University of Kota, Kota

M.Sc. (P/F) Biotechnology-2013

Eligibility: B.Sc. under the 10+2+3 scheme with Chemistry, Zoology, Botany/Microbiology/Biotechnology/Medicine/Pharmacy/Agriculture with a minimum of 50 % marks.

(45% for candidates belonging to the reserved category SC/ST/OBC)

Selection: Common Entrance Test to be conducted by Scheme of Examination and Courses of Study

1. The number of papers and the maximum marks for each paper/practical are shown in the syllabus. It will be-necessary for a candidates to pass in the theory part as well as in the practical part (wherever prescribed) separately.
2. A candidate for a pass at each of the Previous and the Final Examinations shall be required to obtain (i) at least 36% marks in the aggregate of all the papers prescribed for the examination and (ii) at least 36% marks in practical(s) / wherever prescribed at the examination, provided that if a candidate fails to secure at least 25% marks in each individual paper at the examination and also in the Test / Dissertation/ Survey Report / Field Works, wherever prescribed, he shall be deemed to have failed at the examination not withstanding his having obtained the minimum percentage of marks required in the aggregate for that examination.

   No division will be awarded at the previous Examination. Division shall be awarded at the end of the Final Examination on the combined marks obtained at the Previous and the Final Examinations taken together, as noted below:

   First Division 60% On the aggregate mark taken together in the Prev. & Final Exam.
   Second Division 48%
3. If a candidate clears any paper(s) prescribed at the Previous and/ or Final Examination after a continuous period of three years, then for the purpose of working out his division the minimum pass marks only viz. 25% (36% in the case of Practical) shall be taken into account in respect of such paper(s)/Practical(s) are cleared after the expiry of the aforesaid period of three years; provided that in case where a candidate requires more than 25% marks in order to reach the minimum aggregate as many marks out of those actually secured by him will be taken into account as would enable him to make up the deficiency in the requisite minimum aggregate.
4. A total of eight theory papers (3 hours duration each) are prescribed (4 in previous and 4 in final).A combined Practical Examination (10 hrs. duration in two days) shall be conducted each year. Paper setter shall be asked to set total 9 questions for each theory paper (which have been divided into three sections) or 10 questions for each theory paper (which have no sections) out of which the examinee shall be asked to attempt any five questions. The list of papers is as below:

1. A candidate failing at M.Sc. Previous examination may be provisionally admitted to the M. Sc. Final Class, provided that he passes in at least 50% papers as per Provisions of 0.235 (i)

   A candidate may be allowed grace marks in only one theory papers up to the extent of 1 % of the total marks prescribed for that examination.

Teaching and Examination Scheme for
M. Sc. (Previous) Biotechnology, 2013

A.	**Theory Papers**		**Max. Marks**
1.	Biochemistry & Enzyme Technology		100
2.	Biophysics & Bioelectronics		100
3.	Concepts of Microbiology & Immunology		100
4.	Molecular Biology & Genetic Engineering		100
	Combined Practical		200
	a. Major Exercise (2) 30 marks each	60	
	b. Minor Exercise (2) 15 marks each	30	
	c. Preparation (Slide/Mounting)	10	
	d. Spotting (4) 05 marks each	20	
	e. Project work (Experimental Study/Review)	30	
	f. Record	20	
	g. Viva-voce	30	
	Total		**600**

M.Sc. Previous Biotechnology, 2013

Paper -I Biochemistry & Enzyme Technology

Min. pass marks: 36 **Duration: 3 hours** **Max. marks: 100**

Note: Attempt any five questions, taking atleast one question from each section. Each question carries equal marks.

Unit- I

Biochemical evolution: Chemogeny, Biogeny and evolution of chromosome. Organisation and genetic regulatory mechanism time factor in evolution. Evolution of enzyme systems.

Amino Acids and Peptides: Structure, Function, methods of characterisation, Separation techniques based on their structure and properties, Biosynthesis.Nucleic Acids: Nucleic acids and Polynucleotides, Classification, Structure, Function, Separation and Characterization techniques.

Unit- II

Carbohydrates: Mono and Polysaccharides, Classification, Structure, Function, Separation and Characterization techniques, Biosynthesis. Vitamins, Micro and Macro-Nutrients: Classification. Structure, Function, Separation and Characterization techniques. Catabolism and the Generation of Chemical Energy.

Unit- III

Metabolic Strategies : General principles of intermediary metabolism. Regulation of pathways, Strategies for pathway analysis. Lipids: Classification, Structure, Function, Separation and characterization techniques. Metabolism of Fatty Acids: Fatty acid degradation, Biosynthesis of saturated fatty acids, Regulation of fatty acid metabolism.

Unit- IV

Glycolysis, Gluconeogenesis and the Pentose Phosphate Pathway and Regulation . Tricarboxylic Acid Cycle: Steps in TCA cycle, Aspects of TCA cycle reaction, ATP stoichiometry of TCA cycle, Thermodynamics of TCA cycle, Amphibolic nature of TCA cycle, oxidation of other substrates by TCA cycle, Regulation of TCA cycle activity.

Unit-V

Enzymes: Classification. Nomenclature .and General Properties of Enzymes, Effects of substrate, Temperature, pH and inhibitors on enzyme activity. Enzyme Isolation, Purification and Large scale Production. Mechanism of Enzyme Action and Regulation: Active and regulatory sites, Chemical Modification. General Mechanistic Principles, feed back inhibition. Isozymes, Enzyme Activation. Zymogens, Multi-Enzymes complexes and multifunctional enzymes. Steady State Kinetics: Methods of estimation of rate of enzyme catalysed reaction with special reference to Michaelis-Menton Kinetics.

Reference Books:

1. Biochemistry Ed Lubert Stryer. W.H. Freeman and Company, New York.
2. Principles of Biochemistry. Ed Lehninger, Nelson and Cox. CBS publishers and distributors.
3. Harper's Biochemistry. Ed. R.K. Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell. Appleton and Lange, Stanford, Connecticut.
4. Textbook of Biochemistry with Clinical Correlations. Ed. Thomas M. Devlin.Wiley-Liss Publishers
5. Principles and techniques of practical biochemistry. Ed Keith Wilson and John Walker. Cambridge University Press.
6. Biochemistry. Ed Donald Voet and Judith G. Voet. John Wiley & sons, Inc

Paper II Biophysics and Bioelectronics

Min. pass marks: 36 **Duration: 3 hours** **Max. Marks: 100**

Note: Attempt any five questions, taking atleast one question from each section. Each question carries equal marks.

Unit- I

Bioenergetics: Basic bioenergetics. Cellular bioenergetics, whole body bioenergetics. Entropy and evolution relationship. Gibbs free energy. Bioenergetic pathways. Bioenergetics and biocommunication. Control of bioenergetics.

Molecular interactions: Molecular interactions of primary importance. Strong and weak interactions. Biomolecular interactions- DNA protein interactions, Elementary account of DNA drug interaction. Molecular interaction forces-intermolecular and intramolecular forces. Attractive and repulsive forces generated within molecules and their overall effect on molecular interactions.

Unit- II

Sensory receptors: Common senses. Classification of sense organs- by complexity, nature, stimulus or location . General properties of sensory receptors. Sense detection. Mechanorecetion, Chemoreception, Photoreception, Thermoreception.

Photoreceptors: Types of photoreceptors in plants and animals. Human vision and colour perception.Comparison of human vision and machine vision. Causes and control of vision loss. Eye chip vision sensors and Dobelle artificial vision system.

Phonoreceptors: Types of phonoreceptors in animals. Human ear and auditory function. Resonance theory and Telephone theory. Causes and control of hearing loss.Hearing aids and their basic components.

Unit- III

Methods to elucidate structure and biochemical compounds found in living organisms- Centrifugation, Electrophoresis, Tracer techniques, autoradiography, Chromatography (Paper, Thin layer and column chromatography), Spectrophotometry (UV, VIS, IR, NMR and ESR), Electron microscopy (TEM,SEM)
X- ray diffraction.

Unit- IV

DNA fingerprinting:. Principle of DNA fingerprinting, technique for DNA fingerprinting, Uses of DNA fingerprints- disorder diagnosis, establish paternity and personal identification.

Chemical fingerprinting: Basic problems in chemical finger printing of plants. State of the art in the finger printing of plants- Lichens, mosses and higher plants.

Bioelectronics: Biological sensing. Biological manipulation of Cellular engineering. Biologically inspired computing.Importance of bioelectronics technology and future of Bioelectronics.

Unit-V

Biosensors: Bioreceptors and transducers. Origin of biosensors. Transducers used. Growth and Evolution of biosensors. Need for biosensors. Considerations in biosensor development. Requirement for biosensors. Application of biosensors-health care, industrial process control, military application ,environmental monitoring and future prospects.

Biochip: Biochip principle. Types of bioarrays and microfluidic chips; silicon chips and biochips; Molecular chips. Biocomputers: What is biocomputing. Genetic discrimination and biocomputing. Sound and image processing with optical biocomputers. Future of Biocomputer.

Reference Books:

1.Introduction to Electron Microscopy - S. Wischnitzer.
2. Electron Microscopy in Biology - J.R.Harris (ed.).
3.Biophysics by R.N.ROY
4. Biophysics - V. Pattabhi & N. Gautham (Narosa, New Delhi).
5.Fundamentals of Molecular Spectroscopy - C.N. Banwell, (Tata-McGraw Hill)
6.Biological Spectroscopy- I.D. Cambell & R.A. Durk, (Benjamin Cummings)
7. Physical Biochemistry - D. Freifelder (W.H. Freeman & Co.)
8.Physical Biochemistry - K.E. Van Holde (Prentice Hall)
9. Biophysical Chemistry, Vol.II - C.R. Cantor & P.R. Schimmel, (W.H. Freeman &Co.)

Paper III Concept of Microbiology & Immunology

Min. pass marks: 36 **Duration: 3 hours** **Max. Marks: 100**

Note: Attempt any five questions, taking atleast one question from each section. Each question carries equal marks.

Unit-I

Introduction to microbiology-scope and history
Physical and chemical methods of sterilization.Culture media and methods of their preparation. Ultrastructure, Broad classification, isolation, cultivation and uses in agriculture, industry and environment of fungi, algae, protozoa, bacteria and prions. Elementary account of most common diseases caused by microorganisms in human (Typhoid, Tuberculosis, Diptheria, Polio, Hepatitis, Malaria, Amoebiasis), animals (Fowl pox, brucellosis, Rinderpest, Foot and mouth disease of cattle and rabies) and plants (citrus canker,TMV,potato mosaic, green ear disease)

Unit-II

Role of microbes in carbon, Nitrogen, Phosphorus and Sulphur cycle in nature and the biochemistry of these conversions. Viruses: History, classification, phylogeny, chemical and physical characteristics,virus isolation, purification, cultivation and replication, serology and plaque assay. Microscopy: Simple, Light and compound microscopes contrast, dark field, fluorescence and electron (TEM and SEM) microscopy-their principles and applications.

Unit-III

Immune system: Innate and acquired immunity. Clonal nature of immune response. Nature of antigens and super antigens. Antibody structure and function. Antigen-Antibody Interaction:-Precipitation reaction, Immunoelectrophoresis, Immunofluorescence, Agglutination, Radioimmunoassay, ELISA. Cells of Immune System: Hematopoiesis and differentiation, Lymphocytes trafficking, B and T Lymphocytes, Natural killer cells, Mononuclear phagocytes, Granulocytic cells.

Unit-IV

Major Histocompatibility Complex: General structure and function of MHC class I & class II , MHC restriction . Complement: The complement components, function, complement activation-Classical, Alternate and lectin pathways (characteristics & functions) and its biological consequences.
Regulation of Immune response: Antigen processing and presentation, generation of humoral and Cell mediated immune response, Activation of B and T lymphocytes. Cytokinin and their role in immunoregulation.

Unit-V

Hypersensitive reactions :Type I, II, III and delayed type (DTH). Cell-mediated Cytotoxicity: Mechanism of T cell and NK cell mediated lysis. Antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity,Transplantation. Tumour immunology. AIDS and other Immunodeficiency Diseases.Hybridoma technology and Monoclonal Antibodies.

Reference Books:

1. Microbiology - M.J.Pelczar, E.C.S.Chan & N.R.Kreig (Tata McGraw Hill)
2. General Microbiology - R.Y.Stanier, J.L.Ingraham, M.L.Wheelis & P.R.Painter (McMillan)
3. Microbiology - L.M.Prescott, J.P.Harley & D.A.Klein (Mcgraw Hill)
4. Fundamental Principles of Bacteriology - A.J. Salle (TATA McGRAW-HILL)
5. Virology - R. Dulbecco and H.S.Gensberg
6. Molecular Biology - D. Freifelder (Narosa Publishing House)
7. Microbiology - Schaum Series
8. Immunology - Goldsby-Kindt-Osborne –Kuby, W.H Freeman & Co.
9. Cellular and Molecular Immunology - Abbas-Lichtman-Pober, W.B SAUDERS
10.Immunology - Roitt
11. Immunology and Immunotechnology - A.K Chakraborty, Oxford University Press, 2006

Paper IV Molecular Biology and Genetic Engineering

Min. Pass Marks: 36 **Duration 3 hrs.** **Max. Marks: 100**

Note: Attempt any five questions, taking atleast one question from each section. Each question carries equal marks.

Unit- I

Genetic Material: Structure, Chemical composition and organization of DNA. DNA super coiling, Different forms of DNA, artificial chromosomes (BAC, YAC, HAC). Repetitive DNA and satellite DNA. experimental proof of DNA and RNA as genetic material.

DNA Replication – Mechanism of Replication, Imitation, Elongation and Termination, Enzymology of Replication.

DNA Repair – Mechanism of Proof Reading, Types of DNA damage, Types of DNA Repair. Mutation Types and various Mutagens.

Unit- II

Molecular Genetics -DNA Recombination- Holliday Model, Site specific Recombination. Transposons – Transposable Elements, classification of Transposons, examples in Eukaryotes.Transcription – Mechanism in Prokaryotes and Eukaryotic Transcription, Post Transcriptional Modification ,Modifications in RNA - 5'-cap Formation, 3' end Processing and Polyadenylation, RNA Processing, Ribozymes.

Unit- III

Gene Regulation – Prokaryotic Gene Regulatory Mechanism; Operon Concept: Lac and Trp operons. Gene Regulation in Eukaryotes – Attenuation control Regulation by DNA Methylation, Transcription Factors, Enhancer Element.

Genetic Code – Salient Features and Wobble Hypothesis, Initiation and Termination Codon.

Proteins Synthesis: Mechanism in Prokaryotes and Eukaryotes – Translation initiation, elongination, Termination of Translation.

Unit- IV

Basic principles of genetic engineering. Scope of genetic engineering. Basic tools: restriction and modifying enzymes, Gene cloning vectors:Plasmids, Bacteriophages, Phagemids, Cosmids.

Recombinant screening and selection – markers, nucleic acid hybridizations: colony, plaque, dot blot, southern, northern and western blotting. cDNA and genomic libraries.

Unit- V

DNA sequencing techniques, Sanger- Coulson method, Maxam Gilbert method. PCR -steps, Types of PCR and its applications. Transgenic and gene Knockout technologies, Gene therapy: Vectors and gene delivery, Gene replacement/augmentation. Biosafety: Introduction, GMOs, General Concerns, Hazards of environmental engineering, Biosafety Guidelines and regulations. Patent Guidelines and regulations.

Reference Books:

1. "Molecular Biology of the Gene" by Watson-Baker-Bell-Gann-Levine-Losick, 5 th Edn., Pearson Education
2. "Molecular Biology" by D. Freifelder, Narosa Publishing House, New Delhi
3. "Genome" by T.A. Brown, John Wiley & Sons
4. "Microbial Genetics" by D. Freifelder, Narosa Publishing House, New Delhi
5. "Gene VII" by Lewin Benjamin (Oxford)
6. "Molecular Cell Biology" by J.Darnell, H.Lodhis & D.Baltimore (W.H.Freeman & Co.)
7. "DNA Repair & Mutagenesis" by E.C.Friedberg, G.C.Walker and W. Seide (ASM Publisher)
8. Molecular biotechnology- S.B. Primrose
9. Molecular biotechnology- Glick

PRACTICALS

Min. Marks: 72 Duration: 10 Hrs. (2 days) Max Marks: 200

1. pH meter: Buffering capacity of a buffer, indicators. To determine the pKa value and hence the dissociation constant of a given acid by using pH meter.
2. Colorimetry: To determine the association constant of a. given indicator colorimetrically and to prepare the buffer solutions in pH range of 2.2 to 8.0.
3. Potentiometry : Redox potential of Fe^{+2} and Fe^{+3}.
4. Viscometry:
   (a) Radius determination: Glycerol molecule
   (b) Molecular weight determination - Proteins and DNA
5. Spectrophotometry: To find out absorption spectrum of given chromophore and /or oxidised and reduced forms (sodium nitrate and borohydrate).
   (a) Haemoglobin and Methaemoglobin
   (h) NAD and NADH
6. Double beam and recording spectrophometry, Derivatives and difference spectra Indicators, cytochromes, haemoglobin.
7. Estimation of protein: Lowry, Biuret and Bradford methods, standard curves, linear regression and assessment of ranges and reliability.
8. Enzyme assays (LDH, beta galactosidase, acid phosphate, arginase, succinic dehydrogenase) Time, Temperature, Protein concentration, cofactors. LDH: K_m and V_{max} various kinetic plots: Use of computer packages for parametric and non-parametric methods and non-linear regression.
9. Protein purification: Amm sulphate, acetone, TCA pptn. dialysis, concentration.
10. Thin layer chromatography: lipids, mixture of dyes.
11. Chlorophyl estimation: spectrum and turbidity correction in chloroplasts.
12. Polyacrylamide gel electrophoresis of proteins.
13. Microscopy: a) simple, compound, phase contrast b) Micrometry: Calibration of stage and. ocular micrometer and measurement of the given biological sample c) Haemocytometer d) Photography and videotaping (motility, morphometry).
14. Subcellular fractionation: a) Isolation: chloroplast, mitochondria, nuclei etc. b) Centrifugation: differential, density gradient (sucrose. percoll, $CsCl_2$), c) Spectrophotometer: absorption spectrum, activity of the fraction of 260/280 ratio etc.
15. Endonuclease digestion of nuclei and analysis of thc DNA fragments by agarose electrophoresis.
16. Thermal melting of DNA.
17. DNA: a) Isolation of DNA (nuclear and Mt) b) Agarose gel electrophoresis
    c) Detection of DNA modifications: d) Restriction endonuclease digestions and separation of fragments by gel chromatography and density gradient centrifugation e) Base composition analysis of DNA.
18. To find out the capacity and nature of the given ion- exchange resin (Ion Exchange Chromtography).
19. Gel filtration chromatography.
20. DEAE cellulose chromatography of DNA.
21. 2-D gel electrophoresis of proteins and isolectrofocusing.
22. Study of sex linked gene inheritance. Estimating gene frequencies in human population, estimation of heterozygotes frequencies. Isolation / identification of auxotroph mutants in bacteria, recombination in Bacteria. Pedegree analysis, analysis of human karyotes, chromosomal aberrations.
23. Micronucleus test for detecting genotoxins.
24. AME's test for screening genotoxins.
25. Isolation of plasmid DNA - i) minipreparation ii) large scale isolation.
26. DNA ligation, transformation of E.coli.
27. Chararterisation of transformants: DNA gel electrophoresis, blotting and hybridization with labelled DNA probes (Southern Blot) Techniques .
    a) DNA blotting technique b) DNA hybridization.
28. Isolation of cytoplasmic RNA. Electrophoresis of RNA on denaturing gels. Northern blot techniques. In situ detection of RNA in embryos / tissue.
29. Separation of poly A tRNA on oligo-dt columns.

30. cDNA synthesis and cloning.
31. Sequencing and computer analysis.
32. PCR/RFLP technique.
33. In-vitro translation.
34. Cleanliness, media preparation, sterilization, culture methods, dilution techniques in microbiology.
35. Staining techniques in microbiology i) simple staining ii) negative staining iii) Differential staining iv) spore staining v) capsule staining and identification.
36. Isolation of pure culture. Culture: characteristics of microbes.
37. Bacterial growth curve-serial dilution, plating and turbidity measurement.
38. Competent cell preparation. Replica plating, Isolation of auxotrophic mutants in bacteria, recombination in bacteria.
39. Isolation and purification of bacterial DNA. Extracellular enzymatic activities of microbes.
40. Standard qualitative analysis of water (microorganisms).
41. Antibiotic sensitivity test, LD_{50}, Potency of drug/antibiotics and biotransformation.
42. Identification of unknown bacteria by biochemical tests.
43. Immobilization of *Saccharomyces cerevisiae* and alcohol production.
44. Immunodiffusion, Immunoelectrophoresis and ELISA. Radioimmunoassay.
45. Development of monoclonal antibodies by hybridoma technology.
46. Production of polyclonal antobodies by hybridoma technology. immunoelectrophoresis, crossed antigen-antibody electrophoresis, radioimmunoassay, immunoblotting, immunoflourescence, agglutination, rosette formation, complement-fixation.
47. Antigen-induced T cell proliferation.generation of cytotoxic T lymphocytes.