

UNJABI UNIVERSITY, PATIALA

**ORDINANCES
AND
OUTLINES OF TESTS,
SYLLABI AND COURSES OF READING
FOR
M.Sc. BIOTECHNOLOGY PART-I
(SEMESTER I & II)
FOR
20011-12 & 2012-13 SESSIONS**

**PUBLICATION BUREAU
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Price : 00-00
(Excluding Postage)

SYLLABUS

M.Sc. (BIOTECHNOLOGY) PART-I (Semester I & II) 20011-12 & 2012-13 SESSIONS

The course will consist of two semesters in the second year i.e. Semester I and II. In each semester there shall be four theory papers and one practical paper. Each theory paper shall have 4 hours teaching and 3 practical hours per week. The students shall undertake the in-plant training of 6-8 weeks at various Industries/Institutions/R & D Centre etc. after completion of theory and practical examination of II.

Each theory paper shall be of 100 marks of which 80 marks shall be allocated to the Theory Paper set by external examiner. The internal assessment in each paper shall have 20 marks. There shall be one assignments of 5 marks, one test of 10 marks (best of two shall be taken) and 5 marks for seminar.

The awards of internal assessment shall be dispatched by the Head of the Department before the commencement of semester examinations. The Seminars will be allotted to all the students from the respective syllabi of theory papers in such a way that each student could be assessed by the teacher of the subject.

The subjects and distribution of marks shall be as under :

SEMESTER-I

THEORY PAPERS

Paper-I	Principles of Biochemistry	100 marks
Paper-II	Molecular Genetics and Functional Genomics	100 marks
Paper-III	General Microbiology	100 marks
Paper-IV	Immunology and Immuno-technology	100 marks

PRACTICAL PAPERS

Practical Paper-I	Pertaining to Theory Paper I and II	100 marks
Practical Paper-II	Pertaining to Theory Paper III and IV	100 marks

SEMESTER-II

THEORY PAPERS

Paper-V	Genetic Engineering	100 marks
Paper-VI	Molecular Biophysics and Modelling Functional Genomics	100 marks
Paper-VII	Bioprocess and Biochemical Engineering	100 marks
Paper-VIII	Fermentation Technology	100 marks

PRACTICAL PAPERS

Practical Paper-III	Pertaining to Theory Paper V and VI	100 marks
Practical Paper-IV	Pertaining to Theory Paper VII and VIII	100 marks

The marks of M.Sc. I shall be as under :

Semester-I

Theory papers	400 marks
Practical papers	200 marks

Semester-II

Theory papers	400 marks
Practical papers	200 marks

Total **1200 marks**

SEMESTER-I**PAPER-I : PRINCIPLES OF BIOCHEMISTRY (BT)**

Maximum Marks : 80

Time Allowed : 3 Hours

(Theory & Practical separately)

Lectures to be delivered : 60

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of five sections A, B, C, D and E. Section A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section E consists of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all.

INSTRUCTIONS FOR THE CANDIDATES

1. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire Section E.
2. The use of scientific calculators is allowed.

SECTION-A

1. **Introduction to bio-molecules** : biological properties of water, pH, ionization, biological buffers, titration of amino acids, amino acids, proteins and their three dimensional structure, weak and strong interactions, hydrophobic interactions.
2. **Structure and function of carbohydrates** : monosaccharides, disaccharides, polysaccharides, homopolysaccharides (starch, cellulose, chitin), heteropolysaccharides, mucopolysaccharides. Structure and function of nucleic acids : purines, pyrimidines, nucleosides, nucleotides, inter nucleotide bonding, tautomerism.
3. Structure and function of lipids, neutral lipids, phospholipids, isoprenoids, phosphatidyl inositol (intracellular messenger), biological effectors.

SECTION-B

4. **Vitamins** : water soluble and fat soluble, hormones, their structure and functions.
5. **Enzyme** : general properties of enzymes and coenzymes, their nature, classification and nomenclature of enzymes, fundamentals of steady state kinetics, enzyme inhibition, isozymes.
6. **Biological membrane and cell wall** : properties of lipid aggregates, micelles, liposomes, structure and properties, membrane proteins and their function, fluid mosaic model, membrane mediated transport, membrane equilibrium and permeability, chemical, physical composition and biosynthesis of cell wall components.

SECTION-C

7. **Carbohydrate metabolism** : glycolysis, biochemistry of alcohol and lactic acid fermentation, citric acid cycle, pentose phosphate pathway, EDP pathway, disaccharide and polysaccharide metabolism, gluconeogenesis, regulation of carbohydrate metabolism.
8. **Oxidative phosphorylation/respiration** : electron transport chain, photorespiration, microsomal electron transport.

9. **Biochemistry of lipid metabolism** : biosynthesis and catabolism of fatty acids, neutral lipids, phospholipids and cholesterol, glycolate cycle, regulation of fatty acid metabolism.

SECTION-D

10. **Amino acid metabolism** : biosynthetic families of amino acids, ammonia ion assimilation into amino acid by Glu and Gln, regulation of amino acid synthesis.
Degradation of amino acids : oxidative deamination of glutamate, carbon atom degradation, amino acid as major metabolic intermediates, C₃, C₄ and C₅ families, amino acid degradation to succinyl CoA, Leucine, phenyl alanine and tyrosine degradation, Urea cycle, nitrogen fixation and nitrogenase complex.
11. **Nucleotide metabolism** : Purine and Pyrimidine nucleotide Biosynthesis, synthesis of deoxyribonucleotides, degradation of purines, regulation of nucleotide metabolism.
12. **Photosynthesis** : photosynthetic pigments, cyclic and non-cyclic electron flow, oxygen evolution system, Calvin cycle, C₃ and C₄, mode of photosynthesis.

RECOMMENDED READING

1. *Biochemistry* by Voet, D. and J.G. Voet, John Wiley and Co., 1990.
2. *Lehninger Principles of Biochemistry*, Third Edition, David L. Nelson and Michael M. Cox, Printed in India by Repipo Press Pvt. Ltd., New Delhi for Macmillan Press Worth Publishers, 2000.
3. *Biochemistry* by Stryer, L., CBS Publishers and Distribution, New Delhi, 1995.
4. *Catherine Desktop Molecular Modellar* by James M.C. Carbbe, John R. Abbey and Oxford Univeristy Press.
5. *Fundamentals of Nitrogen Fixation* by Postage J.R. Cambridge University Press, Oxfords, 1982.
6. *Harperls Review of Biochemistry*, Martin, D.W.P.A. Mayes, V.W. Rodwell and D.K. Grammer, Lange Medical Publication Marugen Co. Ltd. 1990.
7. *Introduction of Plant Biochemistry* by Goodwin T. W. and E.I. Mercer, Pergamon Press, Oxford, 1983.
8. *Biochemistry – An Introductio* by Qurrand, M.L.A.I. James, Lipid., Chapman and Hall Ltd., London, 1980.
9. *Outlines of Biochemistry* by Conn E.E. and P.K. Stump, Wiley Eastern Ltd., New Delhi, 1989.
10. *Physical Chemistry with application to Biological System* by Chang R. Macmillian Publishers, 1981.
11. *Protein Engineering and Design* by Paul, R. Carey, Academic Press Inc, 1996.
12. *Text Book of Biophysical Chemistry* (Vol. 2 and 3) by Cantor, A.W.H. Greeman and Co., 1980.
13. *Principles of Biochemistry*, Harter, H.R. 2002.

PAPER–II : MOLECULAR GENETICS AND FUNCTIONAL GENOMICS

Maximum Marks : 80

Time Allowed : 3 Hours

(Theory & Practical separately)

Lectures to be delivered : 60

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of five sections A, B, C, D and E. Section A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section E consists of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all.

INSTRUCTIONS FOR THE CANDIDATES

1. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire Section E.
2. The use of scientific calculators is allowed.

SECTION-A

1. **Genetic material and Genomes** : Genome size, gene density and ultrastructure of chromosome in prokaryotes and eukaryotes; DNA supercoiling and topoisomerases, repetitive DNA, transposons.
2. **Molecular tools and techniques** : Electrophoresis, IEF, PFGE, DNA sequencing, PCR, Southern, Northern, Western and Dot blotting; DNA probes, DNA fingerprinting, DNA foot printing, RFLP, ribozymes, antisense RNA/DNA : DNA denaturation/hybridization : cot/rot curves.
3. **DNA replication** : Unit of replication, enzymes involved, replication origin, initiation, elongation and termination, extrachromosomal replicons, reverse transcription. DNA Repair mechanisms; Recombination : Homologous and site specific recombination.

SECTION-B

4. **Transcription** : Process in prokaryotes and eukaryotes, Post, transcriptional, modifications. Transcription inhibitors.
5. **Translation** : Genetic code, protein biosynthesis in prokaryotes and eukaryotes : initiation, elongation and termination, inhibitors of translation; co-translational and post-translational modifications; protein localization protein secretion.
6. **Gene Regulations in prokaryotes** : Operon hypothesis e.g. Lac, Ara, Trp, Hut operons, negative, positive and compound control; stringent response, quorum sensing, Gene regulation in eukaryotes : cell cycle and growth regulation : signal transduction. Growth factors, growth factor receptors apoptosis; genomic imprinting and its consequences, gradient and cascade in development of plants and animals. Role of chromatin in regulating gene expression and gene silencing. Cancer genetics : oncogenes, suppressor genes.

SECTION-C

7. **Genome organization** : bacteriophage genomes : ϕ X174, M13, Mu, T4, HIV and lambda; extra nuclear DNA : plasmids, mitochondrial and chloroplast genomes.
8. **Genome, mapping technologies** : Genetic Mapping : Linkage analysis. Physical mapping : restriction mapping FISH; STS mapping : DNA sequencing, chain termination, chemical degradation, pyrosequencing. Sequence, assembly : shotgun, approach, contig approach, chromosome walking, EST sequencing, RAPD, ribotyping.
9. **Proteome analysis** : 2DGE, DGGE, flow cytometry. MS, MALDI-TOF.

SECTION-D

10. **Functional genomics techniques** : Flow cytometry, SAGE, SADE, Microarrays: DNA, Protein; Gene function analysis : Gene homology analysis. Comparative genomics : Gene evolution, exon shuffling; Genome annotation : Functional domain, gene ontology, Molecular phylogenetics. Gene Knockout : insertional Mutagenesis, iRNA.
11. **Genome environment interaction** : Heat shock, and oxidative stress response; pharmacogenomics pharmacodynamics, pharmacokinetics and pharmacotoxicology, pharmacogenetic polymorphisms e.g. MDR.
12. Application of genomics and proteomics in biotechnology.

RECOMMENDED READING

1. *Biochemistry : Molecular Basis on Cell structure and Function* by Lehninger, A.L., Kalyani Publications, New Delhi; 1983
2. *Genes VII* by Lewin, John Wiley and Sons, New York, 2000.

3. *Genes IX* by Benjamin Lewin, Jones Bartlett Publications, 2008.
4. *Microbial Genetics* by D. Friefelder, Narosa Publishing House, New Delhi, 1989.
5. *Molecular Biology* by D. Friefelder, Narosa Publishing House, New Delhi, 1998.
6. *Molecular Biology and Human Diseases* by A. Macleod and S. Sijkora, Blackwell Scientific Publications Ltd., London, 1984.
7. *Molecular Microbial Ecology Manual* : Ed., ADLSK Kerman, J.D. Van Elsas, F.J. de Bruigin, Kluwer Academic Publications, 1995.
8. *Molecular Biology of Gene* by J.D. Watson, N.H. Hopkin, J.W. Roberts, J.A. Steing and A.M. Weings, Benamin Cummings Publication Co., Amsterdan, 1988.
9. *Genomes 3* by T.A. Brown. Garland Science Publication; 2007.
10. *Proteome Research : New Frontiers in Functional Genomics*. Eds. M.R. Wilkins, R.D. Appel and D.F. Haochshauer, Springer Publication, 1997.
11. *Molecular Genetics of Bacteria*, J.W. Dale, Wiley & Son's Ltd., 3rd Edition, 1998.

PAPER–III : GENERAL MICROBIOLOGY

Maximum Marks : 80

Lectures to be delivered : 60

Time Allowed : 3 Hours

Pass Marks : 35%

(Theory & Practical separately)

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of five sections A, B, C, D and E. Section A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section E consists of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all.

INSTRUCTIONS FOR THE CANDIDATES

1. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire Section E.
2. The use of scientific calculators is allowed.

SECTION-A

1. **Introduction** : Historical development and relevance of microbiology to biotechnology.
2. **Microscope and microscopy** : Principles and applications of bright field, fluorescence, phase-contrast, transmission, electron and scanning electron microscopy, a brief discussion.
3. **Microbial groups** : Prokaryotes (bacteria, archaeobacteria, cyanobacteria, mycoplasma, actinomycetes), eukaryotes (molds, slime molds, yeast, algae, fungi, protozoa) and Viruses (bacterial, plant and animal); a general account of characteristics., structure and function.

SECTION-B

4. **Principles of microbial nutrition** : The requirements for carbon, nitrogen, sulfur, growth factors etc. Role of oxygen in nutrition, nutritional categories among micro organisms.
5. **Methods of microbiology** : Pure culture techniques, preparation of culture media, types of media; sterilization techniques; methods for culturing anaerobes; cultural characteristics, maintenance and preservation of culture.
6. **Strain improvement** : Methods of improvement and stability of biotechnologically important cultures.

SECTION-C

7. **Microbial growth** : Definition, mathematical nature and expression of growth, measurement and efficiency of growth; factors affecting growth; synchronous and diauxic growth; continuous culture; sporogenesis and spore generation.

- 8. Concept of energy generation :** Aerobiosis, anaerobiosis and concept of autotrophs : fermentative types of microorganisms.
- 9. Microbial genetics :** Modes of bacterial recombination, conjugation, transformation and transduction in the bacteria.

SECTION-D

- 10. Micro organisms as geochemical agents :** Fitness of micro organisms as agent of geochemical change; cycles of matter and microbial interactions.
- 11. Biological nitrogen fixation :** Microbiology of symbiotic and non-symbiotic nitrogen fixation; root nodule formation and its functions; structure and functions of heterocyst.
- 12. Microbiology and epidemiology of food poisoning and food borne infections :** Mode of transmission and their prevention.

RECOMMENDED READING

- Brock Biology of Micro Organisms* by M.T. Madigan, J.M. Martinlzo, J. Parker, Prentice Hall, New Jersey, 2000.
- General Microbiology* by R.Y. Stanier, J.L. Ingraham, M.L. Wheelis and P.R. Painter, MacMillan, Hong Kong, 1992.
- General Microbiology* by H.G. Schegel, Cambridge University Press, U.K., 1995.
- Introductory Microbiology* by J. Heritage, E.G.V. Evans and R.A. Killington, Cambridge University Press, U.K., 1996.
- Microbiology* by L.M. Prescott, J.P. Harley, D.A. Klein, WCB Publications, England, 1993.
- Microbiology by A Human Perspective* by E.W. Newster, C.E. Roberts, M.T. Nester, WCB Phis., London, 1995.
- Microbiology* 4th Edition, Devis, B.D. Dulbeco, R. Eisen, H.N. Ginsberg, H.S. Harper and Row Publishers, Singapore, 1990.
- Microbiology : Principles and Applications* by J.G. Greager, J.G. Black and V.E. Davision, Prentice Hall, New Jersey, 1990.
- Principles of Microbiology* by R.M. Atlas Mosby. St. Louis, 1995.

PAPER-IV : IMMUNOLOGY AND IMMUNO-TECHNOLOGY

Maximum Marks : 80

Time Allowed : 3 Hours

(Theory & Practical separately)

Lectures to be delivered : 60

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of five sections A, B, C, D and E. Section A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section E consists of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all.

INSTRUCTIONS FOR THE CANDIDATES

- Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire Section E.
- The use of scientific calculators is allowed.

SECTION-A

- 1. Introduction and scope of immunology :** History, types of immunity, innate immunity, acquired immunity, active and passive immunity.
- 2. Antigens and antigenicity, haptens, epitopes.**
- 3. Immunoglobulins :** Types, structure, distribution, function, molecular biology of immunoglobulin synthesis, organization of immunoglobulin genes; complement system.

SECTION-B

4. **Cellular immunity** : Cells involved in immune system, organs of immune system, lymphocyte, macrophages.
5. **Humoral immune response** : T-dependent and T-independent immune response, Type I hypersensitivity, Type II, III and IV immune reactions, autoimmunity.
6. **Autoimmunity** : Immunomodulation, immunosuppression and immunopotentiality.

SECTION-C

7. **Immunization and vaccines** : Active and passive immunization : traditional and modern vaccines.
8. Interferons, Interleukines and other cytokines.
9. Major histocompatible complex and transplantation immunity.

SECTION-D

10. **Antigen-antibody assays** : Methods to assay humoral immune response (agglutination, immunodiffusion, immunoelectrophoresis, RIA, fluorescent assays, ELISA, physical methods for isolation of antibodies; methods for enumeration of various types of cells in immune system, immunoblot.
11. Methods of assay cell mediated immune response.
12. Hybridoma technology, myeloma cell lines, fusion, selection and screening of positive hybrid cells, cloning methods, purification, characterization and applications of monoclonal antibodies in diagnosis and therapy and in biomedical research, antibody engineering and abzymes.

RECOMMENDED READING

1. *Cellular and Molecular Immunology* by Abbas, A.K. Lichtman, A.H. Pober, J.S. W.B. Saunders Co., Philadelphia, 1994.
2. *Immunology* by A.I. Prentice Hall International London, 1992.
3. *Essential Immunology*, 7th Edition, Roitt LM. Blackwell Scientific Publication, 1992.
4. *Immunology* 2nd Edition, Kuby Janis, W.H. Greenman and COI New York, 1994.
5. *Immunology*, Tizard, I.R. Saunders College Publishing, Philadelphia, 1988.
6. *The Experimental Foundation of Modern Immunology*, Clark, W.R, 3rd Ed. John Wiley and Sons. New York, 1986.

PRACTICAL PAPER-I

Pertaining to :

Theory Paper-I Principles of Biochemistry.

Theory Paper-II Molecular Genetics and Functional Genomics.

M. Marks : 100

Total practical hours : 60

Time : 4 hours

1. Qualitative and quantitative analysis of reducing and total sugars by biochemical and biophysical techniques.
2. Determination of acid value of a fat/oil.
3. Determination of cholesterol-total, free and esterified.
4. Isolation, qualitative and quantitative analysis of lipids.
5. Qualitative and quantitative analysis of protein by biochemical and biophysical techniques.
6. Isolation and estimation of DNA of E. coli.
7. Isolation and estimation of RNA from yeast.
8. Determination of T_m of DNA.
9. Determination of phosphate content of DNA and RNA.
10. Separation of nucleotides by electrophoresis.
11. Demonstration of Hill reaction.
12. Applications of Handerson - Hanelbalch equation for the preparation of buffer solutions.

13. To determine vitamin C content in a citrus fruit.
14. To find α -amylase/invertase activity.
15. To evaluate K_m & V_{max} of α -amylase/invertase activity.
16. Kinetic characterization of free and immobilized enzyme.
17. Determine of nucleic acid (DNA & RNA) by biophysical techniques.
18. Resolution of Serum protein by starch gel electrophoresis.
19. Two Dimensional Gel electrophoresis.
20. Demonstration of Polymerase Chain Reaction (PCR).
21. m-RNA isolation from eukaryotic cells.
22. Demonstration of DNA sequencing.
23. Demonstration of DNA finger printing.
24. Denaturing Gradient Gel electrophoresis.
25. Random Amplified Polymorphic DNA analysis (RAPD).
26. Demonstration of Multiplex PCR.
27. Pharmaco-genetically important enzyme polymorphisms.
28. Detection of chemical carcinogens by ames test.
29. Isolation and characterization of *Serratia marcescens* with altered pigmentation.
30. Demonstration of equipment : radio, amino acid, DNA synthesizer, Micro array Reader, Flow Cytometer etc. at other institutions / R and D centres.
31. Fractionation of rat liver.
32. Isolation of casein from milk.
33. Determination of starch content from wheat flour.
34. Determination of Conjugation mapping in *E.coli*.

PRACTICAL PAPER-II

Pertaining to :

Theory Paper-III General Microbiology

Theory Paper-IV Immunology and Immunotechnology

M. Marks : 100

Total practical hours : 60

Time : 4 hours

1. Staining techniques in Microbiology-simple, negative and differential staining.
2. Isolation, Purification, maintenance and preservation techniques of aerobic and anaerobic cultures.
3. Morphological, cultural and biochemical characterization of micro organisms.
4. Isolation of bacteria and cyanophages.
5. Isolation of Micro organisms by pour plate and streak plate methods.
6. Strain improvement : physical and chemical mutagenesis.
7. Presumptive and confirmation test for the determination of coliform bacteria.
8. Determination of viability of micro organisms.
9. Measurement of size of micro organism.
10. Hanging drop preparation to check motility of micro organisms.
11. Microbial growth measurements by different techniques and determination of factors affecting growth of micro organisms.
12. Immunization of animals via different routes.
13. Determination of TLC and DLC.
14. Enumeration of T and B cells in human body.
15. Purification of IgG from serum by column chromatography.
16. Determination of antigen and antibody reaction by rocket immuno-electrophoresis.

17. Fractionation of anti-serum against an antigen by two dimensional electrophoresis.
18. Radial immuno-diffusion test.
19. Determination of titre of serum by indirect haemagglutination cell mediated immunity by leucocyte migration inhibition test and Antibodies by ELISA method.
20. Estimation of CH-50 activity of serum sample.
21. Determination of phagocytic activity and NBT reduction by macrophages.

SEMESTER-II

PAPER – V GENETIC ENGINEERING

M.Marks : 80

Lectures to be delivered : 60
Time allowed : 3 Hours

INSTRUCTIONS FOR THE PAPER SETTERS

The question paper will consist of five sections A, B, C, D and E. Section-A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section-E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all.

INSTRUCTIONS FOR THE CANDIDATES

1. Candidates are required to attempt one question each from section A, B, C and D of the question paper and the entire Section-E. The use of scientific calculators is allowed.

SECTION – A

1. Introduction, basic tools and techniques of cutting and joining: DNA cutting and modifying enzymes alkaline phosphatase, polynucleotide kinase, DNA ligase, S1 nuclease, exonucleases; PCR: Real Time quantitative PCR, WGA. Ligation of DNA fragments: in-vitro ligation strategies: Joining DNA with ligases, topoisomerases and site specific recombinases. Chemical synthesis of DNA: Adaptors, linkers and Homopolymer tailing for in-vitro ligation.
2. DNA libraries: Genomic libraries construction, amplification and applications. cDNA libraries; construction and applications.
3. Cloning vectors: types of vectors-plasmids, phages, cosmids, phasmids, transposons, etc.; their salient features, genetic map and host-range. In vitro packaging,

SECTION – B

4. Transformation techniques: chemical, physical and biological strategies.
5. Recombinant Selection and identification: direct and indirect methods; reporter genes, immunological methods, South-Western screening, Northwestern screening, maxi and mini cells.
6. Gene Expression in recombinants: Principles of maximizing gene expression, Expression vectors design for downstream processing and protein purification: His-tag, GST-tag and MBP-tag.

SECTION - C

7. Cloning in Bacteria and Yeast: comparative features of Gram-negative, Gram positive, yeast. Two hybrid

system- vectors and applications.

8. Site directed Mutagenesis, Phage display and Cell surface display. Protein Engineering: Directed evolution and Gene shuffling.
9. Cloning in plant: Tissue culture, Ti, Ri and viral vectors Transgenic plants, Pharming.

SECTION – D

10. Cloning in animal cells: Cell lines, Selectable markers, plasmid and viral vectors. Transgenic animals and cloning, Gene therapy: gene Targetting, replacement and knockout strategies,
11. Applications: recombinant products, New Materials and Devices: Biosensors. Agricultural applications, Industrial applications, Medicinal applications: Vaccines and Nucleic acid therapeutics. Environmental applications. R-DNA Regulation guidelines DBT, NIH and FDA.
12. Introduction to Metabolic engineering: Metabolic flux analysis, Tryptophan biosynthesis in E.coli, Lysine production in C.glutamicum, Indigo and Melanin production in E.coli.

RECOMMENDED READING

1. Principles of Gene Manipulations by R.W. Old and S.B. Primrose Blackwell Scientific Publication, 1998.
2. Fundamentals of Genetic Engineering (Vol. 12) by R.H. Rehm and G. Reed Verlag Press, NY, 1993.
3. Treatics Genetic Engineering by P.J. Barrwiley, NY, 1989.
4. Molecular Cloning by J. Sambrook, E.F. Fritsch and T. Maniatis Cold Spring Harbor, NY, 1989.
5. Gene Cloning by T.A. Brown, Van Nosterland and Teinhold, NY, 1992.
6. Recombinant DNA Principles and Methodologies by J. Greene and V.B. Rao, Marcel Dekkel Inc., NY, 1998.
7. Genetic Engineering by R. Williamson (Vol. 1, 2, 3 and 4) Academic Press, NY, 1981.
8. Recombinant DNA methodology by R. WU, I. Grossman and K. Moldane (ed) : Academic Press, San Diego. 1989.
9. Recent Journals.

PAPER–VI : MOLECULAR BIOPHYSICS AND MODELLING

Maximum Marks : 80

Time Allowed : 3 Hours

(Theory & Practical separately)

Lectures to be delivered : 60

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of five sections A, B, C, D and E. Section A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section E consists of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all.

INSTRUCTIONS FOR THE CANDIDATES

1. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire Section E.
2. The use of scientific calculators is allowed.

SECTION-A

1. **Thermodynamics** : Laws of thermodynamics, concept of enthalpy, heat capacity at constant volume and pressure, isothermal expansion, differential scanning calorimetry, concept of entropy, statistical and thermodynamic definitions of entropy, entropy change due to mixing of ideal gases, entropy change due to heating, Gibb's free energy, free energy spontaneity criteria; dependence of free energy on temperature (Gibb's Helmholtz equation), dependence of free energy on pressure, Vant Hoff equation, bioenergetics, physical chemist and biochemist standard states, coupled reactions, high energy bonds.
2. **Chemical kinetics** : Reaction rate, order of reaction, renaturation of DNA – A case study, half life of a reaction. Determination of reaction order, molecularity of reaction. Complex reaction, consecutive kinetics, isotope effect, reactions in solution, fast reaction in solution (the flow method and the relaxation method).
3. **Quantum mechanics** : Wave theory of light. Planck's quantum theory, photoelectric effect, de Broglie's postulate, Bohr's theory of atomic spectra, Huckel theory; Schrodinger's wave equation, Heisenberg's uncertainty. principles, particles in one dimensional box, quantum mechanical tunnelling.

SECTION-B

4. **Biological applications of spectroscopy** : Principles and applications of UV-visible spectrophotometry, spectro-fluorimetry and IR spectroscopy.
5. **Principles and applications of NMR** : Chemical shift, spin-spin coupling Pascal triangle rule, ESR (electron spin spectroscopy) SELECTION rules for allowed transitions, hyperfine splitting.
6. **Optical activity** : Principles and applications of ORD and CD, mass spectrometry, X ray diffraction.

SECTION-C

7. Useful general concepts in molecular modeling, coordinate system, potential energy surface, molecular graphics, units of length and energy.
8. Protein folding and design, conformational properties of the commonly occurring amino acids, properties of some conformationally constrained amino acids, design of medium sized peptides; protein design (coiled coils, four helix bundles).
9. Some basic principles of protein structure, the hydrophobic effect, first principle methods for predicting protein structure, Lattice method for investigation of protein structure, rule based approach using secondary structure prediction, introduction to complex modeling, sequence analysis, Pharmacophores, drug designing.

SECTION-D

10. Parameterization and simulation of the physical properties of phosphorothiodate nucleic acids in the design and characterization of antisense oligonucleotide for the treatment of various human diseases.
11. Computer simulations by a genetic algorithm, implementation of the principles of genetic algorithm for RNA folding, formation of stems, disruption of stems and selection of structure.

12. Molecular dynamics simulation, setting up and running a molecular dynamic simulation; How TATA Box selects its protein partner?

RECOMMENDED READING

1. *Principle of Biochemistry* by Lehninger, David L. Nelson and Michael M. Cox, Third Edition, 2000, Macmillan Worth Publisher, New York, USA.
2. *Biochemistry* by Lubert Stryer, W.H Freeman and Company, New York, Fourth Edition, 1995.
3. *Instant Notes in Biochemistry* by B.D. Hames, N.M. Hooper and J.D. Houghter, Bios Scientific Publishers Limited, Oxford U.K.
4. *Biophysical Chemistry - Principles and Techniques* by Upadhyay and Upadhyay Nath, Himalaya Publishing House, Third Revised Edition 2002, Reprint 2006.
5. *Protein Structure - A Practical Approach*, Second Edition edited by T.E. Creighton The Practical Approach Series, Series Editor B.D Hames IRL Press, Oxford University Press, 1997.
6. *Physical Chemistry for the Biosciences* by Raymond Chang, University Science Books, Sausalito, California 2005.
7. *Physical Biochemistry : Application to Biochemistry and Molecular Biology* by David Freifelder W.H. Freeman & Company New York, Second Edition 1982, Eighteenth Printing.
8. *Molecular Modeling of Nucleic Acids* Edited by Neocles B. Leontis and John Santalucia, Jr 1998 American Chemical Society, Washington, DC.
9. *Biophysical Chemistry : Techniques for the Study of Biological Structure & Function* by Cantz & Schimmel 1980 W.H. Freeman & Company, New York.
10. *Molecular Modeling, Principles and Applications* by Leach, A.R. 2001.

PAPER-VII : BIOPROCESS AND BIOCHEMICAL ENGINEERING

Maximum Marks : 80

Time Allowed : 3 Hours

(Theory & Practical separately)

Lectures to be delivered : 60

Pass Marks : 35%

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of five sections A, B, C, D and E. Section A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section E consists of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all.

INSTRUCTIONS FOR THE CANDIDATES

1. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire Section E.
2. The use of scientific calculators is allowed.

SECTION-A

1. **Introduction** : Principles of upstream and down stream processing.
2. **Bioreactors** : Types-batch, fed batch and continuous system; design, development and scale up.
3. **Bioprocess control and monitoring systems** : Instrumentation for monitoring and controlling of bioreactors, in line and online measurements; instrumentation for fermentation process control; estimation of fermentation output and basic and computer controls system.

SECTION-B

4. **Sterilization principles and practices** : Media sterilization, thermal death-batch and continuous sterilization systems, sterilization of air-fibrous filters.

5. **Aeration and agitation** : Aeration, agitation systems for bioreactors and their design; factors affecting agitation and aeration in shaker roller tubes, static, submerged cultures and factors affecting oxygen solution rates in shake flasks.
6. **Transport phenomenon in bioreactors** : Mass transfer coefficient (KLa) for gases and liquids, dimensionless groups, mass transfer, heat transfer coefficient, determination of KLa, factors affecting KLa value in bioprocess; fluid rheology.

SECTION-C

7. **Isolation and extraction of bioproducts/enzymes** : Separation of cells-foam separation, flocculation, agglomeration, filtration and centrifugation; disruption of cells-physical and chemical.methods : solid-liquid extraction, liquid-liquid extraction.
8. **Recovery/purification of bioproducts/enzymes** : Chromatographic techniques-adsorption, ion exchange, molecular sieve; affinity, hydrophobic; high performance liquid chromatography, gas liquid and gas solid chromatography, electrophoresis; distillation, electro dialysis, evaporation, drying, crystallography.
9. **Scale up** : Optimization and scale up of bioprocesses.

SECTION-D

10. **Bioprocess economics** : Cost determination of bioprocess, capital investment for equipments, raw materials, consumables and other costs etc.
11. **Networking in bioprocesses** : neural networks, mathematical modelling.
12. Role of computers in bioprocess control and applications.

RECOMMENDED READING

1. *Biochemical Engineering* by A. Aiba, A.E. Humphery and N.F. Miki University of Tokyo, 1973.
2. *Biotechnology* Vol. 1, 2 and 7 by Moo Young, Pergamon Press, NY, 1985.
3. *Comprehensive Biotechnology*, Vol. 2 by Moo Young, Pergamon Press, NY, 1985.
4. *Fundamentals of Biotechnology* by P. Prave, F. Eaus, W. Sitting and D.A. Sukatech, ECH Weinheim, 1987.
5. *Biochemical Engineering Fundamentals* by J.E. Bailey and D.F. Ollis, McGraw Hill Co., NY, 1986.
6. *Methods in Industrial Microbiology* by B. Sikyata, Ellis Horwood Ltd., London, 1983.
7. *Principles of Fermentation Technology* by P.F. Stanbury and Whitaker, Pergamon Press, NY, 1984.
8. *Principles of Microbial and Cell Cultivation* by S.J. Pirt, Black Well Scientific Publications, London, 1983.

PAPER-VIII : FERMENTATION TECHNOLOGY

Maximum Marks : 80

Lectures to be delivered : 60

Time Allowed : 3 Hours

Pass Marks : 35%

(Theory & Practical separately)

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of five sections A, B, C, D and E. Section A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section E consists of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all.

INSTRUCTIONS FOR THE CANDIDATES

1. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire Section E.
2. The use of scientific calculators is allowed.

SECTION-A

1. **Raw Materials** : Preparation of conventional and non-conventional substrates for microbial and food fermentation; chemical and biological control of raw materials; storage; transport and homogenization.
2. **Starter cultures** : Techniques for the development of inocula for industrial fermentations; procedures of aseptic inoculation of industrial fermenters.
3. **Microbial growth kinetics** : Batch, fed-batch and continuous systems and their applications.

SECTION-B

4. **Fermentation** : Types-submerged, surface and solid substrate fermentation, factors affecting fermentations.
5. **Microbial biomass for food and feed** : Algal, bacterial, fungal and yeast biomass as single cell protein; solid-state fermentations and submerged fermentation; technologies for the production of SCP.
6. **Biofuels** : Fermentative production of liquid fuels-ethanol, acetone and butanol etc.; factors affecting production of biofuels.

SECTION-C

7. **Production of alcoholic beverages** : Raw materials, culture, fermentation, technology and post fermentation processing of distilled alcoholic beverages (whiskey, vodka, rum, gin etc.)
8. **Production of beer and wine** : Types, principles of brewing process and post fermentation processing.
9. **Production of vinegar** : Raw materials, culture and fermentation conditions, post fermentation processing, recover and applications.

SECTION-D

10. **Agriculture related products** : Production and application of biopesticides and bioinsecticides.
11. **Biofertilizers** : Industrial production of Rhizobium inoculants. *Azotobacter*, *Azospirillum* and Blue-green algae.
12. **Organic Acids** : Fermentative production of citric acid, gibberallic acid, lactic acid, propionic and butyric acid.

RECOMMENDED READING

1. *Prescott and Dunn's Industrial Microbiology* by B. Reed Millan Publishers Ltd., Connecticut, 1982.
2. *Principles of Fermentation Technology* by P.F. Stanbury and A. Whitaker Pergamon Press, NY, 1984.
3. *Comprehensive Biotechnology* by M. Moo-Young (Vol. 3 and 4) Pergamon Press, New York, 1985.
4. *Fundamentals of Biotechnology* by P. Praive, B. Faust, W. Sitting and D.A. Sukatesh, WCH Weinheim, 1987.
5. *Biotechnology, Principles and Applications* by J. Higgins, D.J. Best and J. Jons Blackwell Scientific Publications, London, 1985.
6. *Biotechnology* by R.H. Rehm and G. Reed (Vol. 4, 5, 6 and 7a), Verlag Press, NY, 1982 and 1987.
7. *Essays in Applied Microbiology* by J.R. Norris and M.H. Richmond : John Wiley and Sons, NY, 1981.
8. *Yeast Biotechnology* by D.R. Berry, L Russel and G.G. Stewart : Allen and Unwin, Boston, 1987.
9. *Microbial Biotechnology, Fundamental of Applied Microbiology* by A.N. Glazer and H. Nikaido, W.H. Greenman and Co., NY, 1985.
10. *Biotechnology : Food Fermentation Technology* by V.K. Joshi and A. Panday, Educational, Publishers and Distributors, New Delhi, 1997.

PRACTICAL PAPER-III

Pertaining to :

Theory Paper-V Genetic Engineering

Theory Paper-VI Molecular Biophysics and Modeling

M. Marks : 100

Total Practical Hours : 60

Time : 4 hours

1. Isolation of DNA, RNA and plasmids and staining with ethidium bromide.
2. Electrophoretic separation of DNA fragments and their recovery from gel slabs.
3. Performance of Southern and Northern blotting.
4. Transformation of *E. coli* with plasmids by chemical and electrooration.
5. Purification of mRNA by using immobilized technique.
6. Mapping of restriction sites on a plasmid.
7. Transfer of nopalene dehydrogenase gene into cultured plant tissue by *Agrobacterium tumifaciens*.
8. Cloning using restriction enzyme generated cohesive/blunt ends.
9. Sequencing of DNA fragment with Maxam-Gillbert method.
10. Determination of quality of bioproducts.
11. Qualitative and Quantitative analysis of Proteins and Nucleic acids by V.V. Spectrophotometer.
12. Determination of protein in presence of nucleic acid by spectrophotometer method.
13. Demonstration on measurement of CD spectra of proteins and Nucleic acids.
14. Fluorimetric:determination of Ca²⁺ ions and NADH/NADPH.
15. NMR spectra for structure determination of ethanol.
16. Demonstration on Fraction of α -helix, β -chain' (random coil) in a protein by IR spectroscopy.
17. Demonstration on Mass Spectrometry (peptide mapping).
18. Determination of T_m of DNA.
19. Protein modelling on computer.
20. Polarimeter determination of sucrose in the presence of other sugars.
21. Polarimeter determination of other sugars in the presence of sucrose.
22. Environmental effects on absorption and emission spectra of protein.
23. Polarimeter determination of sucrose in the presence of other sugars.
24. Polarimetric determination of other sugars in the presence of sucrose.
25. Environmental effects on absorption and emission spectra of protein.
26. Protein engineering with non-standard amino acid.
27. Synthesis and assay on method DNA.
28. Incorporation of PM-mercaptoacetyl and CPM-SAC method.

PRACTICAL PAPER-IV

Pertaining to :

Theory Paper-VII Bioprocess and Biochemical Engineering

Theory Paper-VIII Fermentation Technology

M. Marks : 100

Total Practical Hours : 60

Time : 4 Hours

1. Introduction to laboratory scale bioreactor, its fabrication and evaluation of performance.
2. Isolation, extraction and recovery / purification of extracellular and intracellular bioproducts by using various biochemical techniques.
3. Determination of thermal death time of culture-evaluation of a sterilization techniques.
4. Determination of thermal death time of culture-evaluation of a sterilization techniques.
5. Fermentation production of organic acids and ethanol using free and immobilized cells.
6. Production of alcoholic beverages-wine and vinegar using free and immobilized cells.

7. Production of food additives-vitamins and amino acid using free and immobilized cells.
8. Production and evaluation of single cell-protein-fuhgal and yeast biomass.
10. Preparation and evaluation of Rhizobia inoculants.
11. Food preservation by different techniques and their evaluation.
12. Production of dairy products-yoghurt and whey milk.