 04 years as per ordinance no. 31(revised).

If the student desires, credits for interdisciplinary/elective papers can be earned in any school/department.

Out of actual credits, 33 credits must be accrued from core papers, 06 credits from Discipline centric elective papers, 06 credits from Generic Electives, 05 from soft skill Enhancements courses, 22 credits from Practical's and 12 credits from project/ dissertation work. The 16 Virtual Credits have to be earned through Comprehensive Viva Voce examination conducted at the end of every semester (each of 04 credits). From these 103 credits, the credit for each subhead is as under:

S. No.	Type of Subject/Activity	Number of Subjects	Credit/Subject	Total Credit
01.	Core	11	03	33
02.	Discipline Centric Electives	04	1.5	06
03.	Generic Electives	02	03	06
04.	Soft Skill	04	(01*01 + 02*02)	05
05.	Skill Enhancement Courses	01	03	03
06.	Practical	03	(01*06+02*08)	22
07.	Project Work	01	12	12
08.	Comprehensive Viva Voce	1/ Semester	04	16
Total				103

S. No.	Core Subjects (09*03 = 27 Credit)	Elective (Generic) (03*02 = 06 Credit)	Elective (Discipline Centric) (06 Credit)	Soft Skills and Skill Enhancement Courses (30 Credit)	Project (12 Credit)
01.	Basic Mathematics	Design and Analysis of algorithms	Enzyme Technology	Internet & Web Based Programming (CGI PERL & HTML) (03 Credits)	Project Work of 12 Credits.
02.	Computer fundamentals and Biostatistics	Database management System	Immunoinformatics	Seminar (Soft Skills) (01*01 + 02*02 = 05 Credit)	
03.	Bio-molecules		Genomics & Proteomics	Practical's (In every Semester except last semester)	
04.	Cell and Developmental Biology		Metabolic Engineering & System Biology		
05.	Programming in C/C++		Pharmacogenomics		
06.	Molecular Biology		Microscopic Techniques For Image Processing		
07.	Biological Databases and Data Analysis (Bioinformatics-I)				
08.	Recombinant DNA Technology				
09.	Machine Learning Techniques & CADD(Bioinformatics II)				
10.	Structural Biology and Bioinformatics (Bioinformatics III)				
11.	Java Programming				
Total : 103 Credits					

M.Sc. Bioinformatics Syllabus

CONTENTS

Semester I

Course code	Title	Credits
BT BI 501	Basic Mathematics (Core)	03
BT BI 511	Computer fundamentals and Biostatistics (Core)	03
BT BI 521	Bio-molecules (Core)	03
BT BI 531	Cell and Developmental Biology (Core)	03
BT BI 541	Programming in C/C++(Core)	03
BT BI 551	Molecular Biology (Core)	03
BT BI 561	Practical	06
BT BI 571	Seminar & Communication Skills (Soft Skill Development)	01
	Comprehensive Viva Voce	04
	Total credits	29

Semester II

Course code	Title	Credits
BT BI 502	Biological Databases and Data Analysis (Bioinformatics-I): (Core)	03
BT BI 512	Recombinant DNA Technology (Core)	03
BT BI 522	Design and Analysis of algorithms (Generic Elective)	03
BT BI 532	Internet & Web Based Programming (CGI PERL & HTML) (Skill Enhancement Course)	03
BT BI 542	Immunoinformatics (Discipline Centric Elective)	1.5
BT BI 552	Genomics & Proteomics (Discipline Centric Elective)	1.5
BT BI 562	Enzyme & Enzyme Technology (Discipline Centric Elective)	03
BT BI 572	Practical	08
BT BI 582	Seminars (Soft Skill Development)	02
	Comprehensive Viva Voce	04
	Total Credits	29

[##] 03 Credits has to be earned from Discipline Centric electives by the students from SBT. One Generic Elective of 03 credits can be opted by the students from SBT itself or from any other department (UTD).

Semester III

Course code	Title	Credits
BT BI 601	Machine Learning Techniques & CADD(Bioinformatics II) (Core)	03
BT BI 611	Structural Biology and Bioinformatics (Bioinformatics III) (Core)	03
BT BI 621	Database management System (Generic Elective)	03
BT BI 631	Java Programming (Core)	03
BT BI 641	Metabolic Engineering & System Biology (Discipline Centric Elective)	1.5
BT BI 651	Pharmacogenomics (Discipline Centric Elective)	1.5
BT BI 661	Microscopic Techniques For Image Processing (Discipline Centric Elective)	1.5
BT BI 671	Assignments/ Practical	08
BT BI 681	Seminar(Soft Skill Development)	02
	Comprehensive Viva Voce	04
	Total Credits	29

[##] Any 02 out of 03 Discipline Centric electives can be opted by the students from SBT. One Generic Elective of 03 credits can be opted by the students from SBT itself or from any other department (UTD).

Semester IV

Course code	Title	Credits
BT BI 602	Project Work	12
BT BI 612	Comprehensive Viva Voce	04
	Total Credits	16

Total credits for all semester in two years	103

M.Sc. Bioinformatics

Semester – I

Course code	Title	Credits
BT BI 501	Basic Mathematics (Core)	03
BT BI 511	Computer fundamentals and Biostatistics (Core)	03
BT BI 521	Bio-molecules (Core)	03
BT BI 531	Cell and Developmental Biology (Core)	03
BT BI 541	Programming in C/C++(Core)	03
BT BI 551	Molecular Biology (Core)	03
BT BI 561	Practical	06
BT BI 571	Seminar & Communication Skills (Soft Skill Development)	01
	Comprehensive Viva Voce	04
	Total credits	29

Basic Mathematics: 3 Credits

UNIT 1

SET THEORY: Introduction, Examples of Sets, Representation of a set (Roaster form and Set builder form), Notation, Different types of sets, Set operations, , Complement of a set, Set Difference, Venn diagram De Morgan's Law.

MATRICES:

Matrices- Properties of Determinants, Minors and Cofactors, Multiplication of Determinants, Adjoint, Reciprocal, Symmetric Determinants, Cramer's rule; Different types of matrices, Matrix Operations, Transpose of a matrix, Adjoint of a square matrix, Inverse of a matrix, Eigen values and eigen vector.

UNIT 2

Vector Analysis: The concept of a Vector, Vector addition and subtraction, Products of two vectors-Dot product and Cross product, Products of three vectors- scalar triple product and vector triple product, Gradient, Divergence and Curl.

Limits and Continuity: Constants, Types of constants, Variables, Types of Variables, Function, Types of function, Right hand and left hand limits, Working rule for finding out the limit, Continuity: Define, point out discontinuity, Method of finding the continuity, Continuity from right and from left.

UNIT 3

The Binomial Theorem: Define, Binomial theorem for a positive integral index, Binomial Expansion, Finding middle term, general term, Binomial theorem for any index.

UNIT 4

Probability: Introduction, Events and types of events, Probability of events, Mutually exclusive events, favorable events, exhaustive events, independent events, addition theorem on probability, conditional probability, Multiplication theorem, Problem based on probability theorem, Bayes theorem.

UNIT 5

Differentiation and Integration: Introduction, Basic concepts and problems related to differentiation and integration.

Text references:

1. Introduction to Calculus & Analysis, Vol I and II by Richard Courant & Fritz John, Springer publisher.1999
2. Basic Mathematics by Serge A. Lang. Springer Publisher. 1988

3. Higher Engineering Mathematics (40th Ed), by B.S. Grewal and J.S. Grewal. Khanna Publishers, New Delhi. 2007

Computer Fundamentals & Biostatistics: 3 Credits

Unit I

Computer Organization: Block diagram of computer, Memory devices; Advantages and Limitations of Computers; Comparison of different operating systems DOS, Windows, Linux.

Number System: Binary, Hexadecimal, Octadecimal.

Internet Technologies: Web Services – WWW; URL; Servers: Client/ Server essentials - Domain Name Server; FTP server; E-mail server; WEB servers; Web publishing-Browsers-IP Addressing.

Database: Database concept; Database management system; Database browsing and Data retrieval; Data structures and Databases.

Sequence and Genome Databases: Databases such as GenBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; TAIR; PlasmoDB; ECDC, Human Genome Project

Sequence file formats: GenBank, FASTA, PIR, ALN/ClustalW2, GCG/MSF, and PDB.

Unit II

Probability: Fundamental concepts of probability; sample space and events; independent events; mutually exclusive events; axioms of probability; conditional probability; additional and multiplication theorem of probability. Probability and analysis of one & two way samples;

Statistics: Central Limit theorem; Inference; Hypothesis; Critical region and error probabilities; Tests for proportion; Equality of proportions; Equality of means of normal populations (Variance known, Variance unknown)

Unit III

Measure of Central tendency and Dispersion; P-Value of the statistic; Confidence limit; T-Square Test; Chi-square test for independence; Introduction to one way & Two way ANOVA; Regression and Correlation coefficient; Use of statistical tools; preparation of graphs; histograms; charts and diagrams; Data Transofrmation.

Unit IV

Pair-wise Sequence Alignment: BLAST and its variants; FASTA.

Multiple sequence alignment: introduction

Phylogenetic Analysis: Introduction; Molecular Evolution; Cluster Analysis; Phylogenetic clustering by simple matching coefficients; Sequence comparison; Sequence pattern; : Tools used; Phylip and MEGA.

Unit V

Microarray: Goals of a Microarray experiment; Normalization of Microarray data; Detecting differential gene expression; Principal component analysis; Clustering of microarray data;

Structure Determination by X-ray crystallography; NMR spectroscopy

Structure Databases: The primary structure databases (PDB, NDB, and MMDB); secondary structure databases (SCOP, CATH, and Families of Structurally Similar Proteins). File formats for storage and dissemination of molecular structure.

***In-silico* Structure Prediction:** Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure-Structure comparison of macromolecules with reference to proteins.

Texts/References

1. **Wayne W. Daniel**, ***Biostatistics: A foundation for Analysis in the Health Sciences***, 8th Edition, Wiley, 2004.
2. **Prem S. Mann**, ***Introductory Statistics***, 6th Edition, Wiley, 2006.
3. **John A. Rice**, ***Mathematical Statistics and Data Analysis***, 3rd Edition, John A. Rice, Duxbury Press, 2006.
4. **Campbell and Heyer**, ***Discovering Genomics, Proteomics, & Bioinformatics***, 2nd Edition, Benjamin Cummings, 2002.
5. **Cynthia Gibas and Per Jambeck**, ***Developing Bioinformatics Computer Skill***, 1st Edition, O'Reilly Publication, 2001.
6. **Mount D., *Bioinformatics: Sequence and Genome Analysis*,** Cold Spring Harbor Laboratory Press, New York. 2004
7. **C.R. Kothari, *Research Methodology: Methods and Techniques***

Bio-molecules - 3 Credits

Unit - I

Amino acids:

Structure and functional group properties; Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Evolution of protein structure; Structure-function relationships in

model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc.; Tools to characterize expressed proteins.

Proteins- classification and separation, purification and criteria of homogeneity, end group analysis, hierarchy in structure, Ramachandran maps.

Unit – II

Sugars (Carbohydrates):

Mono, di, and polysaccharides; Suitability in the context of their different functions- cellular structure, energy storage, signaling; Glycosylation of other biomolecules - glycoproteins and glycolipids; Lipids - structure and properties of important members of storage and membrane lipids; lipoproteins.

Unit – III

Lipids –Structure and Classification of fatty acids; Structure of triglycerides and phospholipids, Chemical Reactions; structure and properties of important members of storage and membrane lipids; lipoproteins, Glycolipids, Sphingolipids, terpenes and steroids.

Unit - IV

Heterocyclic compounds and secondary metabolites in living systems - nucleotides, pigments, isoprenoids; classifications; functions and their properties in the body.

Principles of thermodynamics:

Classes of organic compounds and functional groups - atomic and molecular dimensions, space filling and ball and stick models.

Unit - V

Bioenergetics:

Basic principles; Equilibria and concept of free energy; Coupled processes; Glycolytic pathway; Kreb's cycle; Oxidative phosphorylation; Photosynthesis.

Texts/References

1. V.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.

Cell and Developmental Biology- 3 Credits

Unit I

Cell Theory & Methods of Study:

Microscope and its modifications – Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM), Electron tunneling and Atomic Force Microscopy, etc.

Membrane Structure and Function

Structural models; Composition and dynamics; Transport of ions and macromolecules; Pumps, carriers and channels; Endo- and Exocytosis; Membrane carbohydrates and their significance in cellular recognition; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata.

Unit - II

Organelles

Nucleus – Structure and function of nuclear envelope, lamina and nucleolus; Macromolecular trafficking; Chromatin organization and packaging; Cell cycle and control mechanisms; Mitochondria – structure, organization of respiratory chain complexes, ATP synthase, Structure- function relationship; Mitochondrial DNA and male sterility; Origin and evolution; Chloroplast– Structure-function relationship; Chloroplast DNA and its significance; Chloroplast biogenesis; Origin and evolution.

Endo-membrane System and Cellular Motility: Organization and role of microtubules and microfilaments; Cell shape and motility; Actin-binding proteins and their significance; Muscle organization and function; Molecular motors; Intermediate filaments; Extracellular matrix in plants and animals.

Unit – III

Cellular Movements and Pattern Formation

Laying of body axis planes; Differentiation of germ layers; Cellular polarity; Model plants like Fucus and Volvox; Maternal gene effects; Zygotic gene effects; Homeotic gene effects in Drosophila; Embryogenesis and early pattern formation in plants; Cell lineages and developmental control genes in Caenorhabditis.

Unit – IV

Cell cycle – Molecular events and model systems; Control mechanism; Apoptosis.

Cellular basis of differentiation and development - mitosis, gametogenesis and fertilization, development Arabidopsis; Spatial and temporal regulation of Gene Expression

Differentiation of Specialized Cells

Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Cellular basis of immunity; Differentiation of cancerous cells and role of proto-oncogenes; Phase changes in Salmonella; Mating cell types in yeast; Surface antigen changes in Trypanosomes; Heterocyst differentiation in Anabaena; Sex determination in Drosophila.

Unit - V

Biology of cancer; properties and features of cancer cells; oncogenes; tumor suppresser genes; mechanism of cancer; metagenesis; types of cancer

Genes, Mutation and Mutagenesis: UV and chemical mutagens; Types of mutation; Ames test for mutagenesis; Methods of genetic analysis.

Genetic Systems of Yeast and Neurospora.

Extra-Chromosomal Inheritance.

Texts/References

1. Lodish et al., Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.
2. Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.
3. Watson et al., Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA, 2003.
4. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley-Blackwell, 2002.
5. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.

Programming in C/C++: 3 Credits

UNIT-I

C language: Introduction ; Tokens; Keywords; Identifier ; Variables; Constants; Operators ; Expression; Data types; Operator precedence

Statement: Input statement, Output statement, Conditional and Unconditional Control Statement – Looping Statement: while, do-while, for – nested loop – Arrays.

Overview of C++: Object oriented programming, Introducing C++ classes, Concepts of object oriented programming. Classes & Objects : Classes, Structure & classes, Union & Classes, Friend function, Friend classes, Inline function, Scope resolution operator, Static class members: Static data member, Static member function, Passing objects to function, Returning objects, Object assignment.

UNIT-II

Array and Pointers references: Array of objects, Pointers to object, Type checking C++ pointers, The This pointer, Pointer to derived types, Pointer to class members, References: Reference parameter, Passing references to objects, Returning reference, Independent reference, C++ 's dynamic allocation operators, Initializing allocated memory, Allocating Array, Allocating objects.

Constructor & Destructor: Introduction, Constructor, Parameterized constructor, Multiple constructor in a class, Constructor with default argument, Copy constructor, Default Argument, Constructing two dimensional Array, Destructor.

UNIT-III

Function & operator overloading : Function overloading, Overloading constructor function finding the address of an overloaded function, Operator Overloading: Creating a member operator function, Creating Prefix & Postfix forms of the increment & decrement operation, Overloading the shorthand operation (i.e. +=,-= etc), Operator overloading restrictions, Operator overloading using friend function, Overloading New & Delete, Overloading some special operators, Overloading [ ], ( ), -, comma operator, Overloading << .

UNIT-IV

Inheritance : Base class Access control, Inheritance & protected members, Protected base class inheritance, Inheriting multiple base classes, Constructors, destructors & Inheritance, When constructor & destructor function are executed, Passing parameters to base class constructors, Granting access.

Virtual functions & Polymorphism: Virtual base classes; Virtual function, Pure Virtual functions, early Vs. late binding

UNIT-V

String Handling: String declaration; String library functions; String Manipulation; Creating string objects, manipulating string objects, relational operators, string characteristics, Comparing and swapping

Sorting: Bubble sort, Selection sort, Insertion sort

Searching: Linear search, Binary search

Text References:

1. Programming in ANSI C by E. Balagurusamy. Tata McGrawHill Publishing Company Limited. 2007
2. Object Oriented Programming using C++ by Lafore, R. Galgotia Publishers. 2006
3. C: The Complete Reference by By **Herbert Schildt,** 4th Edition; McGraw-Hill/Osborne Media Publications
4. C++: The Complete Reference by By **Herbert Schildt,** 3th Edition; McGraw-Hill/Osborne Media Publications

Molecular Biology - 3 Credits

Unit I

Nucleotides: Structure; classification; Biosynthesis of purine and pyrimidine nucleotides from ribose including regulation, salvage pathways.

Genome organization

Organization of bacterial genome; Structure of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA re-association kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome phasing; DNase I hypersensitive regions; DNA methylation & Imprinting.

Unit II

DNA Structure; Replication; Repair & Recombination

Structure of DNA - A-,B-, Z- and triplex DNA; Measurement of properties-Spectrophotometric, CD, AFM and Electron microscope analysis of DNA structure; Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single strandedcircular DNA; Gene stability and DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination.

Unit III

Prokaryotic & Eukaryotic Transcription

Prokaryotic Transcription; Transcription unit; Promoters- Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Anti-termination; Transcriptional regulation-Positive and negative; Operon concept-lac, trp, ara, his, and gal operons; Transcriptional control in lambda phage; Transcript processing; Processing of tRNA and rRNA Eukaryotic 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; Transcriptional and post-transcriptional gene silencing

Post Transcriptional Modifications

Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA.

RNA splicing: Nuclear splicing, spliceosome and small nuclear RNAs, group I and group II introns, Cis- and Trans-splicing reactions, tRNA splicing, alternate splicing.

Unit IV

Translation & Transport

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; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation

Unit V

Antisense and Ribozyme Technology Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyrne; hammer- head, hairpin and other ribozymes, strategies for designing ribozymes, Applications of antisense and ribozyme technologies. RNA interference.

Molecular Mapping of Genome Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, Simple sequence repeat loci, Southern and fluorescence in situ hybridization for genome analysis, Chromosome microdissection and microcloning, Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, Molecular markers linked to disease resistance genes.

Text/references

1. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
3. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002.

PRACTICAL [Total 06 Credits]

Lab on Molecular Biology

1. Plasmid DNA isolation and DNA quantization: Plasmid minipreps
2. Restriction digestion
3. Preparation of competent cells.
4. Agarose gel electrophoresis
3. Restriction Enzyme digestion of DNA
4. Purification of DNA from an agarose gel
5. DNA Ligation
6. Transformation of E.coli with standard plasmids, Calculation of transformation efficiency

7. Cloning of genomic DNA in standard plasmid vectors
8. Confirmation of the insert, Miniprep of recombinant plasmid DNA, Restriction mapping
9. Polymerase Chain reaction, using standard 16srRNA eubacterial primers
10. RFLP analysis of the PCR product
11. Transformation of yeast Saccharomyces cerevisiae

Lab on Computer Fundamentals and Biostatistics

1. Introduction to MS EXCEL-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.
2. Use of bar diagram, histogram, scatter plots, etc. graphical tools in EXCEL for presentation of data. Introduction to SYSTAT package.
3. Searching PubMed,
4. Bioinformatics Resources: NCBI, EBI, DDBJ, RCSB, ExPASy
5. BLAST BLASTn, BLASTp, PSI-BLAST,
6. Sequence manipulation Suite: BioEDIT
7. Multiple sequence alignment: Clustal W/ Clustal X and T-Coffee
8. Primer designing by primer 3
9. Phylogentic Analysis.
10. Protein Modeling,
11. Protein structure Analysis, Docking,
12. Sequence file formats: GenBank, FASTA, GCG, MSF

Lab on Biochemistry and Analytical Techniques

1. To prepare an Acetic-Na Acetate Buffer system and validate the Henderson-Hasselbach equation.
2. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
3. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC.
4. AN ENZYME PURIFICATION THEME (such as E.coli Alkaline phosphatase or any enzyme of the institutions choice).
(a) Preparation of cell-free lysates
(b) Ammonium Sulfate precipitation
(c) Ion-exchange Chromatography
(d) Gel Filtration

Lab on Object Oriented Programming through 'C++'

1. Display a protein details using escape sequence
2. Calculate rotations per minute [rpm = 1000 √RCF / 11.17r]
3. Create amino acid dictionary using switch construct
4. Identify the glucose level in a blood using if - else if construct [The glucose level is identified by <70 – hypoglycemia, 70-180 hyperglycemia, > 180 diabetics]
5. Identify the type of two peptides using nested if [peptide length is < 8 small, poly otherwise]
6. Create a class which shows the various forms of constructors
7. Inheritance implementation
8. Function overloading example
9. Operator overloading example
10. Dynamic polymorphism implementation
11. Writing C programs for Bioinformatics applications: (10 assignments)
    a) Extract a protein or nucleic acid sequence from any of the databank files (GenBank entry, Swiss-Prot, EMBL entry etc.) Syllabus
    b) Interconverting the sequence from one databank format to the other eg. GenBank format to FASTA format, FASTA to PIR format etc.
    c) Determining the base composition in a nucleic acid sequence and amino acid composition in a protein sequence.
    d) Generating the complimentary sequence of a DNA sequence Pattern search algorithms
    e) Search for a specific oligonucleotide pattern (eg. GAACATCC) in a given DNA sequence.
    f) Find the position where a specific sequence say “GGTCCCGAC” will hybridize a given DNA sequence.
    g) Find the restriction enzyme cleavage sites eg. where PVUZ, ECORI etc. will cut the DNA.
    h) Locate palindromic sequence stretches in a DNA sequence.
    i) Count the number of Open Reading frames (ORF’s) in a DNA sequence.
    j) Calculate the codon usage in a nucleic acid sequence.
    k) Translate a DNA sequence into protein sequence in the forward and reverse frames.
    l) Implementation of the Needleman-Wunsch algorithm for pair wise alignment and testing alignment score with randomized pairs of sequences also.

SEMESTER II

Course code	Title	Credits
BT BI 502	Biological Databases and Data Analysis (Bioinformatics-I): (Core)	03
BT BI 512	Recombinant DNA Technology (Core)	03
BT BI 522	Design and Analysis of algorithms (Generic Elective)	03
BT BI 532	Internet & Web Based Programming (CGI PERL & HTML) (Skill Enhancement Course)	03
BT BI 542	Immunoinformatics (Discipline Centric Elective)	1.5
BT BI 552	Genomics & Proteomics (Discipline Centric Elective)	1.5
BT BI 562	Enzyme & Enzyme Technology (Discipline Centric Elective)	03
BT BI 572	Practical	08
BT BI 582	Seminars (Soft Skill Development)	02
	Comprehensive Viva Voce	04
	Total Credits	29

[##] 03 Credits has to be earned from Discipline Centric electives by the students from SBT. One Generic Elective of 03 credits can be opted by the students from SBT itself or from any other department (UTD).

Biological Databases and Data Analysis (Bioinformatics-I): 3 Credits

UNIT I

Introduction and Bioinformatics Resources: Knowledge of various databases and bioinformatics tools available at these resources, the major content of the databases, Literature databases

Sequence databases (EMBL, GenBank, DDBJ, SWISS-PROT, PIR, TrEMBL)
Protein family/domain databases (PROSITE, PRINTS, Pfam, SMART)
Cluster databases (Prodom, Systers)
Specialist databases (Flybase, Kegg)
Search engines (SRS, Entrez)

Sequence analysis: Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues.
Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series.

UNIT II

Pair Wise Sequence Alignment:

1) **Dynamic Programming –** Smith and Waterman & Needlemen and Wunch Algorithm; Use of Pair-wise alignments for analysis of Nucleic acid and protein sequences and interpretation of results.

2) **Heuristic Based Methods:** BLAST and FASTA algorithms, various versions of basic BLAST and FASTA.

Multiple sequence alignments (MSA): The need for MSA, basic concepts of various approaches for MSA (e.g. progressive, hierarchical etc.). Algorithm of CLUSTALW and PileUp and their application for sequence analysis (including interpretation of results), concept of dendrogram and its interpretation, Use of HMM-based Algorithm for MSA (e.g. SAM method)

UNIT III

Phylogeny: Phylogenetic analysis, Definition and description of phylogenetic trees and various types of trees, Method of construction of Phylogenetic trees [distance based method (UPGMA, NJ), Maximum Parsimony and Maximum Likelihood method]. The Fitch/Margoliash method; Character-based Methods – maximum parsimony, maximum likelihood; Phylogenetic softwares – PAUP, PHYLIP, MacClade

UNIT IV

Sequence patterns and profiles: Basic concept and definition of sequence patterns, motifs and profiles, various types of pattern representations viz. consensus, regular expression (Prosite-type) and sequence profiles; profile-based database searches using PSI-BLAST, analysis and interpretation of profile-based searches. Biological motifs (concensus, regular expressions, profiles, PSSMs, HMMs)

Algorithms for derivation and searching sequence patterns: MeMe, PHI-BLAST, SCanProsite and PRATT. Algorithms for generation of sequence profiles: Profile Analysis method of Gribskov, HMMer.

UNIT V

Data production and data flow (mapping, DNA sequencing, generation of scaffolds & contigs)
Gene prediction (ab initio & similarity based)
Genome annotation (pipelines, databases)

Text References:

1. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory Press, New York. 2004
2. Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., Wiley India Pvt Ltd. 2009
3. Bioinformatics for Dummies by Jean-michelClaverie Cedric Notredame. Publisher: Dummies
4. Introduction to Bioinformatics by Aurther M lesk
5. Developing Bioinformatics Computer Skills By: Cynthia Gibas, Per Jambeck
6. Structural Bioinformatics

RECOMBINANT DNA TECHNOLOGY : 3 Credits

Unit I

Basics Concepts : DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNaselfootprinting; Methyl interference assay

Unit II

Cloning Vectors Plasmids: Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; 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.; Intein- based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors

Unit III

Cloning Methodologies: Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression

Unit IV

PCR and Its Applications: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; Tvectors; 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, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)

Unit V

Sequencing methods: Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; 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; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

Text/references

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1- 3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Selected papers from scientific journals.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

Design & Analysis of Algorithm: 3 Credits

UNIT I

Basic Concepts of Algorithms: Introduction; Notion of Algorithm; Fundamentals of Algorithmic Solving; Important Problem types; Fundamentals of the Analysis Framework – Asymptotic Notations and Basic Efficiency Classes. Big 'O' notations, Time and space complexity of algorithms and common functions; String Matching: Naïve algorithm, Boyer Moore algorithm.

UNIT II

Mathematical Aspects and Analysis of Algorithms: Mathematical Analysis of Non-recursive Algorithm – Mathematical Analysis of Recursive Algorithm – Example: Fibonacci Numbers – Empirical Analysis of Algorithms – Algorithm Visualization.

UNIT III

Analysis of Sorting and Searching Algorithms: Brute Force; Selection Sort and Bubble Sort; Sequential Search and Brute-force string matching; Divide and conquer; Merge sort; Quick Sort; Binary Search; Binary tree-Traversal and Related Properties; Decrease and Conquer; Insertion Sort; Depth first Search and Breadth First Search.

UNIT IV

Algorithmic Techniques: Transform and conquer; Presorting; Balanced Search trees; AVL Trees; Heaps and Heap sort; Dynamic Programming; Warshall's and Floyd's Algorithm; Optimal Binary Search trees; Greedy Techniques; Prim's Algorithm; Kruskal's Algorithm; Single-Source Shortest Path: Dijkstra's Algorithm; Huffman trees; Minimum Spanning Tree.

UNIT V

Algorithm Design Methods: Backtracking; n-Queen's Problem; Hamiltonian Circuit problem; Subset-Sum problem; Branch and bound; Assignment problem; Knapsack problem; Traveling salesman problem.

Text References:-

1. Design and analysis of algorithms by Horrowick
2. Design and analysis of algorithms by Corman
3. Data structure by Baluja
4. Fundamentals of Algorithms by E. Horowitz and S. Sahani., Galgotia Book source Pvt. Ltd. 1999
5. Data Structures by Seymour Lipschutz., Tata Mc-Graw-Hill publication. 2007

Internet & Web Based Programming (CGI, Perl & HTML): 3 Credits

UNIT I

Internet Basics: The Basics of the Internet, Concepts of a Domain, Networking concepts, IP Addressing, Resolving Domain Names, Structure of an IP address, Overview of TCP/IP and its services, The World Wide Web, FTP and Telnet.

UNIT II

Hyper text markup language (HTML): How a Web Browser communicates with a web server, what is HTML and various HTML tags, Commonly used HTML commands, Lists, Adding Graphics to HTML documents, to create and use Tables, the concept of Hyperlink, Types of Hyperlinks, Introduction to Frames, Using the <Frameset> and the <Frame> tag. Other tags and versions of HTML such as DHTML and XML.

UNIT III

Common Gateway Interface (CGI): The concept of CGI, Why CGI is used, How CGI works, The two methods of Data submissions, the differences in the two methods of submissions, the importance of Environment variables in a CGI program, the basic steps required to process from information in a CGI program, Why Perl is the language of choice for programming in CGI.

UNIT IV

Perl Language: The basics of the Perl Language, the concept of Perl Strings and their types, the values that can be stored in scalar variables, Arrays, how to extract information from both types of Arrays, the importance of the special Hash Array, Performing operations & Controlling program Flow, Perl Functions, File Handling. Literal Representation of a Hash, Hash Functions, Using Hashes for the Genetic Code, Gene Expression Data Using Hashes

UNIT IV

Perl applications for biological data:

Bioperl: Introduction to Bioperl, Installing procedures, Architectures, General Bioperl Classes, Sequences (Bio::Seq Class, Sequence Manipulation), Features and Location Classes (Extracting CDS), Alignments (AlignIO), Analysis (Blast, Genscan), Databases (Database Classes, Accessing a local database), Implementing REBASE

Text Reference:

1. HTML/PERL/JAVA – Ivan Bayross
2. Beginning Perl for Bioinformatics (1 st Edition) by Tisdall, J., O'Reilly Publishers. 2004
3. Learning Perl (5th Edition) by Randal L. Schwartz, Tom Phoenix and Brain d Foy, O'Reilly Publishers, 2008
4. Advance Perl Programming by Sriram Srinivasan
5. Writing CGI application with Perl by Kevin Meltzer and Brent Michalski

Immunoinformatics :1.5 Credits

Unit I

Immune systems: Innate and adaptive immunity in vertebrates,

Antibodies: Immunoglobulins, Immunoglobulin classes and subclasses, Immunogenetics, Antibody numbering

The major histocompatibility complex (MHC): MHC polymorphism: Causes of MHC polymorphism, MHC supertypes. HLA nomenclature

Unit II

Antigen processing and presentation

Contemporary challenges to the immune system: Infectious diseases, clustering of infectious disease organisms, autoimmune diseases.

Membrane receptors for antigen: The B-cell surface receptor for antigen (BCR), CDR and LDR regions, The T-cell surface receptor for antigen (TCR), Antigen recognition diversity

Epitopes: Affinity Maturation, Recognition of Antigen by B cells, Neutralizing Antibody, Prediction of epitopes.

Unit III

Vaccine design: Rational Vaccine design, Categories of vaccines, Polytype vaccines, Therapeutic vaccines, Evolution and escape due to variations.

Mathematical models the immune system: Reverse immunology and approaches in computer aided vaccine design,

Viral bioinformatics: computational views of host and pathogen.

Unit IV

Browsing and searching immunological databases: Databases of epitopes, IMGT/HLA sequence database, BciPep, Epitome, CED, AgAbDb, Antibody:, Sequence analysis in immunology: Alignments, Molecular evolution and phylogeny, Prediction of functional features of biological sequences.

Methods applied in immunological bioinformatics: Sequence weighing methods, Pseudocount Correction methods, and Performance measures for prediction methods

Prediction of cytotoxic and helper T cell epitopes: MHC Class I epitopes, MHC Class II epitopes.

Web-based tools for vaccine design: Databases of MHC ligands, Prediction servers.

Text/Reference:

1. Immunological Bioinformatics (2005) by Ole Lund, Morten Nielsen, Claus Lundegaard, Can Kesmir, and Soren Brnak, The MIT press.

2. Immunoinformatics: Bioinformatics Strategies for Better Understanding of Immune Function (2003), Wiley; 1 edition.

3. Essential Immunology. Blackwell Science by Ivan M. Roitt and Peter J. Delves.

Genomics and Proteomics -1.5 Credits

Unit I

Introduction

Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

Unit II

Genome sequencing projects

Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.

Unit III

Proteomics

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.

Unit IV

Pharmacogenetics

High throughput screening in genome for drug discovery- identification of gene targets, Pharmacogenetics and drug development

Unit V

Functional genomics and proteomics

Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays; Structural proteomics

Texts/References

1. **Voet D, Voet JG & Pratt CW**, ***Fundamentals of Biochemistry***, 2nd Edition. Wiley 2006

2**. Brown TA, *Genomes***, 3rd Edition. Garland Science 2006

3. **Campbell AM & Heyer LJ**, ***Discovering Genomics, Proteomics and Bioinformatics,*** 2nd Edition. Benjamin Cummings 2007

4. **Primrose S & Twyman R**, ***Principles of Gene Manipulation and Genomics***, 7th Edition, Blackwell, 2006.

5. **Glick BR & Pasternak JJ**, ***Molecular Biotechnology***, 3rd Edition, ASM Press, 1998.

Enzyme & Enzyme Technology - 3 Credits

UNIT I

Scientific writing – Introduction- Types of scientific writings- Thesis or dissertation- Popular science writing- Types of publications- Open Access Resources- Choosing a journal- Instructions to authors - Scientific paper writing – Structure and Style- Authorships –figures tables with legends - References and citations - Acknowledgements- Conflict of interest - Peer review mechanismScientometric Analyses of a paper/ journal- Plagiarism issues

UNIT II

Dissertation writing and grammar - Thesis: Format- Writing style; Grammar - Nouns -Adjectives - Verbs - Adverbs - Pronouns and determiners - Conjunctions and prepositions - Phrases – Clauses- spellings- Word choice -Punctuation.

UNIT III

Oral presentation- Planning the oral presentations and visuals- In-class discussion (Students in small groups or individually will take up the assignments or select a research project/ topic and prepare oral presentations followed by a Q&A sessions)

UNIT IV

Poster Presentation- Elements and Significance of poster presentations- Planning and designing a poster- Individual Poster presentation (Students select a research project/topic and prepare posters followed by a Q&A sessions)

UNIT V

Personality development, Ethics and values - elements of recruitment, selection, interview techniques- Personality Development - team work- inter personal and intra-personal interactions –human behavior at work- Time and human resources management- planning and scheduling, stress at work- work-life balance- Culture and cultural ethos- cultural diversity-diversity in organizations.

Texts/References

1. Scientific Writing: Easy When You Know How by Jennifer Peat, BMJ books. 2002
2. Successful Scientific Writing: A step-by-step Guide for Biomedical Scientists (3rd Ed.) by J.R. Matthews and R.W. Matthews, Cambridge University Press. 2008
3. From Research to Manuscript: A Guide to Scientific Writing by Michael Jay Katz, by Springer. 2006,
4. Writing and Presenting Scientific Papers, 2nd Edition by BrigittaMalmfors, Phil Garnsworthy and Michel Grossman, Nottingham University Press, 2004, Viva Books Pvt. Ltd. 2011
5. Scientific Writing- A Reader and Writer's Guide, by Jean Luc- Lebrun, World Scientific Publishers, 2007

PRACTICAL [Total 08 Credits]

Lab on Bioinformatics:

1. Sequence Analysis Packages: EMBOSS, NCBI ToolKit, SMS
2. Database search engines: Entrez, SRS, DBGET
3. Pair wise alignment:
    (i) Search tools against Databases:
    (ii) BLAST
    (iii) FASTA
4. Multiple sequence alignment:
    a. Clustal
    b. Dialign
    c. Multalign
5. Protein motif and domain analysis:
    a. MEME/MAST
    b. eMotif
    c. InterproScan
    d. ProSite
    e. ProDom

f. Pfam

6. Visualization Tool
    a. RasMol
    b. Cn3D
    c. MolMol
    d. PyMol

7. Phylogenetic analysis – MEGA, PAUP, PHYLIP

8. Protein and nucleic acid properties: Proteomics tools at the ExPASy server, GCG utilities and EMBOSS

Lab on Internet & Web Based Programming (CGI, Perl & HTML)

1. LINUX Operating System: Overview of Linux Architecture, Installation, Booting and Shutdown Process, System Processes(an overview), User Management- Types of users, Creating Users, Granting Rights, File System management
2. Uses of Scalar and Array Variables to manipulate DNA/RNA/Protein sequence data
3. Concatenation DNA fragments, transcribing DNA into RNA
4. Calculating the Reverse complement of a DNA strand
5. Uses of common Array Operators
6. Uses of Do-Until Loops
7. Uses of 'substr' function to look into the string
8. Reading a sequence data from a file and writing the results to a file
9. Opening and closing a Directory Handle, Reading a Directory and other directory manipulation functions.
10. Uses of Subroutines
11. Uses of Hashes for the genetic code: translating codons into amino acids
12. Uses of subroutine to read FASTA files
13. Translate a DNA sequence in all six reading frames
14. Uses of Regular Expressions
15. Extract annotation and sequence from GenBank file
16. Parsing GenBank annotation using arrays
17. Extract sequence chains from PDB file
18. Uses of CGI.pm Module and Passing Parameters via CGI, Debugging CGI programs
19. Installing Bioperl, Uses of Bioperl modules for sequence manipulation, accessing local database

Lab on Immunoinformatics

Browsing and searching sequence & structure databases to retrieve data of Immunoglobulin: sequence and structure

1. Study of Antibody sequence and structure
    a) Antibody numbering: Kabat & Chothia methods o Equivalence between different numbering schemes & PDB numbering o Visualisation of structure & mapping CDRs on structure
    b) Study of variable and constant domains o Drawing topology diagram
2. Study of Ag-Ab interactions

a) Searching for Ag-Ab complexes
b) Use of molsurfer, explorer etc
c) Charaterisation of binding sites
    - ♣ Ab-protein complex
    - ♣ Ab-peptide complex
    - ♣ Geometric and molecular interaction

3. Sequence analysis in immunology
    a) Alignments: antibody sequences
    b) Alignments: antigen sequences, molecular evolution, variability analysis and phylogeny
4. Prediction of sequential epitopes
5. Prediction of conformational epitopes
6. Estimation of accuracy of predicted epitopes: use of experimental data
7. Prediction of cytotoxic and helper T cell epitopes
    a) MHC Class I epitopes o MHC Class II epitopes
8. Web-based tools for vaccine design
9. Predicting immunogenicity
    a) Combination of MHC and Proteasome predictions o Combination of MHC, TAP, and Proteasome predictions

SEMESTER III

Course code	Title	Credits
BT BI 601	Machine Learning Techniques & CADD(Bioinformatics II) (Core)	03
BT BI 611	Structural Biology and Bioinformatics (Bioinformatics III) (Core)	03
BT BI 621	Database management System (Generic Elective)	03
BT BI 631	Java Programming (Core)	03
BT BI 641	Metabolic Engineering & System Biology (Discipline Centric Elective)	1.5
BT BI 651	Pharmacogenomics (Discipline Centric Elective)	1.5
BT BI 661	Microscopic Techniques For Image Processing (Discipline Centric Elective)	1.5
BT BI 671	Assignments/ Practical	08
BT BI 681	Seminar(Soft Skill Development)	02
	Comprehensive Viva Voce	04
	Total Credits	29

[##] Any 02 out of 03 Discipline Centric electives can be opted by the students from SBT. One Generic Elective of 03 credits can be opted by the students from SBT itself or from any other department (UTD).

Machine Learning Techniques & CADD (Bioinformatics – II): 3 Credits

UNIT I

Markov Chains & Hidden Markov Models: Introduction to Markov chains and HMM using Markov chains for discrimination of biological sequences. Forward and backward algorithms; Parameters estimation for HMMs. HMMs for pairwise and multiple sequence alignments. Profile HMMs.

UNIT II

Machine Learning and Bioinformatics: Introduction to various Machine Learning techniques and their applications in Bioinformatics. Support Vector Machine, Artificial Neural Network; Neural Networks and their practical applications towards the development of new models, methods and tools for Bioinformatics.

UNIT III

Machine Learning Algorithms

a) Dynamic Programming
b) Gradient Descent
c) EM/GEM Algorithms
d) Markov-Chain Monte-Carlo Methods
e) Simulated Annealing
f) Evolutionary and Genetic Algorithms

UNIT IV

CADD and Molecular Docking: Introduction, Basic Procedure; Constant and Flexible Docking.

Drug design: Drug discovery process; Target identification and validation; lead optimization and validation; Methods and Tools in Computer-aided molecular Design,

Analog Based drug design:-Pharmacophores (3D database searching, conformation searches, deriving and using 3D Pharmacophore, constrained systematic search, Genetic Algorithm, clique detection techniques, maximum likelihood method).

Structure based drug design:- Docking, De Novo Drug Design (Fragment Placements, Connection Methods, Sequential Grow), Virtual screening.

UNIT V

Structure Activity Relationship: Introduction to QSAR, QSPR, Various Descriptors used in QSARs: Electronics; Topology; Quantum Chemical based Descriptors. Regression Analysis, The Significance and Validity of QSAR Regression Equations, Partial Least Squares (PLS) Analysis, Multi Linear Regression Analysis. Use of Genetic Algorithms, Neural Networks and Principle Components Analysis in the QSAR equations.

Text References:

1. Chemoinformatics: A Textbook by Johann Gasteiger.
2. Bioinformatics second edition by David M Mount
3. Bioinformatics: Methods and Applications Genomics, Proteomics And Drug Discovery
4. Bioinformatics: the Machine Learning Approach by Pierre Baldi and Soren Brunak; Second Edition; The MIT Press

Structural Biology and Bioinformatics (Bioinformatics-III): 3 Credits

UNIT I

Prediction of protein structure: Secondary structure: Algorithms of Chou Fasman, GOR methods. Tertiary Structure: basic principles and protocols, Methods to study 3D structure.

Protein structure comparison and classification: classes, folds; the concepts in 3D structure comparison, purpose of structure comparison, algorithms such as FSSP, VAST and DALI.

Protein Folding: Principles of protein folding and methods to study protein folding.

UNIT II

Molecular Mechanics: Introduction, The Morse Potential, The Harmonic Oscillator Model for Molecules, Comparison of Morse and Harmonic Potential, Two atoms connected by a bond, Poly atomic Molecules, Energy due to Stretch, Bend, Stretch-Bend, Torsional strain, van der Waals and Dipole-Diploe interactions.

Types of Potentials: Lennard-Jones, Truncated Lennard-jones, Exponential-6, Ionic and Polar potentials. Types of Force Fields: AMBER, CHARMM, Merck Molecular Force Field, Consistent Force Field, MM2, MM3 and MM4 force fields.

UNIT III

Potential Energy Surface: Convergence Criteria, Characterizing Stationary Points, Search for Transition States. Optimization: multivariable Optimization Algorithms, level Sets, Level Curves, Gradients, Optimization Criteria, Unidirectional Search, Finding Minimum Point, Gradient based Methods-Steepest Descent and Conjugate Gradient Methods.

UNIT IV

Molecular Dynamics Simulation: Introduction, Radial distribution functions, Pair Correlation function, Newtonian dynamics, Integrators- Leapfrog and Verlet algorithm, Potential truncation and shifted-force potentials, Implicit and explicit Solvation models, Periodic boundary conditions, Temperature and pressure control in molecular dynamics simulations.

UNIT V

Computational RNA Structure analysis: Secondary and tertiary structure of RNA. Various algorithms of RNA folding and their analysis. Energy minimization in RNA folding. RNA sequence alignment based on secondary structure and its applications in functional genomics and phylogeny.

Text References:

1. Computational Chemistry and Molecular Modeling-Principles and Applications by Ramachandran, Deepa and Namboori., 2008, Springer_Verlag.
2. Molecular Modeling Principles and Applications (2nd Ed.) by Andrew R. Leach., Prentice Hall, USA. 2001
3. Molecular Modelling for Beginners, (2nd Edition) by Alan Hinchliffe., John Wiley & Sons Ltd.2008
4. Molecular Modeling and Simulation – An Interdisciplinary Guide by Tamar Schlick., Springer-verlag 2000
5. Computational Medicinal Chemistry for Drug Discovery, edited by Patrick Bultinck., Marcel Dekker Inc. 2004

Database Management System: 3 Credits

UNIT I

Introduction, Database System Versus File Systems, Characteristics of Database, Database Concepts, Schemas & Instances, DBMS architecture and Data Independence, Data Models, Database Languages & Interfaces, View of Data, Database users and Administrators, Database System Structure, Database System Applications data models- Entity Relationship Model, Relational Model. ER Model: Keys, Constraints, Design Issues, Extended ER features, Reductions of ER Schema to Tables.

UNIT II

Structured Query Language – Basic Structure, Set Operations, Aggregate Functions, Null Values, Nested Sub queries, Views, Integrity: Domain constraints, Joined Relations, Data-Definition Language

Relational Databases: Integrity and Security, Relational – Database designs; Pitfalls in Relational Design Database, Functional dependencies, Decomposition Normal Forms – 1NF, 2NF, 3NF & Boyce-Codd NF, Data Storage – Ordered indices

UNIT III

Data Storage and Querying: Storage and File Structure, Indexing and Hashing, Query Processing, Query Optimization

UNIT IV

Transaction Management: Transactions, Concurrency Control, Recovery System; Properties of transactions: Concurrency problems, Serialisability and Locking techniques, Granularity of Data Items – Database System Architecture and Information retrieval: Centralized and Client-Server Architecture

UNIT V

Database System Architectures: Distributed Databases, Parallel Databases, Data Warehousing and Data Mining

Text References:

1. Database System Concepts (4th Ed.) bySilberschatz, A., Korth, H.F. and Sudarshan, S., 2002, McGraw Hill Publishers.
2. An Introduction to Database Systems (7th Ed.) by Date, C.J., Addison Wesley Publishers. 2000
3. Fundamentals of Database Systems (4th Ed.) by Elmasri and Navathe, Addison Wesley Publishers. 2004
4. Principles of Database Systems (2nd Ed.) by Ullman, J. D., Galgotia Publications. 2001

Java Programming: 3 Credits

UNIT I

C++ Vs JAVA, JAVA and Internet and WWW, JAVA support systems, JAVA environment., JAVA program structure, Tokens, Statements, JAVA virtual machine, Constant & Variables, Data Types, Declaration of Variables, Scope of Variables, Symbolic Constants, Type Casting.

Operators: Arithmetic, Relational, Logical Assignments, Increment and Decrement, Conditional, Bitwise, Special, Expressions & its evaluation. If statement, if…else… statement, Nesting of if…else… statements,,else…if Ladder, Switch, ? Operators, Loops – While, Do, For, Jumps in Loops, Labelled Loops.

UNIT II

Defining a Class, Adding Variables and Methods, Creating Objects, Accessing Class Members, Constructors, methods Overloading, Static Members, Nesting of Methods. Inheritance: Extending a Class, Overriding Methods, Final Variables and Methods, Final Classes, Finalize Methods, Abstract methods and Classes, Visibility Control.

UNIT III

Arrays: One Dimensional & two Dimensional, strings, Vectors, wrapper Classes, Defining Interface Extending Interface, Implementing Interface, Accessing Interface Variable, System Packages, Using System Package, Adding a Class to a Packages, Hiding Classes.

UNIT IV

Creating Threads, Extending the Threads Class, Stopping and Blocking a Thread, Life Cycle of a Thread, Using Thread Methods, Thread Exceptions, Thread Priority, Synchronization, Implementing the Runnable Interface.

UNIT V

Local and Remote Applets Vs Applications, Writing Applets, Applets Life Cycle, Creating an Executable Applet, Designing a Web Page, Applet Tag, Adding Applet to HTML File, Running the Applet, Passing Parameters to Applets, Aligning the Display, HTML Tags & Applets, Getting Input from the User.

BioJava - Installing BioJava, Symbols, Basic Sequence Manipulation (DNA to RNA, Reverse Complement, motif as regular expression), Translation (DNA to Protein, Codon to amino acid, Six frame translation), Proteomics (Calculate the mass and pI of a peptide), Sequence I/O (File Formats conversions), Locations and Features (PointLocation, RangeLocation, Feature modifications), BLAST and FASTA (Blast and FastA Parser, extract information from parsed results)

Text/references

1. E. Balaguruswamy, “Programming in Java”, 2nd Edition, TMH Publications Peter Norton, “Peter Norton
2. Herbert Schildt, Java- A Beginners Guide (4th Ed.)., Tata Mc-Graw-Hill publication. 2007
3. Computing Concepts with Java 2 Essentials (2nd Ed.) by Horstmann, C.S., John Wiley Publishers.2000
4. Object Oriented Design and Applications (2nd Ed.) by Benjamin, Cummings and Booch, G., Addison Wesley Publishers. 1994

Metabolic Engineering & System Biology – 1.5 Credits

UNIT I

Major Metabolic Pathways: Gluconeogenesis, Pentose phosphate pathway, Glycogen synthesis and degradation, Fatty acid oxidation and synthesis, Amino acid catabolism, Purine and pyrimidine nucleotide synthesis etc.

Metabolic Pathways databases: KEGG, EcoCyc and MetaCyc; EMP, Malaria Parasite Metabolic Pathways, Boehringer Mannheim -Biochemical Pathways

UNIT-II

Enzymes, Compounds and Reactions databases

- LIGAND - Biochemical Compounds and Reactions
- ENZYME - Enzymes
- BRENDA - Comprehensive Enzyme Information System

Metabolic Engineering- Basics
Rational Metabolic engineering design

UNIT III

Systems Biology Networks - basics of computer networks, Biological uses and Integration; Self-organizing maps and Connectivity maps - definition and its uses.

Networks and Pathways – Types and methods; Metabolic networks.

Unit IV

Simulation of pathways: Whole cell: Principle and levels of simulation – E-cell and v-cell, Virtual Erythrocytes; Pathological analysis. Flux Balance Analysis. Biochemical metabolic pathways, Metabolomics and enzymes. Interconnection of pathways, metabolic regulation. Networks and Motifs: Gene Networks: basic concepts, computational models. Lambda receptor and lac operon as an example.

Text/references

KlippEdda, Liebermeister Wolfram, WierlingChristoph, Kowald Axel, Lehrach Hans, Herwig Ralf. Systems Biology: A Textbook. Publisher: Germany, Wiley-VCH. 2009. ISBN: 9783527318742.

Alterovitz Gil, Ramoni Marco F. Systems Bioinformatics: An Engineering Case-Based Approach. Publisher: Boston, Artech House Publishers. 2007. ISBN: 9781596931244

Pharmacogenomics: 1.5 Credits

1. Pharmacogenomics, benefits, practical applications, the promise of Pharmagogenomics today leading to personalized medicines, human genetic variation-example of CYP gene variation leading to variable metabolism of drugs, distribution of variation, mutation and its kinds, natural selection, variation in ethnic groups races.

2. Pharmacology, clinical pharmacology, drugs, drugs legislation and safety, types of drugs-example of latest drugs, drug potency and efficacy and toxicity, ADME of drug-drug absorption, drug distribution, drug metabolism and drug excretion, drug therapeutic levels, therapeutic index, drug abuse, drug response in patients by correlating gene expression, regulation of gene expression, polymorphism, alleles, single nucleotide polymorphism, genotyping.

3. Genetic biomarkers- biomarkers on drug development, biomarkers in clinical development, biomarkers for molecular diagnostics-example of cancer biomarkers, pharmacogenetics and drug development.

Texts/References

1. Wu R and Lin M, *Statistical & Computational Pharmacogenomics*, CRC Press, 2008
2. Yan Q*, Pharmacogenomics in Drug Discovery and Development*, Springer-Verlag New York, LLC, 2008
3. Meyer UA and Tyndale RF, *Pharmacogenomics*, 2nd Edition, CRC Press, 2005.
4. Innocenti F, *Pharmacogenomics: Methods and Applications*, Springer-verlag New York, LLC, 2005
5. Rothstein MA and Collins FS, *Pharmacogenomics: Social, Ethical and Clinical Dimensions*, Wiley John & Sons, Inc., 2003

Microscopic Techniques For Image Processing - 1.5 Credits

Unit I

Transmission electron microscopy: Wave nature of electrons – Electromagnetic lenses – Basic components of Transmission Electron Microscope – Alignment of TEM – Major operational modes of TEM.

Unit II

Scanning electron microscopy: Basic systems of the SEM – Contrast and three-dimensionality of the SEM image – Stereo imaging with the SEM

Unit III

Specimen preparation for EM: TEM : Specimen preparation for TEM – Fixation – Washing – Dehydration – Embedding – Specimen staining for TEM – Positive staining and negative staining – Metal shadowing techniques – CryoEM. Ultramicrotomy: Shaping the specimen block – Types of ultramicrotome knives – EM grids – Support films for grids – Ultramicrotome and section processing.

SEM: Surface cleaning – Rinsing and dehydration – Specimen drying techniques – Specimen fracture procedures – Replication procedures – Specimen mounting – Specimen coating for conductivity.

Unit IV

Image processing and image analysis by computer: Capturing the image – Conventional vs. digital – Image processing – Controlling contrast, brightness and gamma – Removing noise – Fast Fourier Transform – images for publication and presentation – Three dimensional imaging.

Unit V

Atomic Force microscopy and Confocal Microscopy: Atomic force microscopy (AFM) including contact-mode, tapping-mode and lateral-force AFM Confocal Microscopy: Basics of Confocal Microscopy, Sample Preparation, Confocal Optics, And Resolution.

Text/Reference:

1. Electron Microscopy: Principles and techniques for biologists by John J Bozzola, and Lonnie Dee Russell., Jones & Bartlett Learning. 1999
2. Principles and Techniques of Electron Microscopy: Biological Applications by M.A.Hayat., Cambridge University Press. 2000
3. Handbook of Biological Confocal Microscopy, by Pawley, J.B., Springer-verlag. 2006

PRACTICAL [Total 08 Credits]

Lab on Java Programming:

1. Working with Objects, Arrays, Conditionals and Loops.
2. Creating Classes and Applications in Java.
3. Java Exception handling
4. Streams and I/O, Using Native Methods and Libraries
5. Simple Animation and Threads, Advanced Animation, Images and Sound.
6. Managing Simple Events and Interactivity.
7. Local and global alignment of sequences
8. Creating User Interfaces with AWT, Modifiers.
9. Multithreading example

10. Java Programming Tools, Working with Data Structures.

Lab on Database management System:

Data Definition Language (DDL) statements:

1. Creating database, Selecting database, Deleting database, Creating table, Modifying Table, Deleting table
2. Data Manipulation statements: Inserting, updating and deleting records
3. Retrieving Records: Retrieving specific rows and columns
4. Use of MySQL operators – Arithmetic operators, Comparison Operators, Logical operators Math functions, Aggregate functions
5. String operations
6. Limiting, Sorting and grouping query results
7. Handling null values
8. Renaming or aliasing table and column names
9. Using subqueries
10. Using Joins – joining a table to itself, joining multiple tables
11. Use of Indexes
12. Security Management
13. Granting and Revoking rights on tables

Lab on Bioinformatics II/III:

1.Structure Prediction: Advanced Modelling,
2.Modeller Interface: Chimera
3.Structural Validation: Procheck, WHATIF, VERIFY 3D
4.Energy Minimization
5.Tutorial on Molecular Dynamics: Gromacs
6.Binding Site Identification: Pocket- Finder
7.Structure based Drug Design:- Molecular Docking
8.Ligand Designing: Chemaxon
9.Ligand based Drug Design:- QSAR
10. Protein –protein Interaction and Visualization: Osprey, ViSant, Cytoscape, and STRING
11. RNA Structure Prediction

SEMESTER IV

Course code	Title	Credits
BT BI 602	Project Work	12
BT BI 612	Comprehensive Viva Voce	04
	Total Credits	16

Project Work (Credit: 25)

The course is required satisfactory completion and defense of the Masters dissertation.

This process includes:

a) Conceptualization of the independent research
b) Collection, analysis, and interpretation of data,
c) Thesis writing
d) Oral presentation of findings
e) Viva-Voce.

NOTE: Dissertation activity must be completed within prescribed time frame for the semester.

SCHOOL OF BIOTECHNOLOGY, D.A.V.V., INDORE.

SYLLABUS FOR Ph.D. COURSE WORK (BIOTECHNOLOGY)

COURSE	TITLE	CREDITS
COURSE-I	Research Methodology	4
COURSE-II	Advanced Biotechnology	3
COURSE-III	Computer Application	3
COURSE-III	Review of Literature	3
	Comprehensive Viva-Voce	3
	Total Credits	16

COURSE-I

Research Methodology

4 Credits

Objective: To gain knowledge about research in general, experimental approaches and analyses tools

Unit 1: Introduction to research

Concepts of research, discovery, innovation, invention. Concepts of blanks, controls and experimental designs of different nature of experimentations. Formulation of research problem, hypothesis, hypothesis generation, null hypothesis, alternate hypothesis, data collection and sampling methodologies.

Unit 2: Research ethics

Nature and purpose of ethics, Bioethics and biosafety protocols for biotechnological research; Animal ethical issues, IPR and patenting issues, conflict of interest, plagiarism, research misconduct, authorship, mentoring, social responsibilities of researchers.

Unit 3: Statistical methods

General overview of statistics- Mean, mode, median, standard deviation, standard errors, t-test, chi square test, multiple comparison tests (post hoc tests), ANOVA, correlation coefficient, level of significance, use of statistical tools (MS-EXCEL, Prism, SPSS) for different types of statistical tests. Probability distributions-Normal, Bionomial and Poisson distribution. Parametric and non-parametric statistics.

Unit 4: Scientific and technical writing

Introduction to publications. Research Journals (types), Peer review process, paper submission (off and online mode). Paper writing steps and process. Paper presentations, Report writing (Including pre-writing considerations and thesis writing).

Unit 5: Soft skills and Personality development

Concept of happiness and the ways to become happy; Differentiation among dreams, goals and objectives; Johari's window model to convert unknown into known. Paraphrasing and features of a good presentation for lectures and research, importance of dialogues/ communications & discussions- and the ways to improve them.

COURSE-II

Advance Biotechnology

3 Credits

Objective: To gain knowledge and applicability of advance tools and techniques used in biological research

Unit 1: General techniques used in Biotechnological research

Gel electrophoresis of DNA, RNA and protein. Southern, Northern and Western Blotting techniques. Fluorescent in situ hybridization (FISH), Electron microscopy- Transmission electron microscopy (TEM) and Scanning electron microscopy (SEM), Fluorescence microscopy and Inverted microscopy. Techniques used for protein/ antigen detection-Enzyme linked immunosorbent assay (ELISA), Radioimmuno assay (RIA), Fluorescence activated cell sorting (FACS). Animal tissue culture techniques- Culturing of the mammalian cells, their maintenance and experimentation using cell lines; Plant tissue culture techniques- Media preparation, Explant preparation and processing, artificial seeds preparation, anther culture, pollen culture, somatic embryogenesis, callus culture, sterilization and plating techniques.

Unit 2: Genomics based tools and techniques

Genome sequencing techniques and applications- Next-Generation sequencers, Sequencing strategies and the shotgun method, Massive parallel sequencing and their applications.

Applications of gene structural components such as coding sequences (CDS), untranslated regions (UTR's), expressed sequence tags (EST) etc. Types of gene polymorphism and their effects. Gene-disease association and polygenic diseases.

Unit 3: Transcriptomics based tools and techniques

Insights into Microarray, Serial analysis of gene expression (SAGE), real time PCR and their applications in high throughput gene expression studies. Gene expression through epigenetic regulation, mi-RNA & si-RNA pathways, antisense RNA technology.

Unit 4: Proteomics based tools and techniques

Tools for proteome analysis such as isoelectric focusing (IEF); Two dimensional PAGE, Mass spectrometry (MS-MS; MALDI-TOF), multidimensional HPLC. Protein structural determination by X-Ray crystallography, NMR, circular dichroism (CD). Antibody-array, Yeast hybrid systems for protein-protein and protein RNA interactions, FRET, BRET, Co-immunoprecipitation.

Unit 5: Metabolic engineering and recombinant DNA technology

Extension and diversion of metabolic pathways for production of commercially important products. Expression vectors, plantibodies, bioreactors, edible vaccines, development of knockout animal models and animal cloning. Production of transgenic crops, diagnostics and therapeutics using recombinant DNA technology.

COURSE-III

Computer Applications

3 Credits

Objective: To gain theoretical background and practical experience of various computer software and statistical tools for research applications

Unit 1: MS Word

Features and applications related to presentation of text in suitable format and saving the data for future applications. Practical knowledge of MS Word to type the script, insert tables, figures, and graphs to prepare thesis and research papers in presentable format.

Unit 2: MS Excel

Use of worksheets to enter experimental data, edit data, copy data and move data in the excel sheet. Use of in built statistical functions for computations of means, standard deviation, correlation, regression coefficients etc. Preparation of bar diagram, histogram, charts, and scatter plots in EXCEL for presentation of data.

Unit 3: MS Power Point

Preparation of Power point presentations, insertion of figures, graphs, charts in presentation, preparation of scientific posters for presentations; Use of various formatting and presentation techniques.

Unit 4: Use of SPSS & Internet Applications

Methods of preparation of data sheets and entering the data according to its characteristics. Use of various statistical tools on SPSS. Overview of networking, Internet and its applications. Exploring various websites and search engines for collecting quality literature and secondary data related to research work.

Unit 5: Basic Bioinformatics

Bioinformatics and its relation with advanced biology. Examples of related tools (FASTA, BLAST, RASMOL), Databases (GENBANK, Pubmed, PDB) and software (RASMOL, Ligand Eplorer). Introduction to sequences and alignments; Local alignment and Global alignment, Phylogenetic analysis.

COURSE-IV

Review of Literature

3 Credits

Objective: To collect the available literature in the chosen field of research, preparation of chronological order about the development of research in the specific area, identification of gaps in knowledge and developing the planning and methodology to fill the gaps.

Sources of research material, literature survey, compiling records. Various types of scientific documents- Original research paper, review paper, book chapter, theses, project report and conferences.
Components of a research paper-IMRAD system, title, author, and addresses, abstract.
Dealing with publishers-submission and review process.
Oral and poster presentations of research work in conferences/ symposia.
Skill development for communication of research findings to scientific community and for general audience.

Comprehensive Viva-Voce: As per provision of Ordinance-14, student will have to appear for comprehensive Viva-Voce.