KURUKSHETRA UNIVESITY, KURUKSHETRA

Curriculum For M.Sc. Biotechnology

Scheme of Examination

(Effective from the Academic Session 2011-2012)

Semester–I

Paper No.	Nomenclature	Internal Marks	External Marks	Total Marks	Time (Hours)
BT-101	Biomolecules	20	80	100	Three
BT-102	Microbiology	20	80	100	Three
BT-103	Molecular Cell Biology	20	80	100	Three
BT-104	Biotechniques	20	80	100	Three
BT-105	Lab. Course based on Biomolecules and Biotechniques	-	70	70	Six (Two Sessions of Three Hours each)
BT-106	Lab. Course based on Molecular Cell Biology & Microbiology	-	70	70	Six (Two Sessions of Three Hours each)
				Total: 540	

Semester – II

Paper No.	Nomenclature	Internal Marks	External Marks	Total Marks	Time (Hours)
BT-107	Principles of Genetic Engineering	20	80	100	Three
BT-108	Bioinformatics	20	80	100	Three
BT-109A	Animal Cell & Tissue Culture	10	40	50	Three
BT-109B	Plant Cell & Tissue Culture	10	40	50	Three
BT-110	Enzyme Technology	20	80	100	Three
BT-111	Lab. Course based on Genetic Engineering & Bioinformatics	-	70	70	Six (Two Sessions of Three Hours each)
BT-112	Lab. Course based on Cell & Tissue Culture and Enzyme Technology	-	70	70	Six (Two Sessions of Three Hours each
BT-113	Seminar	20		20	One
				Total: 560	

KURUKSHETRA UNIVESITY, KURUKSHETRA
CURRICULUM FOR M.Sc. BIOTECHNOLOGY
Scheme of Examination
(effective from the Academic Session 2011-2012)

Semester – III

Paper No.	Nomenclature	Internal Marks	External Marks	Total Marks	Time (Hours)
BT-114	Molecular Genetics	20	80	100	Three
BT-115	Plant Biotechnology	20	80	100	Three
BT-116	Microbial Biotechnology	20	80	100	Three
BT-117	Immunology	20	80	100	Three
BT-118	Lab. Course based on Plant Biotechnology & Molecular Genetics	-	70	70	Six (Two Sessions of Three Hours each)
BT-119	Lab. Course based on Microbial Biotechnology & Immunology	-	70	70	Six (Two Sessions of Three Hours each)
				Total : 540	

Semester – IV

Paper No.	Nomenclature	Internal Marks	External Marks	Total Marks	Time (Hours)
BT-120	Environmental Biotechnology	20	80	100	Three
BT-121	Animal Biotechnology	20	80	100	Three
BT-122	Lab. Course based on Environmental & Animal Biotechnology	-	70	70	Six (Two Sessions of Three Hours each)
BT-123	Project Report / Field Training Report		70	70	
BT-124	Seminar	20		20	One
				Total : 360	

Grand Total of Marks: 2000

Semester – 1

Paper BT-101 Biomolecules

Marks: 80
Internal Assessment: 20
Time: 3 hrs.

NOTE :

1. Nine questions will be set in all
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit.
3. All questions will carry equal marks.

Unit-I

Water : Structure, hydrogen bonding, as a biological solvent, ionization and fitness of the aqueous environment for living organisms; pH; Buffers; Henderson-Hasselbalch equation; Physiological buffers.

Carbohydrates : Structure, occurrence and biological importance of important monosaccharides, oligosaccharides and polysaccharides; Ring structures and anomeric forms; mutarotation; sugar derivatives; reactions of monosaccharides; Glycosaminoglycans; Heteropolysaccharides of bacterial and algal cell walls; Proteoglycans; Glycoproteins; Lectins.

Unit-II

Amino acids and Proteins : Common structural features, classification by R group, Zwitter ion structures, acid-base properties and titration curves of amino acids; Essential amino acids; Separation of amino acids; Peptides including biologically active peptides; Classification and different structural levels (Primary, secondary, tertiary & quaternary) of proteins; Ramachandran plot; Determination of amino acid composition of proteins; Characteristic amino acid composition of proteins; Determination of amino acid sequences of proteins; Effect of amino acid sequence on the function of a protein and stability of α-helix; Protein folding and role of chaperons in protein folding; Chemical synthesis of polypeptides.

Unit-III

Lipids : Classification, structures, nomenclature and properties of fatty acids; Essential fatty acids; Acylglycerols; Characterization of fats-Saponification value, iodine number, rancidity, acid value,Reichert-Meissel number; Structures and properties of different types of phospholipids and sphingolipids (sphingomyelins, cerebrosides & gangliosides); Structure and functions of prostaglandins, Prostacyclins, Thromboxanes, and Leukotrienes; Terpenes of biological significance; Sterols and bile acids.

Unit-IV

Nucleic Acids : Structure and properties of purines and pyrimidine bases; Nucleosides and Nucleotides; Biologically important nucleotides; Nucleic acids as the

genetic material – experimental evidences; Chargaff's rules; The covalent backbone of nucleic acids; Double helical model of DNA structure; Structural polymorphism of DNA (A,B and Z-DNA) and RNA; Denaturation & annealing of DNA; Biological functions of nucleotides; Chemical synthesis of oligonucleotides.

Recommended Books :

1. Lehninger: Principles of Biochemistry, 4th edition, by David L. Nelson and M.M. Cox (2005) Maxmillan/Worth publishers/W.H. Freeman & Company
2. Biochemistry (2004) by J.David Rawn, Panima Publishing Corporation, New Delhi
3. Biochemistry, 2nd edition, by R.H. Garrett and C.M. Grisham (1999). Saunders College Publishing, N.Y. Sons, NY.
4. Biochemistry, 4th edition, by L.Stryer (1995). W.H. Freeman & Co., N.Y.
5. Fundamentals of Biochemistry, 2nd ed., by Donald Voet, Judith G.Voet and Charlotte W. Pratt (2006), John Wiley & Sons, INC
6. Biochemistry: The chemical reactions of living cells, 2nd edition, by David E.Metzler (2001), Harcourt Academic Press.
7. Principles of Peptide synthesis (1984), Miklos, Bodansky, Springer-Verlag Berlin, Heidelberg

Semester – I

Paper BT-102 Microbiology

Marks: 80
Internal Assessment : 20
Time: 3 hrs.

NOTE:

1. Nine questions will be set in all
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit.
3. All questions will carry equal marks.

Unit – I

Various branches and applications of Microbiology, History and contributions of various scientists to this science with particular reference to the contribution of the following scientists- A.V.Leeuwenhoek, Louis Pasteur, Edward Jenner, Robert Koch, Alexander Fleming and Joseph Lister.
Morphology and arrangement of bacterial cells, Bacterial- flagella, Fimbriae, capsule, spores and cysts, cell walls of Gram +ve and Gram –ve bacteria, Nutritional requirements and nutritional categories of microorganisms, Physical factors for growth, Enrichment culture techniques for isolation of microorganisms, pure culture techniques and preservation techniques, study of growth curve, measurement of growth.

Unit – II

Distinguishing features of bacteria, viruses, fungi, protozoa, algae. Criteria used for characterization including molecular approaches, Classification, Nomenclature and Identification of microorganisms,taxonomy and nomenclature based upon Bergey's manual; Gram (+) and Gram (-) bacteria of medical and industrial importance (Pseudomonas, Azotobacter, Rhizobium, Agrobacterium); characteristics of Mycobacterium and Mycoplasmas; photosynthetic prokaryotes (purple bacteria, green bacteria, cyanobacteria) and actinomycetes; brief account of different types of viruses with special reference to lambda phage, herpes, adenoviruses and retroviruses, viriods and prions; fungi and algae of industrial importance.

Unit – III

Sterilization methods- dry heat, moist heat, radiations, filtration, gaseous sterilization, Validation of sterilization processes; Factors affecting antimicrobial action, Mode of action of antimicrobial agents, Antibiotics and their mode of action, Microbiological assay of antibiotics (ampicillin, streptomycin, tetracycline etc.), Disinfectants; Types of toxins and their mode of action.

Unit – IV

Microbial ecology: Biogeochemical cycles; Physical environment: Microenvironment & Niche Microorganisms and ecosystems. Soil microbiology: Types & functions of

microorganisms in soil. Microorganism associations with vascular plants (Mycorrhizae, rhizobia) Microorganism growth in goods, good spoilage & control, good born diseases.

Recommended Books :

1. Lim, D.V. (1989) Microbiology, West Publishing Company, New York.
2. Brock, T.D. (1990) Microbiology: A text book of Industrial Microbiology. 2nd edition, Sameur Association.
3. Tortora, G.J., Funke, B.R. and Case, (1996) Microbiology: An introduction, Benjamin Cummings.
4. Atlas, R.M. (1998) Microbiology: Fundamental and applications. 2nd edition, Macmillan Publishing Company, New York.
5. Pelezar, M.J., Chan, E.G.S. and Krieg, N.R. (1998) Microbiology.
6. Heritage, J., Evance, E.G.V. and Killington, R.A. (1999) Microbiology in action. Cambridge University Press.
7. Prescott, L.M., Harley, J.P. and Klein, D.A. (1999) Microbiology. W.C.B. Oxford.
8. Polasaa, H. Microbial gene technology. South Asian Publishers. New Delhi.

Semester – I

Paper BT-103 Molecular Cell Biology

Marks : 80
Internal Assessment : 20
Time : 3 hrs.

NOTE :

- Nine questions will be set in all
- Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit.
- All questions will carry equal marks.

Unit-I

Overview of cells and cell research: Origin and evolution of cells, Cells as experimental models, tools of cell biology.

Fundamentals of Molecular Biology: Heredity, Genes, and DNA, Expression of Genetic Information, Recombinant DNA, Detection of Nucleic Acids and Proteins, Gene Function in Eukaryotes

Unit-II

Nucleus: Nuclear envelope and traffic between the nucleus and cytoplasm, internal organization of the nucleus, nucleolus, nucleus during mitosis.

Protein Sorting and Transport: Endoplasmic reticulum, Golgi apparatus, and Lysosomes, mechanism of vesicular transport

Unit-III

DNA Replication: DNA polymerases, replication fork, fidelity of replication, origins and initiation of replication, replication at the ends of chromosomes.

DNA Repair: Direct reversal of DNA damage, excision repair, error-prone repair, recombinational repair.

RNA Synthesis and Processing: Prokaryotic transcription, Eukaryotic transcription: RNA polymerases and transcription factors, RNA processing and turnover,

Protein Synthesis, Processing and Regulation: Translation of mRNA, Protein folding and processing, regulation of protein function, protein degradation

Unit-IV

Cell Signaling: Signaling molecules and their receptors, functions of cell surface receptors, pathways of intracellular signal transduction, signal transduction and cytoskeleton, signaling in development and differentiation.

Cell death and cell renewal: programmed cell death, stem cells and maintenance of adult tissues. Embryonic stem cells and therapeutic cloning.

Cancer: Development and causes of cancer, tumor viruses, oncogenes, tumour suppressor genes, application of molecular biology to cancer prevention and treatment

Recommended Books

1. The Cell - A Molecular Approach, Cooper, Geoffrey M. Sunderland (MA): Sinauer Associates, Inc. ; c2000
2. Cell and Molecular Biology: Concepts and Experiments, 5th Edition, Gerald Karp : Wiley 2007
3. Essentials of Molecular Biology, David Friefilder, Jones and Barllett Publications.
4. Gene VII (7th Edition) Benjamin Lewin, Oxford University Press, U.K., 2000.
5. Molecular Biology and Biotechnology. A comprehensive desk reference, R.A. Meyers (Ed.) VCH Publishers, Inc., New York, 1995.
6. Molecular Biology LabFax, T.A. Brown (Ed.), Bios scientific Publishers Ltd., Oxford, 1991.
7. Molecular Biology of the Cell (2nd edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J.D. Watson. Garland publishing, Inc., New York, 1994.
8. Molecular Biology of the Gene (4th edition), J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitz and A .M. Weiner, The Benjamin/Cummings Publ. Co., Inc., California, 1987.
9. Molecular Cell Biology (2nd Edition) J. Darnell, H. Lodish and d. Baltimore, Scientific American Books, Inc., USA, 1994.
10. Encyclopaedia of Molecular Biology, J. Kendrew, Blackwell Scientific Publications, Oxford.

Semester – I

Paper BT-104 Biotechniques

Marks : 80
Internal Assessment : 20
Time : 3 hrs.

NOTE:

1. Nine questions will be set in all
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit.
3. All questions will carry equal marks.

Unit -I

Cell Separation, disruption, extraction and concentration techniques: Microfiltration, Centrifugation, Ultrasonication, High pressure Homogenisation, Bead Milling, Ultrafiltration, Diafiltration and their applications, reverse osmosis, Lyophilisation.

Centrifugation Methods: Principles of Sedimention, centrifugation techniques and their applications, differential centrifugation, density gradient and ultracentrifugation techniques.

Unit -II

Microscopy: Light Microscopy – Magnification, Resolving power, Numerical aperture, Limit of Resolution, Principles and applications of bright field, phase contrast, fluorescence, scanning and transmission electron microscopy.

Spectroscopy: Principles of biophysical methods used for analysis of biopolymer structure -X-ray diffraction, fluorescence, UV and visible, ORD/CD, NMR and ESR spectroscopy, Atomic absorption and Atomic emission spectroscopy.

Unit -III

Chromatography: Principles and applications of Paper, Thin layer, Gel-filtration, ion-exchange, Affinity chromatography, Gas liquid chromatography, High pressure liquid chromatography (HPLC); Reversed Phase chromatography ,Hydrophobic interaction chromatography.

Unit -1V

Electrophoresis: Concept, Factors affecting electrophoresis, Agarose gel electrophoresis, Pulse field gel electrophoresis, PAGE, SDS-PAGE, ,Isoelectrofoccusing, 2 Dimentional electrophoresis

Radioisotope Techniques: Radioactivity, Units of radioactivity, Radioactive decay, Rate of radioactive decay, Measurement of radioactivity- Geiger counter, Lequid scintillation counting, Autoradiography, Effect of radiations on biological system, Cerenkov radiations, Tracer technique-Principle and applications

Recommended Books:

1. Molecular Cloning : a Laboratory Manual, J. sambrook, E.F. Fritsch and T.Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000
2. Richard E. Venn (2003), Principal and Practice of Bioanalysis. Taylor and Francis.
3. Walker J. and Wilson K (2000), Principles and Techniques-Practical Biochemistry, 5th Edition, Cambridge University Press, London.
4. Freifelder D. (1982), Physical Biochemistry – Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freeman and Company, San Fransisco
5. Slater R.J. (1990), Radioisotopes in Biology-A Practical Approach, Oxford University Press, New York
6. Switzer R.L. and Garrity L.F. (1999), Experimental Biochemistry, W.H. Freeman and Company, New York
7. Sawhney, S.K. and Singh R (2000), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
8. Atlas R.M. (1995), Microbiology – Fundamentals and Applications, Mc Millan Press, New York
9. Upadhayaye, A ; Upadhyaye, K and Nath N. (2002), Biophysical Chemistry : Principles & Techniques, Himalaya Publication House, New Delhi.
10. David Sheehan, Physical Biochemistry; Principles and applications (2000):Wiley Press
11. Simon Roe, Protein purification techniques –A practical approach, Oxford University Press.

Semester – I

Paper BT-105 Lab. Course based on Biomolecules and Biotechniques

Marks: 70
Time : Six Hours
(Two Sessions of Three Hours each)

Biomolecules

1. Safety measures to be taken while handling Biochemicals.
2. Working of Spectrophotometer and verification of Lambert – Beer's Law.
3. Preparation of various types of solutions – Standard solution, Molal, Molar, Normal, acid solution, Buffers etc.
4. Preparation of Standard Curves for quantitative estimations.
5. Extraction and estimation of sugar from biological materials
6. Titration curve for amino acids
7. Estimation of proteins by Biuret, Lowry and Bradford method.
8. Analysis of fats/oils – iodine number, saponification value, acid value, free fatty acids.
9. Determination of various metabolites in given biological samples.
10. Quantitative estimation of DNA and RNA content in the given sample by coloured reaction.

Biotechniques

1. Paper and Thin Layer Chromatography
2. Gel Filtration Chromatography
3. Ion-exchange Chromatography
4. Affinity Chromatography
5. PAGE
6. Agarose gel electrophoresis
7. Microscopy
8. Microfiltration
9. Ultrafiltration
10. Ultrasonication
11. Lyophilisation
12. Centrifugation

Semester – I

Paper BT-106 Lab. Course based on Molecular Cell Biology & Microbiology

Marks: 70
Time : Six Hours
(Two Sessions of Three Hours each)

Molecular Cell Biology

1. Genomic DNA isolation from *E .coli* and blood.
2. RNA isolation from *E. coli*/ blood
3. Plasmid DNA isolation from *E. coli.*
4. Molecular weight determination of the DNA.
5. Spectrophotometric analysis of DNA/ RNA.
6. Determination of Tm value.
7. Plasmid purification using DNA binding membrane

Microbiology

1. Lab rules for biosafety in Microbiology lab.
2. Measurement of the growth of microbial culture.
3. Study of Thermal death point and thermal death time of microbes.
4. Isolation and enumeration of micro-organisms of air, water and soil.
5. Pure culture of micro-organisms.
6. Various staining methods – Gram staining, capsule, spore, fungal staining etc.
7. Micrometry.
8. Phage titration studies.
9. Growth curve.
10. Biochemical tests useful in bacterial taxonomy.
11. Parameters for identification of unknown micro-organisms.
12. Antibiotic sensitivity test and MIC value.
13. Evaluation of disinfectants and antiseptics/ antiseptics
14. Evaluation of sterilization methods.

Semester II
Paper BT-107 Principles of Genetic Engineering

Marks : 80
Internal Assessment : 20
Time : 3 hrs.

NOTE :

1. Nine questions will be set in all
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit.
3. All questions will carry equal marks.

Unit – I

Genetic Engineering
Introduction and scope of Genetic Engineering, Miles stones in Genetic engineering, Central role of *E.coli*.

Nucleic Acids
Purification of total cell DNA, plasmid DNA, phage DNA, Yield Analysis, , Nucleic acid blotting and hybridization

Manipulation of purified DNA
DNA modifying enzymes- Terminal deoxynucleotidyl transferase, Polynucleotide kinase, Alkaline phosphatase, Nucleases, Methylases

Restriction Endonucleases- Host controlled restriction and modification, Nomenclature, types, Recognition sequence, blunt and sticky ends, applications.

Ligases- *E. coli* and T4 DNA ligases, Linker, Adaptor, Homopolymer tailing

Gene Cloning Vectors
General features, Types of cloning vectors-
Plasmid,bacteriophage,phagemid,cosmid,artificial chromosomes (YAC, BAC, PAC)

Unit – II

Transformation of *E. coli*
Concept, Selection of transformed cells, Identification of recombinants (bacteria and phages)

Cloning of Specific Gene-
Direct selection, Identification from a gene library-genomic library, cDNA synthesis and cloning-Properties of cDNA, mRNA enrichment, cDNA library.

Methods for Clone Identification
Screening strategies- Colony and plaque hybridization, Abundancy probing, Heterologus probing, Immunological screening, Differential screening, Subtractive hybridization.

Protein-Protein interactions-Phage display, Yeast two hybrid system, Yeast three hybrid system.

Unit – III

Nucleic Acid Sequencing
DNA Sequencing: Rapid DNA sequencing techniques and strategic details of range of methodologies eg. Dideoxyribonucleotide, Chemical degadation, Automated DNA sequencing, Thermal cycle sequencing, Pyrosequencing.

Polymerase Chain Reaction
Concept, Basic PCR reaction, Factors affecting the PCR, Types of PCR (RT-PCR, Real time PCR, Allele specific PCR, Multiplex PCR) , Applications of PCR

Site Directed Mutagenesis
Oligonucleotide directed mutagenesis, PCR amplified oligonucleotide directed mutagenesis, Random mutagenesis with degenerate oligonucleotide primers / nucleotide analogs.

Unit – IV

Gene expression and Regulation studies

Primer extension, S1 mapping, RNase protection assay, Gel retardation assay, Deletion analysis, Reporter genes, DNA foot printing, Modification interference assays, HRT, HART

Manipulation of gene expression in prokaryotes
Problems with production of recombinant proteins in *E coli*
Optimizing expression of foreign genes in *E.coli*- Strong and regulatory promoters, Codon usage, Fusion proteins, Increasing protein stability and secretion, Translation expression vectors, Protease deficient host strains.

Heterologus protein production in Eukaryotes
Saccharomyces cerevisiae and *Pistia pastoris* expression systems
Bacuolovirus Insect cell expression systems
Mammalian cell expression system

Recommended Books:

1. Gene cloning and DNA analysis – An Introduction (2006) 5th edition, T.A Brown, Blackwell publisher.
2. Essential genes (2006), Benzamin Lewin, Pearson education international.
3. Genome-3 (2007) T.A Brown. Garland science, Taylor & Francis, NewYork.
4. Principles of gene manipulation and Genomics (2006) 7th edition, S.B Primose and R.M Twyman, Blackwell publishing.
5. Principles of Genetic Engineering (2009), Mousumi Debnath, pointer publisher, Jaipur.

6. Molecular Biotechnology-Principles and Applications of Recombinant DNA (2003) 3rd edition, Bernard R Glick and Jack J pasternak. ASM press, Washington.

7. Human Molecular Genetics (2004) 3rd edition, Tom Strachan & Andrew P Read, Garland science.

8. Molecular Biology of Gene (2008) 6th edition, Watson, Baker,Bell. Gann,Levine and Losick, Pearson education Inc.

9. Biotechnology-Applying the genetic Revolution (2009), Clark and Pazdernik, Academic Press

10. Molecular Cloning : A Laboratory Manual (2000), J. sambrook, E.F. Fritsch and T.Maniatis, Cold Spring Harbor Laboratory Press, New York

11. DNA Cloning : A Practical Approach (1995) , D.M. Glover and B.D. Hames, IRL Press, Oxford,
12. Genetic Engineering. An Introduction to gene analysis and exploitation in eukaryotes (1998), S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford.

Paper BT–108 Bioinformatics

Marks : 80
Internal Assessment : 20
Time : 3 hrs.

NOTE :

1. Nine questions will be set in all
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit.
3. All questions will carry equal marks.

Unit -I

Bioinformatics and Biological Databases

Bioinformatics: Introduction**,** Goal, Scope, Applications, Limitations, and New Themes

Biological Databases: Introduction**,** Types of Databases, Biological Databases, Pitfalls of Biological Databases, Information Retrieval from Biological Databases

Sequence Alignment

Pairwise Sequence Alignment: Evolutionary Basis, Sequence Homology versus Sequence Similarity, Sequence Similarity versus Sequence Identity, Methods, Scoring Matrices, Statistical Significance of Sequence Alignment

Database Similarity Searching: Unique Requirements of Database Searching, Heuristic Database Searching, Basic Local Alignment Search Tool (BLAST), FASTA, Comparison of FASTA and BLAST, Database Searching with the Smith–Waterman Method

Multiple Sequence Alignment: Scoring Function, Exhaustive Algorithms, Heuristic Algorithms, Practical Issues

Profiles and Hidden Markov Models: Position-Specific Scoring Matrices, Profiles, Markov Model and Hidden Markov Model

Protein Motifs and Domain Prediction: Identification of Motifs and Domains in Multiple Sequence Alignment, Motif and Domain Databases Using Regular Expressions, Motif and Domain Databases Using Statistical Models, Protein Family Databases, Motif Discovery in Unaligned Sequences, Sequence Logos

Unit -II

Gene and Promoter Prediction

Gene Prediction: Categories of Gene Prediction Programs, Gene Prediction in Prokaryotes, Gene Prediction in Eukaryotes

Promoter and Regulatory Element Prediction: Promoter and Regulatory Elements in Prokaryotes, Promoter and Regulatory Elements in Eukaryotes, Prediction Algorithms

Molecular Phylogenetics

Phylogenetics Basics: Molecular Evolution and Molecular Phylogenetics, Terminology, Gene Phylogeny versus Species Phylogeny, Forms of Tree Representation, Why Finding a True Tree Is Difficult, Procedure

Phylogenetic Tree Construction Methods and Programs: Distance-Based Methods, Character-Based Methods, Phylogenetic Tree Evaluation, Phylogenetic Programs

Unit -III

Structural Bioinformatics

Protein Structure Basics: Amino Acids, Peptide Formation, Dihedral Angles, Hierarchy, Secondary Structures, Tertiary Structures, Determination of Protein Three-Dimensional Structure, Protein Structure Database

Protein Structure Visualization, Comparison, and Classification: Protein Structural Visualization, Protein Structure Comparison, Protein Structure Classification

Protein Secondary Structure Prediction: Secondary Structure Prediction for Globular Proteins, Secondary Structure Prediction for Transmembrane Proteins, Coiled Coil Prediction

Protein Tertiary Structure Prediction: Methods, Homology Modeling, Threading and Fold Recognition, Ab Initio Protein Structural Prediction, CASP

RNA Structure Prediction: Introduction, Types of RNA Structures, RNA Secondary Structure Prediction Methods, Ab Initio Approach, Comparative Approach, Performance Evaluation

Unit -IV

Genomics and Proteomics

Genome Mapping, Assembly, and Comparison: Genome Mapping, Genome Sequence Assembly, Genome Annotation, Comparative Genomics

Functional Genomics: Sequence-Based Approaches, Microarray-Based Approaches, Comparison of SAGE and DNA Microarrays

Proteomics: Technology of Protein Expression Analysis, Posttranslational Modification, Protein Sorting, Protein–Protein Interactions

Recommended Books:

1. Bioinformatics for Dummies, Jean-Michel Claverie, Cedric Notredame, 2003, John Wiley & Sons
2. Bioinformatics Computing, Bryan P. Bergeron, 2002, Prentice Hall
3. Introduction to Bioinformatics, Arthur M. Lesk, 2002, Oxford University Press
4. Instant Notes in Bioinformatics, D.R. Westhead, J. H. Parish, R.M. Twyman, 2002, Bios Scientific Pub
5. Fundamental Concepts of Bioinformatics, Dan E. Krane, Michael L. Raymer, Michaeel L. Raymer, Elaine Nicpon Marieb, 2002, Benjamin/Cummings
6. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition, Andreas D. Baxevanis, B. F. Francis Ouellette, 2001, Wiley-Interscience
7. Introduction to Bioinformatics, Teresa Attwood, David Parry-Smith, 2001, Prentice Hall
8. Bioinformatics: A Primer, Charles Staben, 2001, Jones & Bartlett Pub
9. Bioinformatics: Sequence and Genome Analysis, David W. Mount, 2001, Cold Spring Harbor Laboratory Press
10. Bioinformatics: Sequence, Structure and Databanks: A Practical Approach (The Practical Approach Series, 236), Des Higgins (Editor), Willie Taylor (Editor), 2000, Oxford Univ Press

Semester - II

Paper BT-109A Animal Cell & Tissue Culture

Marks : 40
Internal Assessment : 10
Time : 3 hrs.

NOTE :

- Nine questions will be set in all
- Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit.
- All questions will carry equal marks.

Unit - 1

Animal cell and tissues culture: Historical background, development, advantages and limitations of cell & tissue culture.

Requirements of cell & tissue culture: aseptic area, incubation, preparation and sterilization, storage, specialized equipment, consumable items.

Aseptic techniques: elements of aseptic environment, sterile handling, laminar flow, standard procedure.

Culture vessels and substrates: the substrate, choice of culture vessel, treated surfaces.

Unit-II

Defined media and supplements: physicochemical properties, balanced salt solutions, complete media, role of serum and supplements, **serum free media**: advantages and disadvantages of serum and serum free media, replacement of serum, development of serum free media.

Unit-III

Primary culture: types of primary cell culture, isolation of the tissue, primary culture,
Sub-culturing of animal cells: Subculture and propagation, Criteria for subculture, Subculture of monolayer cells, growth cycle and split ratio, propagation and subculture in suspension.
Cloning and selection: dilution and suspension cloning, scaling up in suspension and monolayer, large scale production of cells using bioreactors, microcarriers and perfusion techniques.

Cell line characterization: need for characterization, authentication, cell morphology, chromosome content, DNA content, RNA and protein expression, enzyme activity, antigen markers.

Unit-IV

Production of high value therapeutics: enzymes, hormones, monoclonal antibody, cytokines, tissue plasminogen activators**.**

Applications of animal cell culture: virology, cancer research, gene therapy, drug development and cytotoxicity, animal cloning, genetic counseling, cryopreservation of cells.

Recommended Books:

1. Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD.
2. Animal Cell Culture Methods In: Methods in Cell Biology, Vol. 57, Ed. Jenni P Mather and David Barnes, Academic Press.
3. Animal Cell Culture Techniques. Ed. Martin Clynes, springer.
4. Biotechnology, Vol. 7b 1993 Rehm. H.J. and Reed, G.(eds) VCH Publications.
5. Cell Culture Lab Fax. Eds. M Butler & M. Dawson, Bios Scientific Publications Ltd. Oxford.
6. Cell Growth and Division: a Practical Approach. Ed. R. Basega, IRL Press.
7. Culture of Animal Cells, (3rd edition), R. Ian Freshney. Wiley-Liss.

Semester II

Paper BT- 109B - Plant Cell & Tissue Culture

Marks : 40
Internal Assessment : 10
Time : 3 hrs.

NOTE :

1. Nine questions will be set in all
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit.
3. All questions will carry equal marks.

Unit - I

Introduction to plant cell and tissue culture and historical perspective.

Laboratory organization, aseptic manipulations and culture media – composition, preparation and development.

Callus culture; Initiation and maintenance of suspension culture- batch and continuous culture, assessment of growth and viability; Static techniques of single cell culture. Organogenesis, somatic embryogenesis and synthetic seeds.

Unit - II

Micropropagation – technique, factors affecting *in vitro* culture of plants (physical, chemical, genotypic and others), applications and limitations of micropropagation.

Meristem, shoot tip culture and production of virus free plants.

Somaclonal variations, molecular basis of variation and their significance in plant breeding.

Unit - III

In vitro production of haploid plants – Androgenesis (anther and pollen culture) and Gynogenesis (ovary and ovule culture). Significance and uses of haploids in agriculture.

Wide hybridization and embryo rescue technique.

Unit - IV

Protoplast culture and somatic hybridization – Isolation, culture and fusion of protoplast, selection of fusion products and plant regeneration, assessment of somatic hybrid plants, production of cybrids, applications of protoplast culture and somatic hybridization in the improvement of crop plants.

In vitro germplasm conservation and cryopreservation.

Recommended Books:

1. Plant tissue culture – Theory and Practice (2005) by Bhojwani S. S. and Razdan M. K., Elsevier publication.
2. Elements of Biotechnology by P. K. Gupta, Rastogi pub.
3. Biotechnology in crop improvement (1998) by H. S. Chawla, International Book distributing company.
4. Plant cell, organ and tissue culture (1995) by Gamborg O.L. and Phillips G.C., Springer Verlag pub. Germany.
5. Plant Tissue Culture – Basic & Applied (2005) by Jha T.B. & Ghosh B., Universities press.
6. Plant cell culture – A practical approach (1994) Dixon R.A., Gonzales R.A. Oxford University press, UK.
7. Bhojwani S.S. (2003), Agrobiotechnology & Plant Tissue Culture
8. Smith R.H. (2000), Plant Tissue Culture, Academic Press
9. Evans D.A. (2003), Plant Cell Culture, Taylor & Francis

Semester -II
Paper BT-110 Enzyme Technology

Marks : 80
Internal Assessment : 20
Time : 3 hrs.

NOTE :

1. Nine questions will be set in all
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit.
3. All questions will carry equal marks.

Unit-I

History of enzymology, advantages of enzymes over chemical catalysts, Nomenclature and classification of enzymes; Determination of three dimensional structure of enzyme by X-ray crystallography and NMR spectrometry, importance of 3-D structure of an enzyme; Classification of enzyme structures, structures adopted by enzymes, principles that govern the 3-D structure adopted by enzymes; Forces for stability of 3-D structure; Denaturation and renaturation;Isoenzymes, enzyme specificity, monomeric and oligomeric enzymes, multienzyme complex, holoenzyme, apo-enzyme, cofactor, coenzyme, prosthetic group; enzyme activity unit, turn over number and specific activity, Ribozymes and Abzymes – A brief account.

Unit -II

Enzyme action; effect of enzyme on the rate and equilibrium of a reaction; principles that explain catalytic power and substrate specificity of enzymes; enzyme substrate complex, factors responsible for catalytic efficiency of enzyme; proximity and orientation effect, acid-base catalysis, covalent catalysis, strain and distortion theory; Nature of active site, identification of functional groups at active sites; regulatory enzymes- covalently modulated enzymes, allosteric enzymes and their mode of action; regulation of enzyme activity in the living system.

Unit -III

An introduction to enzyme kinetics and its importance, Methods used for investigating the kinetics of enzyme catalyzed reactions; factors affecting the velocity of enzyme catalysed reaction; Michaelis-Menten equation, Vmax, Km and its significance; Lineweaver Burk plot- its advantages and limitations, Eadie- Hofstee and Hanes plots; enzyme inhibition, types of enzyme inhibitions- competitive, uncompetitive, noncompetitive, mixed type inhibition and determination of Ki, feed-back inhibition; Bisubstrate reactions- brief introduction to sequential and pingpong mechanism with examples.

Unit -IV

Strategies used for enzyme production, isolation and purification, method of calculating the purification fold; estimation of enzyme activity; characterization of an enzyme, criteria of enzyme purity, determination of the molecular weight (Mr) and

the number of sub-units of an enzyme; enzyme immobilization and its importance; protein engineering; enzyme therapy, enzyme inhibitors and drug design; enzymes as biosensors, enzyme reactors; Applications of enzymes in medicine, textile, leather, detergent, paper, bakery, dairy industry, beverage and fruit processing, food processing and preservation, clinical applications of enzyme estimation.

Recommended Books:

1. Segal, L.H (1975). Enzyme Kinetics, Wiley Interscience, USA
2. Walsh, C (1979). Enzymatic reaction mechanism, Freeman and Company, USA.
3. Gerhartz, W (1990) Enzyme in Industry, production and application VCH.
4. Shultz, A.R. (1994) Enzyme Kinetics, Cambridge Press.
5. Fresht (1995) Enzyme structure and mechanism, 2nd edition, Freeman and Company.
6. Trevor, P. (1995) Understanding Enzymes, 4th edition, Prentice Hall/Ellis, Harwood, England.
7. Dixon, M and Webb E.C (1997) Enzymes, 3rd edition, Academic Press, New York.
8. Nicholas C. Price and Lewis Stevens (2001) Fundamentals of Enzymology. 3rd edition.

Semester -II

Paper-BT-111 Lab. Course based on Genetic Engineering and Bioinformatics

Marks: 70
Time : Six Hours
(Two Sessions of Three Hours each)

Genetic Engineering

1. Restriction Digestion of DNA
2. Ligation of DNA fragments
3. Preparation of competent cells, Bacterial transformation
4. PCR
5. Gene cloning in plasmid vector
6. Gene expression in *E. coli* and analysis of gene product

Bioinformatics

7. Detailed study of NCBI Homepage.
8. To perform BLAST for Nucleotide Sequence
9. To perform virtual library via NCBI
10. To perform BLAST for a protein sequence
11. To perform multiple sequence alignment via CLUSTAL
12. To perform phylogenetic analysis
13. To display PDB structure using Rasmol
14. Comparative study of the two formats: Gene Bank/ Genepept and FASTA
15. Analysis of Prosite pattern

Semester – II

Paper BT-112 Lab. Course based on Cell & Tissue Culture and Enzyme Technology

Marks: 70
Time : Six Hours
(Two Sessions of Three Hours each)

Animal Cell & Tissue Culture

1. Components of an animal cell culture lab
2. Aseptic techniques used in animal cell culture
3. Isolation and culturing of animal cells from primary tissue explant
4. Sub-culturing of monolayer confluent cells
5. Counting of animal cells using hemocytometer
6. Staining of monolayer confluent cells using geimsa and crystal violet
7. To discriminate between viable and non viable cells using trypan blue
8. Animal cell cloning in microtitvation plates.

Plant Cell & Tissue Culture

1. To study the laboratory organization and aseptic manipulations in PTC lab.
2. Preparation of Murashige and Skoog medium, stocks of macronutrients, micronutrients, vitamins and hormones, autoclaving, filter sterilization of hormones and antibiotics.
3. Surface-sterilization of seeds, establishment of axenic plants, acclimatization of tissue culture plants and establishment in pots.
4. Callus induction using various explants.
5. Regeneration of shoots, root induction, role of hormones in morphogenesis.
6. Anther culture
7. Protoplast isolation and culture
8. Initiation and maintenance of cell suspension cultures of plant cells
9. Development of synthetic seeds
10. To study development of S.E.

Enzyme Technology

1. To estimate the quantity of protein by UV-absorption method
2. To estimate the activity of amylase enzyme in serum/urine, saliva
3. Assaying of alkaline phosphatase activity
4. Study of enzyme kinetics

a. Time course of enzyme catalysed reaction
b. Effect of substrate concerntration on the activity of enzyme
c. To determine the Km and Vmax of the reaction
d. Effect of enzyme concentration
e. Temperature optima for the enzyme
f. pH optima for the enzyme

5. Partial purification of enzyme by change of pH, temperature, addition of organic solvents and ammonium sulphate fractionation and to determine the specific activity of the enzyme
6. Purification of enzyme by Adsorption/Affinity/Ion exchange/gel-filtration chromatography and to determine the specific activity of the enzyme
7. Immobilization of the enzyme

Semester - III
Paper BT-114 Molecular Genetics

Marks : 80
Internal Assessment : 20
Time : 3 hrs.

NOTE :

1. Nine questions will be set in all
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit.
3. All questions will carry equal marks.

Unit – I

Eukaryotic Genome Structure and Organization

Packaging of DNA into chromosomes, Special features of metaphase chromosomes, Chromosome banding, Genome size and complexity, Gene organization, Multigene families, Pseudo genes, Repetitive DNA, Chromatin domains, Chromatin modifications

The Mutability of DNA

An overview of mutation and polymorphism, VNTR polymorphism, Hot spots, DNA damage- spontaneous, Induced (Alkylation, oxidation, radiation), Genotoxicity/ mutagenicity test systems (Ames test, Sister chromatid exchanges, Micronucleus, Comet assay), Signature Tagged Mutagenesis (STM), Gene trap vector, Gene conversion.

Unit – II

Transcription Regulation in Prokaryotes

Positive and negative control of transcription, Repression and activation, Organization and regulation of Lac, Trp and Ara operon in *E. coli.,* Organization of genome in lambda phage, Regulation of lytic cascade, Antitermination, Repressor proteins, Establishment of lysogeny, Balance between lysogeny and lytic cycle.

Transcription Regulation in Eukaryotes

Eukaryotic activators, DNA binding domains, Transcriptional repressors, Signal transduction and control of transcriptional regulators, Gene silencing, Epigenetic gene regulation

Regulatory RNAs

Riboswitches, Interfering RNA (RNAi) and gene expression, Short interfering RNA (si RNA) and its fuctions, Micro RNA and its fuctions, Antisense RNA and gene expression

Unit – III

Site-Specific Recombination and Transposition

Concept, Recombinases and their function, cre-lox recombination, Biological role of site specific recombination, Classes of transposable elements-DNA transposons, Virus like transposons, Non viral retro transposons, Mechanism of DNA and RNA mediated transposition

Genome Mapping

Shot gun approach, Clone contig approach, DNA markers for genetic mapping, RFLP, SSP, SNPs, Physical mapping-Restriction mapping, Florescent *in situ* hybridization (FISH), Sequence tagged sites (STS) mapping

Unit – IV

Genome Sequencing

High throughput sequencing, Clone by clone approach, whole genome shot gun sequencing

Comparative Genomics

Concept, Comparative genomics of eukaryotes and its role in evolution.

Transcriptome Analysis

Transcriptome, Rapid Amplification of cDNA ends (RACE), SAGE, DNA microarrays

Recommended Books:

1. Essential genes (2006), Benzamin Lewin, Pearson education international.
2. Genome-3 (2007), T.A Brown Garland science, Taylor & Francis, NewYork.
3. Principles of gene manipulation and Genomics (2006) 7th edition, S.B Primose and R.M Twyman, Blackwell publishing.
4. Molecular biotechnology-Principles and Applications of Recombinant DNA (2003) 3rd edition, Bernard R Glick and Jack J pasternak, ASM press, Washington.
5. Human Molecular Genetics (2004) 3rd edition, Tom Strachan & Andrew P Read, Garland science.
6. Molecular Biology of Gene (2008,) 6th edition, Watson, Baker *etal*, Levine and Losick, Pearson education Inc.
7. Principles of Genetics (2005), 8th Edition,Gardener *et.al,* John Wiley, New York.
8. Essential Genetics – A Genomic Perspective (2002) 3rd Edition, Hartl & Jones, Jones and Bartlett.
9. Genetics: Conceptual approach (2003), Benjamin A.P, W.H. Freeman & Company, New York.
10. Gene IX (2009) Lewin B, Jones and Bartlett.
11. Biotechnology-Applying the genetic Revolution (2009), Clark and Pazdernik, Academic Press
12. Principles of Genetics (2006), 4th edition, Snustad and Simmons, Wiley

Semester - III

Paper BT-115 Plant Biotechnology

Marks : 80
Internal Assessment : 20
Time : 3 hrs.

NOTE :

1. Nine questions will be set in all
2. Question No. 1, which will be short answer type coveringthe entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit.
3. All questions will carry equal marks.

Unit - I

Plant genetic transformation:

Organization of plant genome – Nuclear genome, Chloroplast genome and mitochondrial genome. Transposon and T – DNA tagging.

Chloroplast transformation – vector designing, method and advantages

Agrobacterium mediated transformation – Ti and Ri plasmids, role of virulence genes, mechanism of T-DNA transfer, vectors based on Ti and Ri plasmids – cointegrate and binary vectors, technique and factors affecting *Agrobacterium* mediated transformation of plants.

Direct gene transfer – particle bombardment, PEG-mediated, electroporation, microinjection and alternative methods.

Screenable and selectable markers, molecular characterization of transformants.

Marker free methodologies, methods for multiple gene transfer in plants.

Gene silencing in transgenic plants.

Unit - II

Strategies for introducing biotic and abiotic stress resistance/tolerance:

Viral resistance; Fungal resistance; Insect resistance; Herbicide resistance; Various abiotic stresses (like drought, salinity, temperature and flooding).

Genetic engineering of plants for molecular farming/pharming:

Production of medically related proteins in plants, nutritional enhancement of plants (carbohydrates, seed storage proteins, vitamins), manipulation of flower colors and other value addition compounds (like industrial enzymes).

Unit - III

Plant cells as biofactories for the production of secondary metabolites:

Production of useful secondary metabolites through plant cell cultures;

Strategies used for high yield of product – development and selection of high yielding cell line cultures, optimization of factors affecting yield of plant cells (physical culture conditions, media and other biochemicals), bioreactors and immobilized plant cell culture, biotransformation, permeabilization of cells and removal of secreted products.

Unit - IV

Intellectual Property Rights, Biosafety and Ethical Issues – Intellectual property rights (IPR); Patents, trade secrets, copyright, trademarks; Plant genetic resources; GATT & TRIPPS; Patenting of biological material; Patenting of transgenic organisms

and genes; Plant breeders rights (PBRs) and farmers rights; Concerns about GM crops – environmental, biosafety and ethics**.**

Recommended Books:

1. Plant Genetic Engineering Vol. 1 - 6 (2003) Singh R. P and Jaiwal P. K. (Eds.), Sci tech publishing LLC, USA.
2. Elements of Biotechnology by P. K. Gupta, Rastogi pub.
3. Biotechnology in crop improvement (1998) by H. S. Chawla, International Book distributing company.
4. Gene transfer to plants by Potrykus I. and Spangenberg G., Springer Verlag, Germany.
5. Plant tissue culture – Theory and Practice (2005) by Bhojwani S. S. and Razdan M. K., Elsevier publication.
6. Plant biotechnology (2000) by Hammond J, McGarvey P. and Yusibov V. (Eds.) Springer verlag, Germany.
7. Plant gene isolation – Principles and practice (1996) by Foster G.D. and Twell D., John Wiley & Sons, USA.
8. Plant Biotechnology – The genetic manipulation of plants (2003) by Slater A., Scott N. and Fowler M., Oxford pub.
9. Practical application of Plant Molecular Biology (1997) by Henry R.J., Chapman and Hall.
10. Plants, genes and agriculture (1994) by Chrispeels M.J., Sadava D.E, Jones & Bartlett pub., UK.

Semester - III
Paper BT-116 Microbial Biotechnology

Marks : 80
Internal Assessment : 20
Time : 3 hrs.

NOTE :

- Nine questions will be set in all
- Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit.
- All questions will carry equal marks.

Unit – I

Microbial Biotechnology: Scopes application and challenges. Isolation preservation and improvement of industrially important microorganisms. Kinetics of microbial growth and product formation. Fermentation system; batch and continuous system, fed batch system, multistage system. Solid state fermentation. Overproduction of primary and secondary metabolites.

Unit – II

Fermentation raw materials: Media for industrial fermentations; criteria used in media formulation. Fermenter/bioreactor design and operation; types of fermentor, stirred tank reactor, bubble column reactor, airlift reactor, packed bed reactor, fluidized bed reactor and trickle bed reactor, agitation and aeration in a reactor, mass transfer. Foam formation and control.

Unit - III

Industrial production of alcohol (ethanol, wine and beer) and improvement by genetic engineering. Microbial production of acids (citric, acetic and gluconic acid) solvents (glycerol acetone and butanol) aminoacids (lysine and glutamic acid).Production of antibiotics ; Penicillin and cephalosporin.

Unit – IV

Microbial polysaccharides: fermentative production of xanthan gums,. Bacterial bioplastics, genetic engineering of microorganisms for the production of poly-3 hydroxyalkanoates.
Microbial inoculants: Food starter cultures; baker's yeast, starter cultures for the dairy industry, meat starter cultures
Biomass production: single cell protein (SCP) production; microbial inoculants; Microbial transformation of steroids and sterols.

Recommended Books :

1. Stansbury P.F. et al. (1997), Principles of Fermentation Technology, Pergmon Press Oxford.
2. Ward O.P., (1998), Fermentation Biotechnology – Principles, Process and Products. Prentice Hall Publishing, New Jersey.
3. Rehm H.J. Reed G.B. Punler A and Stadler (1993), Biotechnology, Vol. 1-8, VCH Publication.
4. Prescolt and Dunn (1992), Industrial Microbiology, 4th Edition CBS Publication, New York.
5. Arnold I. Demain and Julian E. Davies (1999), Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press, Washington D.C.
6. Glazer and Nikaido (1998) Microbial Biotechnology By WH Freeman & Company, New York.
7. Cruger and Cruger (2002), Biotechnology – A Textbook of Industrial Microbiology, 2nd Edition, Panima Publishing Corporation, New Delhi.

Semester - III

Paper BT-117 Immunology

Marks : 80
Internal Assessment : 20
Time : 3 hrs.

NOTE :

- Nine questions will be set in all
- Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit.
- All questions will carry equal marks.

Unit - I

Introduction and overview

Introduction and overview of immunology, cells of immune system, innate and cellular immunity, physical and chemical barriers, cellular defenses, inflammation, receptors involved in innate immune system, cells and organs involved in adaptive immune response, fate of antigen after penetration, interrelationship between innate and acquired immunity.

Unit – II

Antigens, antibodies and their interactions

Requirements of immunogenicity, primary and secondary responses, major classes of antigens, basic structure of antibodies, antibody classes and biological activity, antigenic determinants on immunoglobulins, immunoglobulin super family, organization and expression of immunoglobulin genes, antigen-antibody interactions: immunoprecipitation, agglutination, ELISA, immunofluorescence, flow cytometry

Unit - III

Generation of B- cell and T- cell responses

Biology of B lymphhocytes: introduction, ontogeny, B cell membrane proteins, signal transduction molecules associated with membrane immunoglobulins, *biology of T-cells:* antigen specific T cell receptors, T cell differentiation, thymic selection, role of major histocompatibility complex in immune response, activation and function of T and B cells, cytokines, complement system.

Unit - IV

Immune system in health and disease

Hybridoma technology: commercial production of antibodies using monoclonal antibodies. *Vaccines:* live attenuated, killed, subunit, conjugate and DNA vaccines. Production of recombinant antibodies and edible vaccines, development of diagnostics and immunoprophylactics using biotech and nanotech tools

Recommended Books:

1. Benjamin E. (1996), Immunology – A short course 3rd Edition, John Wiley, New York
2. Kuby J. (1997), Immunology, 3rd Edition, W.H. Freeman & Co., New York
3. Roitt, I.M. (1997), Essential Immunology, 9th Edition, Oxford Black Well Science, London
4. Tizard I.R. (1995), Immunology – An introduction, 4th Edition, Philadephia Sauders College press.
5. Gupta P.K. (2003), Biotechnology and Genomics, Rastogi Publications Meerut
6. Anant Narayan, Text Book of Immunology,
7. Pommerville et al (2004), Alcamo's Fundamentals of Microbiology, Jones and Barteett Publishers.

Semester III

Paper BT-118 Lab. Course based on Plant Biotechnology & Molecular Genetics

Marks: 70

Time : Six Hours

(Two Sessions of Three Hours each)

Molecular Genetics

1. Spontaneous and induced mutations
2. SNP Detection
3. Lymphocyte culturing for chromosome preparation, chromosome banding techniques.
4. Genotoxicity assays – Ames test, Micronuclei, Comet assay, Sister chromatid exchanges etc.
5. DNA fingerprinting technique

Plant Biotechnology

1. Selection system for transformants
2. Agrobacterium mediated transformation
3. Reporter gene (GUS) assay.
4. Isolation of Plant genomic DNA from the leaves tissue
5. Isolation of plasmid vector from *Agrobacterium*
6. Restriction digestion of plant genomic DNA
7. Transgene detection by amplification
8. Southern blotting of DNA
9. Secondary metabolites isolation from plant tissues**.**

Semester-III

Paper BT-119 Lab. Course based on Microbial Biotechnology & Immunology

Marks: 70

Time : Six Hours

(Two Sessions of Three Hours each)

Microbial Biotechnology

1. Working of fermenter, Fermentation
2. Production of wine, beer, ethanol
3. Isolation of industrially important micro-organisms
4. Screening for lignocellulolytic and pectinolytic micro-organisms
5. Isolation of protease/lipase/amylase producing micro-organisms
6. Isolation of keratinase producing micro-organisms
7. Production of xylanase/Cellualse/Pectinase by microbes and activity estimation

Immunology

1. To perform immunodiffusion by Mancini and Ouchterlony method.(single or double) immunodiffusion
2. To perform immunoelectrophoresis with a given antigen-antibody system
3. To perform Enzyme-linked Immunosorbent assay (Antibody capture and DOT ELISA)
4. To perform latex agglutination and Antibody conjugation
5. Detection of B gal in transfected cells
6. Antibody labeling
7. Isolation of a polyclonal antibody using salt precipitation and affinity chromatography
8. Production and isolation of a monoclonal antibody

Semester – IV
Paper BT-120 Environmental Biotechnology

Marks : 80
Internal Assessment : 20
Time : 3 hrs.

NOTE:

- Nine questions will be set in all
- Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit.
- All questions will carry equal marks.

Unit – I

Environmental Biotechnology : An overview, concept, scope and market Biological control of air pollution.
Bacterial examination of water for potability.
Testing of water for physiochemical parameters including BOD & COD.
Solid waste : Sources and management (composting, wormicomposting and methane production).

Unit – II

Waste water : origin, composition and treatment. Physical, chemical and biological treatment of waste water. Aerobic processes : activated sludge, oxidation ponds, trickling filter towers, and rotating discs. Anaerobic processes: anaerobic digesters, anaerobic filters and upflow sludge blanket reactors. Microbiology and biochemistry of aerobic and anaerobic waste water treatment processes.
Treatment of industrial effluents: distillery effluent, paper and pulp mill effluent, tannary effluent, textile dye effluent, removal of heavy metals from waste waters.

Unit – III

Bioremediation : Bioremediation of fuel oils and lubricants in soil and water. Degradation of sulphur compounds present in coal and petroleum. Microbial degradation of xenobiotics, genetic engineering of biodegradation pathways.

Environmental Monitoring: Biosensors for environalmenal applications, BOD sensor, ammonia sensor, Nitrite sensor and sulphite ion sensor. Indicator organisms: Safety indicators and Quality indicators

Unit – IV

Microbial Insecticides : Bacteria, fugi and viruses. Use of R-DNA technology to enhance the efficacy microbial insecticides.
Biofertilizers
Microbes in oil recovery and bioleaching.
Biodeterioration of stored plant food materials, leather, wool, metals, textiles, stone & related building. Control of microbial bideterioration.

Recommended Books:

1. Environmental Chemistry. A.K. De, Wiley Eastern Ltd., New Delhi.
2. Introduction to Biodeterioration. D. Allsopp and K.J. Seal, ELBS/Edward Arnold.
3. Environmental Biotechnology. Agarwal S. K. (1998), APH Publishing Corporation, New Delhi.
4. Bioremediation Protocols. David S. (1997), Humana Press, New Jersey.
5. Environmental Science and Technology. Stankey E.M. (1997), Lewis Publishers, New York.
6. Microbial Biotechnology. Glazer and Nikaido (1998), WH Freeman & Company, New York.
7. Biodegradation and Bioremediation: Soil Biology. Singh A. and Ward O.P. (2004), Springer

Semester - IV
Paper BT-121 Animal Biotechnology

Marks : 80
Internal Assessment : 20
Time : 3 hrs.

NOTE:

1. Nine questions will be set in all
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit-wise with two questions from each unit. The candidates will be required to attempt Question No. 1 and four others selecting one question from each unit.
3. All questions will carry equal marks.

Unit -I

Animal Biotechnology- Scope, global perspective and new horizons, Historical perspective, and economically important livestock breeds, Model animals in animal biotechnology and genetic engineering.

Somatic Cell Genetics: Production of hybrid cells, Properties of hybrids, Applications hybrid cells,

Unit -II

Gene Transfer into Animal Cells: DNA transfer techniques into mammalian cells: calcium phosphate precipitation, DEAE-dextran procedure, polycation DMSO, microinjection, electroporation; Selectable markers, viral vectors for gene transfer into mammalian cells: SV40, adenovirus, vaccinia, bovine papiloma virus, baculovirus, retrovirus.

Transgenic animals: Transgenic mice: Methodology and applications; Transgenic cattle, Livestock transgenesis- production of drugs using animals

Unit -III

Biotechnology in livestock assisted reproduction, biodiversity and conservation: Biotechnology in conservation of livestock diversity, Superovulation, Embryo biotechnology- Embryo collection, evaluation, and transfer, IVF and *in vitro* embryo production, Cryobanking of germplasm, oocytes and sperm, Somatic cell nuclear transfer, Stem cells technology in livestock

Unit-IV

Animal cloning: Concepts of animal cloning, Principles and techniques of cloning, Applications of animal cloning.

Animal genomics: crucial role for health and biomedical sciences. Models used in animal genomics. Functional genomics and livestock traits assessment, Livestock in the post genomic era of biology and medicine

Recommended Books:

1. Animal Cell Biotechnology, Vol. 1-6 Spier, R.E. and Griffiths, J.B. (eds), Academic Press.
2. Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD.

3. Animal Cell Culture Methods In: Methods in Cell Biology, Vol. 57, Ed. Jenni P Mather and David Barnes, Academic Press.
4. Biotechnology, Vol. 7b 1993 Rehm. H.J. and Reed, G.(eds) VCH Publications.
5. Comprehensive Biotechnology. Vol. **I,** Murray Moo-Young (ed.) 1985, Academic Press, USA
6. Culture of Animal Cells, (3rdedition), R. Ian Freshney. Wiley-Liss.
7. Genetic engineering: An introduction to gene analysis and exploitation in eukaryotes Kingsman, S.M. and Kingsman, AJ. 1988. Blackwell scientific Publ. U.K.
8. Molecular Biotechnology: Principles and Applications of Recombinant DNA 2nd Ed. 1998. Glick, B.R. and Pasternak, J.J., ASM Press, USA.
9. Molecular Genetics 2 Strachan, Tom and Read, Andrew P. New York and London: Garland Science,1999

Semester - IV

Paper BT-122 Lab. Course based on Environmental & Animal Biotechnology

Marks: 70

Time : Six Hours

(Two Sessions of Three Hours each)

Environmental Biotechnology

1. To determine TDS, DO, COD, BOD of given water sample
2. Total bacterial population of given samples of water by standard plate count technique (SPC)
3. To check the potability of given water sample
4. To check the presence of coliform in given water sample by Multiple- tube fermentation test or most probable number test (Presumptive, confirmed and completed test)
5. To check the presence of coliforms using membrane filter method
6. To check the presence of faecal and non- faecal coliforms in the given water sample and confirmation of faecal coliforms
7. To determine the quality of given milk sample
8. Isolation and immobilization of dye-degrading microbes

Animal Biotechnology

1. To check the cytotoxicity in the cultured animal cells
2. Detection of mycoplasma, bacteria and fungi in cell cultures
3. Characterization of animal cells using intracellular and cell surface markers
4. Animal cell cloning using dilution and suspension method
5. Culturing of hematopoietic stem cells from blood
6. Apoptosis and proliferation assay of cells
7. Culturing of amniotic fluid cells/ amniocytes
8. Cryopreservation of animal cells
9. FISH in analysis of genes and chromosomes