

M.D.UNIVERSITY, ROHTAK
SCHEME OF STUDIES & EXAMINATION
2ND YEAR B. TECH. IN BIOTECHNOLOGY, F SCHEME
SEMESTER III
EFFECTIVE FROM THE SESSION 2010-11

S.No	Course No.	Subject	Teaching Schedule				Examination Schedule				Duration of exam
			L	T	P/D	Total	Th.	Sess	P/VV	Total	
1.	BT -201F	Cell Biology	3	1	-	4	100	50	-	150	3
2.	BT - 203 F	Microbiology	3	1	-	4	100	50	-	150	3
3.	BT- 205 F	Biochemistry	4	1	-	5	100	50	-	150	3
4.	BT- 207 F	Genetics	3	1	-	4	100	50	-	150	3
5.	BT -209 F	Fundamentals of Life Sciences	3	1		4	100	50	-	150	3
6.	BT- 211 F	Organic chemistry	3	1	-	4	100	50	-	150	3
7.	BT - 213 F	Cell Biology & Genetics Lab.	-	-	2	2	-	50	50	100	2
8.	BT- 215 F	Microbiology Lab.	-	-	3	3	-	50	50	100	3
9.	BT- 217 F	Biochemistry lab	-	-	3	3	-	50	50	100	3
10.	BT- 219 F	Fundamentals of Life sciences Lab	-	-	2	2	-	50	50	100	2
		Total	19	6	10	35	600	500	200	1300	

M.D.UNIVERSITY, ROHTAK
SCHEME OF STUDIES & EXAMINATION
2ND YEAR B. TECH. IN BIOTECHNOLOGY, F SCHEME
SEMESTER IV
EFFECTIVE FROM THE SESSION 2010-11

S.No	Course No.	Subject	Teaching Schedule				Examination Schedule				Duration of exam
			L	T	P/D	Total	Th.	Sess	P/VV	Total	
1.	BT –202 F	Molecular Biology	4	1	-	5	100	50	-	150	3
2.	BT – 204F	Immunology	3	1	-	4	100	50	-	150	3
3.	BT – 206F	Industrial Microbiology	3	1	-	4	100	50	-	150	3
4.	BT – 208F	Bioprocess Engineering-I	3	1	-	4	100	50	-	150	3
5.	BT – 210F	Bio-analytical Techniques	3	1	-	4	100	50	-	150	3
6.	BT-212 F	Biostatistics	3	1	-	4	100	50	-	150	3
7.	BT– 214F	Molecular Biology lab	-	-	3	3	-	50	50	100	3
8.	BT– 216 F	Immunology lab	-	-	3	3	-	50	50	100	3
9.	BT– 218F	Industrial Microbiology lab	-	-	3	3	-	50	50	100	3
10.	BT – 220F	Bio analytical techniques lab	-	-	2	2	-	50	50	100	2
		Total	19	6	11	36	600	500	200	1300	

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 3RD SEM

BT- 201 F

CELL BIOLOGY

Periods/week L:3 T:1
Duration of Ext. Exam: 3 Hrs

MAX. MARKS :150
Sessional:50
External:100

Instructions for setting of paper: Nine questions are to be set in total. First question will be short answer question covering whole syllabus and will be compulsory to attempt. Next eight questions will comprise of two questions each from the four sections. Student will be required to attempt four questions selecting one from each section. Each question will be of 20 marks.

Section -A

The Cell: Introduction, Discovery, Cell Theory, Diversity of Cell size, Shape and Structure, Basic properties, Organization, compartmentation, Organelles Architecture, Cell Fractionation.

Cell Membrane and Permeability: An overview, Brief History of Structural Studies, Membrane Proteins and Lipids, concept of Fluidity, Dynamic Nature, Transport of Nutrients.

Section - B

Ultra Structure of Cytoplasm:

Cytoskeleton: Structure and composition of intermediate filaments, Microtubules and Microfilaments.

Endoplasmic Reticulum: Structure and Functions and Role in Protein segregation.

Golgi complex: Structure, Biogenesis and Role in Protein Secretion.

Lysosomes, Vacuoles, Microbodies: Structure and Function.

Ribosomes : Structure, Function and Role in Protein Synthesis.

Mitochondria : Structure, Biogenesis and Genomes.

Chloroplast : Structure, Biogenesis and Genomes.

Nucleus : Structure, Cell Cycle and its regulation.

Section C

Cell signaling And Communication : General Principles, G Protein linked receptors, Enzyme linked cell surface receptor, Kinase receptors Second messengers, Hormone receptors interaction, Convergence Divergence and crosstalk among different signaling pathway, calcium and NO as intracellular messenger.

Cell interaction: Cell junctions, cell Adhesion and Extracellular matrix, Reception-integerins, Plant Cell wall, Apoptosis.

Cancer : Carcinogenesis, Agents, Process, Tumor Cells, Protooncogenes and viral oncogenes and molecular basis.

Section D

Muscle Contraction: Structure of muscle, Structural proteins of muscles, Energetics and Regulation of muscle contraction.

Neurons and neurotransmitters: Resting potential, Action potential, synaptic transmission, neurotransmitters and receptors, the generation of action potential by sensory stimuli and mechanisms of nerve impulse.

List of Text / Reference Books:

1. Cell and Molecular Biology-De Robertes
2. Cell Biology-Sadava, Jones and Bartlett publisher
3. Essential of Cell Biology-Alberts et Al, Garland Publisher.
4. The Cell- A Molecular Approach. Cooper, ASM Press..
5. Molecular Biology of Cell Albert Et Al, John Wiley and Sons.
6. Cell and Molecular Biology, Concepts and Experiments, Gerald Karp, John Wiley and Sons
7. Molecular Biology of The Cell, Lodish et al, 5th Ed
8. Cell and Molecular Biology, Sheeler & Bianchi

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 3RD SEM

BT-203 F

MICROBIOLOGY

Periods/week L:3 T:1
Duration of Ext. Exam: 3 Hrs

MAX. MARKS :150
Sessional:50
External:100

Instructions for setting of paper: Nine questions are to be set in total. First question will be short answer question covering whole syllabus and will be compulsory to attempt. Next eight questions will comprise of two questions each from the four sections. Student will be required to attempt four questions selecting one from each section. Each question will be of 20 marks.

SECTION A

Introduction to Microbiology: Scope and brief history of microbiology (Contributions of Leuwenhoek, Pasteur, Koch, Jenner, Winogradsky, Beijerinck); Microbial taxonomy: systems of classification (Haeckel,s three kingdom concept, Whittaker's five kingdom classification, microbial phylogenetic groups, Bergey,s manual); criteria for classification including molecular approaches.

Microbial diversity: Overview of prokaryotes and eukaryotes. Morphology, Structure and chemical composition of bacteria. General characteristics of major groups of bacteria: archebacteria, eubacteria, actinomycetes, rickettsias, chlamydiae and mycoplasma. Salient features of fungi, protozoa and algae; Structure and life cycle of virus (Lytic and Lysogenic)

SECTION B

Microbial Nutrition and Metabolism:

Nutritional requirements:- Macronutrients, micronutrients and growth factors; classification of microorganisms based on nutrition; Laboratory culture of microorganisms: Culture media, aseptic technique, pure culture and preservation techniques, use of plant residues in media: starch, cellulose, hemicellulose and lignin

Microbial Metabolism: An overview of Metabolism -: Carbohydrate catabolism: glycolysis, alternate to glycolysis-ED pathway, pentose phosphate pathway; cellular respiration : aerobic and anaerobic; photosynthesis; overview of lipid and protein metabolism.

SECTION C

Sterilization methods: Physical methods: Heat sterilization, Radiation Sterilization and Filter Sterilization Chemical methods: Disinfectants and Antiseptics, growth factor analogs and antibiotics

Fermentation technology: A historical perspective, microbiology of industrial fermentation, biomass formation, methods to study biomass, central and intermediary metabolism.

SECTION D

Bacterial reproduction and growth- Modes of cell division and process of sporulation. Growth curve (log, exponential, stationary and cell death), mathematical expression of growth, diauxic growth, synchronous and continuous growth, methods of growth measurement, effects of environmental factors on growth: temperature, pH, water availability and oxygen.

Preservation of gene pool in industrial organism: Types and handling of culture collections, methods of preserving microbes.

List of Text / References Books :

1. Brock Biology of Microorganisms M.T. Madigan; J.M. Martinko; J.Parker Prentice Hall Int Inc.
2. Microbiology: Pelczar et al, tata Mc Graw Hill, New Delhi
3. Microbiology: Prescott et al., 2003, 5th edition Mc Graw Hill, USA
4. Microbiology An Introduction: Tortora, Funke, Case. Benjamin-Cummings Publishing company.
5. General Microbiology: Stanier RY, Ingraham JL, Wheelis ML, Painter PR. McMillan.
6. Microbiology: Weistreich GA, Lechtman MD. McMillan Publishing Co.

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 3RD SEM

BT - 205 F

BIOCHEMISTRY

Periods/week L:4 T:1
Duration of Ext. Exam: 3 Hrs

MAX. MARKS :150
Sessional:50
External:100

Instructions for setting of paper: Nine questions are to be set in total. First question will be short answer question covering whole syllabus and will be compulsory to attempt. Next eight questions will comprise of two questions each from the four sections. Student will be required to attempt four questions selecting one from each section. Each question will be of 20 marks.

Section A

Introduction to Biochemistry

Water and its Properties: Physico-chemical properties of water, acids bases and buffers, covalent bonds, non-covalent interactions in biological systems. Dissociation and dissociation constants, pH and buffers. pI, pKa, Hasselbach Hendersson equation and its implications.

Bioenergetics: First and second laws of thermodynamics and concept of free energy, high-energy phosphate compounds, ATP and its participation in metabolic network.

Section B

Amino acids and Proteins: Structure, properties, classification and functions of amino acids, structure and function of proteins. Protein denaturation and renaturation, folding pathways, folding accessory proteins, proteins purification procedures.

Protein metabolism: metabolic fate of amino group, transamination and deamination, decarboxylation and oxidative degradation of amino acids, Nitrogen excretion and urea cycle.

Section C

Carbohydrates: Definition classification, Basic structure, properties and functions of monosaccharides and related compounds, di-saccharides and poly-saccharides. Structural polysaccharides-cellulose and chitin, storage polysaccharides-starch, glycogen, peptidoglycan and glycosaminoglycans, proteoglycans and glycoproteins.

Carbohydrate metabolism: Glycolysis, kreb's cycle. Pentose phosphate pathway, glyoxylate cycle, glycogenolysis and glycogenesis, gluconeogenesis. Pyruvate Dehydrogenase and its regulation. TCA cycle: reactions regulation and Amphibolic nature, glyoxalate cycle, Electron Transport Chain, inhibitors and uncouplers of oxidative phosphorylation.

Lipids: Classification of lipids and fatty acids. General Structure and function of major lipid subclasses, acylglycerols, phosphoglycerides, sphingolipids, glycosphingolipids and terpenes, sterols, steroids.

Lipid metabolism: Biosynthesis of odd and even carbon saturated and unsaturated fatty acids, formation of ketone bodies, biosynthesis of triacylglycerols, membrane phospholipids, cholesterol and steroids.

Section D

Nucleic Acids- Structure and functions: Structure and properties of purine and pyrimidine bases. Nucleosides and nucleotides. Biologically important nucleotides.

Nucleic acid metabolism: Biosynthesis and break down of purine & pyrimidine nucleotide by de-novo and salvage pathway

Enzymes: Nomenclature and classification, co-enzymes and co-factors, reaction and derivation of Michaelis-Menten equation, Lineweaver-Burke plot, inhibition kinetics and allosteric regulation of enzymes, isozymes, mode of catalysis.

Vitamins and Hormones: their structure, properties and biological functions.

List of Text / Reference Books:

1. A.L. Lehninger, D.L. Nelson, M.M. Cox, "Principles of Biochemistry", 3rd Edn., worth Publishers, 2000.
2. L. Stryer, J.M. Berg, J.L. Tymoczko, "Biochemistry", 5th Edition, W.H. Freeman and Co., 2002.
3. Harper's Biochemistry, 25th edition, by R.K. Murray, P.A Hayes, D.K. Granner, P.A. Mayes and V.W. Rodwell (2000). Prentice Hall International.
4. Fundamentals of Biochemistry by Donald Voet and Judith G Voet (1999), John Wiley & sons, NY
5. Biochemistry, 4th edition, by G. Zubay (1998). Wm.C. Brown Publishers.
6. Biochemistry, 2nd edition, by Laurence A. Moran, K.G. Scrimgeour, H.R. Horton, R.S.Ochs and J. David Rawn (1994), Neil Patterson Publishers Prentice Hall.

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 3RD SEM

BT- 207 F

GENETICS

Periods/week L:3 T:1
Duration of Ext. Exam: 3 Hrs

MAX. MARKS :150
Sessional:50
External:100

Instructions for setting of paper: Nine questions are to be set in total. First question will be short answer question covering whole syllabus and will be compulsory to attempt. Next eight questions will comprise of two questions each from the four sections. Student will be required to attempt four questions selecting one from each section. Each question will be of 20 marks.

SECTION A

Classical and Non-Classical Genetics.

Introduction, History, Classical and molecular, Genetics , Mendel's Laws of inheritance and its applications, Monohybrid and Dihybrid Crosses, Types of dominance, Test cross and back cross, common gene interactions: Complementary genes, Supplementary genes, Cumulative genes, Duplicate genes, Inhibiting genes, Lethal genes, Penetrance Expressivity, Pleiotropy, Atavism, Modifiers, Qualitative and Quantitative characters, Physical basis of heredity., genetic basis of continuous phenotypic variety, Analysis of genetic data.

SECTION B

Chromosomes:

General Features of chromosomes: Morphology, Chemical composition, Structure and functions, Chromosomal aberrations: Structural and Numerical changes, The chromosomal theory of inheritance, Sex determination, Sex influenced characters, sex limited inheritance.

Organization of chromosomes:

Chromosome organization and molecular structure, The structure of bacterial chromosomes, the structure of Eukaryotic Chromosome Special chromosomes: Lampbrush Chromosomes, Polytene Chromosomes, and Accessory Chromosomes, euchromatin, heterochromatin, Repetitive and non repetitive DNA.

Linkage, Crossing Over and Recombination: Linkage, Crossing Over, Recombination in Chromosomes, Chromosome mapping, Genetic mapping: Gene mapping from two point and three point test cross, mapping by tetrad analysis, Complementation.

SECTION C

Cytoplasmic Inheritance: Cytoplasmic inheritance in Eukaryotes, Maternal Inheritance, Cytoplasmic Inheritance by Cell Organelles, Cytoplasmic Inheritance by Endosymbionts, Cytoplasmic inheritance in haploids, cytoplasmic inheritance in Prokaryotes.

Mutation: Characteristics, Classification and Molecular basis, Physical Mutagens and Chemical Mutagens, Detections of Mutation, Directed Mutagenesis, Application of Mutation, Mechanism of DNA repair.

SECTION D

Population Genetics: Gene frequency, Genotype Frequency, Gene pool, Hardy-Weinberg law, Random Union of gametes, Random mating among Genotypes, Factors affecting gene frequencies : Migration, Mutation, Natural Selection, Random Drift and Founder's Principle, Inbreeding and Outbreeding.

Inheritance of Quantitative Characters: Quantitative and Qualitative Character, Inheritance of Quantitative Characters, Multiple factor hypothesis, Analysis of quantitative data: Mean, Range, Variance, Standard Deviation, Coefficient of Variation, Effect of Environment on Quantitative characters. Cause of Variations.

Genetic And Man: Human Genetics: Introduction to human Genome, genetic Studies: Genetic Diseases, Blood Groups, Disputed Parentage, Histocompatibility, Immune response, Linkage Studies, Somatic Cell Hybridization, Antibodies and Antigens Variability, Cytogenetics, Evolutionary Genetics.

List of Text / Reference Books:

1. Principles of Genetics by Gardner published by John Wiley & Sons.
2. Genetics: Analysis and Principles by Robert J. Brooker, 3rd Edition published by MC Graw Hill Science.
3. Genetic by M.W Strickberger Published by Prentice Hall College Division.
4. Genetic: Analysis of genes and genomes by Daniel Harti, 7th Edition published by Jones and Bartlet.
5. Genetic by P.J Russel, 5th Edition published by Addison Wesley Longman, Inc. California.
6. Concept of Genetics by William S. Klug, Michael Charlotte Spencer and Michael A , Palladino, 9th Edition published by Benjamin Cumming.
7. Genetics by Benjamin Pierce, 3rd Edition Published by W.H. Freeman.
8. Essential of Genetics: A genomic perspective by Daniel L Harti and Elizabeth W. Jones , 4th Edition Published by Jones and Bartlet.

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 3RD SEM

BT-209 F

FUNDAMENTAL OF LIFE SCIENCES

Periods/week L: 3 T: 1

Duration of Ext. Exam: 3 Hrs

MAX. MARKS: 150

Sessional: 50

External: 100

Instructions for setting of paper: Nine questions are to be set in total. First question will be short answer question covering whole syllabus and will be compulsory to attempt. Next eight questions will comprise of two questions each from the four sections. Student will be required to attempt four questions selecting one from each section. Each question will be of 20 marks.

Section A

The vertebrates: Salient features of Pisces (roho), amphibians (frog), reptiles (lizard), aves (pigeon), and mammals (human beings).

The kingdom Plantae: General characteristics of Bryophytes (moss), Pteridophytes (pteris), Gymnosperms (pinus) and Angiosperms (rose).

Morphology and anatomy of Angiosperms: General Plant organization: Organ systems of the plant body – root and shoot and their modifications. Characteristics of dicots and monocots.

Section B

Human Anatomy and physiology:

The types of cells and body organisation. The Skin, The Skeleton, Muscles, Cardiovascular System, Respiratory System, Lymphatic System, The Gut and Digestion, Urinary System, Reproductive System, System, The, Endocrine System

Plant Physiology:

Photosynthesis: chloroplasts and light; carbon dioxide fixation and carbohydrate synthesis; Photosynthesis: environmental and agricultural aspects; respiration; assimilation of nitrogen and sulfur; and lipids and other natural products.

Section C

Developmental Biology: Principles of Developmental Biology, blastulation, gastrulation, cleavage, fertilization, parthenogenesis, metamorphogenesis, regeneration, aging and theories of aging.

Plant Reproduction and development: Growth and development; hormones and growth regulators: auxins and gibberellins; cytokinins, ethylene, abscisic acid, and other compounds; the biological clock: rhythms of life; growth responses to temperature; photoperiodism; environmental physiology and stress physiology.

Section D

Biodiversity & Conservation: Conservation biology, Endangered species, Ex-situ conservation, In-situ conservation, Ecology, Gene pool, Genetic pollution, Genetic erosion, Megafauna, National Wildlife Federation, National Wildlife Magazine, Wildlife management, Wildlife Enforcement Monitoring System

Economic botany: Food crops Cereals (general), Legumes (general); **Cash crops:** Bamboo, Coconut (*Cocos*), Cotton (*Gossypium*), Sugar cane (*Saccharum*), Mushrooms, Natural rubber (*Hevea* and *Parthenium*), Sunflower (*Helianthus*), and safflower (*Carthamus*), Tea (*Camellia*), Wood and wood characteristics

Medicinal Plants: Foxglove and digitalis (*Digitalis*), Quinine (*Cinchona*), Rauwolfia (*Rauwolfia*), Marijuana (*Cannabis*), poppy (*Papaver*).

List of Text and Reference books

1. Guyton, A.C. and Hall, J.E., 2000, A Text Book of Medical Physiology, Xth Edition, W.B. Saunders Company.
2. Ganong, H, 2003, Review of Medical Physiology, 21st Edition, McGrawHill.
3. Strand Fluer, 1978, Physiology (a regulatory system approach) McMillan Pub. Co.
4. David Shier, Jakie, Butler & Lewis, 1996, Human Anatomy & Physiology, WCB, USA.
5. Scott F. Gilbert, A Companion to Developmental Biology 8th Edition Sinaur Associates
6. Salisbury & Ross, Plant Physiology, Wiley International.
7. Cultler DF, Botha T, Stevenson DW, Plant Anatomy: An Applied Approach, 2008, Wiley-Blackwell
8. Dickison WC, Integrative Plant Anatomy, Academic Press, New York
9. Lersten NR, Flowering Plant Embryology, Blackwell Publishing
10. Greenaway T, Plant Kingdom: A Guide to Plant Classification and Biodiversity, Raintree
11. Maiti RK and Pal V 2006 An Introduction to Modern Economic Botany, Eastern Book Corporation

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 3RD SEM

BT-211 F

ORGANIC CHEMISTRY

Periods/week L: 3 T:1

Duration of Ext. Exam: 3 Hrs

MAX. MARKS: 150

Sessional: 50

External: 100

Instructions for setting of paper: Nine questions are to be set in total. First question will be short answer question covering whole syllabus and will be compulsory to attempt. Next eight questions will comprise of two questions each from the four sections. Student will be required to attempt four questions selecting one from each section. Each question will be of 20 marks.

Section A

1. Types of Organic Reaction : Substitution, Addition, Elimination, Rearrangement Reactions: Wanger – Meerwin rearrangement, Cope rearrangement, Hyper conjugation : concept & consequences, hydrogen bonding: nature type, stability and its importance in organic compound.

2. IUPAC Nomenclature: Systematic IUPAC nomenclature of alkenes alkynes Cycloalkanes, aromatics bicyclic and polyfunctional organic compounds, bond line notation.

Section B

3. Reagents: Biological methylating reagents, Bayer & villager reaction, Reducing Agents : Their applications in Organic Chemistry with special emphasis on LiAlH₄, NaBH₄, Pt / Ni / H₂, METAL / NH₃, Solution, Diimide, Hydroboration Tri -n- butyl tin hydride.

4. Stereo Chemistry : Classification of stereomers , diastereomers , separation of enantiomers, absolute configuration (R & S) projection formulae stereochemistry of compounds containing two asymmetric C-atoms stereochemistry of biphenyls, Geometrical isomerism - concept ,E & Z nomenclature. Tautomerism–Concept, Ring chain tautomerism, Ring chain isomerism, properties , reactions of keto enol tautomers, Epoxides: properties & nucleophilic ring opening of epoxides.

Section C

5. Carbonyl Compounds : Nature & structure of carbonyl group ,Relative reactivities of carbonyl compounds , hydration & addition of alcohol to aldehydes and ketone , Addition of ammonia & ammonia derivatives to aldehydes & ketones , wolf – kishner reduction & its mechanism, aldol condensation, claisen , condensation reformatsky reaction & perkin reaction.

6. Acid Derivatives: Acid catalysed & base catalysed hydrolysis of esters & acid amides amono- lysis & alcohol lysis of esters.

Section D

7. Polymers : Classification of polymers functionality , chain growth and step growth polymers, co-ordination polymerization, epoxy resins, urea formaldehyde

resins, Natural rubber & its vulcanizations, elastomers, biopolymers, synthesis of drugs.

8. Peptide Bond Synthesis: Protection of N-terminal & C- terminal of amino acids, formation of peptide bonds, solid phase peptide synthesis.

List of Text / Reference books:

1. Organic Chemistry by I. L. FINAR
2. Modern Organic Chemistry by D.R.Boyed.
3. Organic chemistry by Paula Yurkanis Bruice.
4. Principle of organic synthesis by Richard Norman & James M Coxon.
5. Reaction Mechanism by O.P. Aggarwal.

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 3RD SEM

BT - 213 F CELL BIOLOGY & GENETICS LAB

Periods/week L:0 T:0 P: 2

Duration of Ext. Exam: 2 Hrs

MAX. MARKS : 100

Sessional: 50

External: 50

1. To study and observe the structure of prokaryotic cell.
2. To study and observe the structure of eukaryotic cell.
3. To count the number of cells using haemocytometer
4. To prepare temporary stained mounts of onion root tips to study mitosis cell division.
5. To prepare temporary stained mounts of insect gonads to study meiosis cell division.
6. To prepare temporary stained mounts of dicot stem.
7. To prepare temporary stained mounts of monocot stem.
8. To study cell membrane properties.
9. Isolation subfractionation and enzymatic analysis of cell organelles.
10. To study the technique of microtomy.

TEXT / REFERENCES BOOKS

1. Cell and Molecular Biology, Sheeler & Bianchi
2. Cultler DF, Botha T, Stevenson DW, Plant Anatomy: An Applied Approach, 2008, Wiley-Blackwell

NOTE. :

A College must offer 70% of the above listed exp. The remaining 30% exp. may be modified by college according to facilities available.

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 3RD SEM

BT- 215 F

MICROBIOLOGY LAB

Periods/week L:0 T:0 P: 3

MAX. MARKS : 100

Duration of Ext. Exam: 3 Hrs

Sessional: 50

External: 50

1. Microscopy: Use of microscopes, microscopic examination of microorganisms.
2. Micrometry: Microscopic measurement of microorganisms.
3. Staining methods.
4. Preparation of culture media.
5. Isolation and enumeration of microorganisms from different sources.
6. Pure culture techniques – Streak plate, Pour plate, Spread plate
7. Measurements of growth and study of effect of various factors on growth of Microorganisms temp. , pH, salt concentration, U.V. & R.H.
8. Biochemical tests useful in bacterial taxonomy.
9. Water microbiology – BOD, multiple tube fermentation tests.
10. Milk Microbiology –SPC, testing the quality of milk.

TEXT / REFERENCES BOOKS

1. Experiment in Microbiology, Plant pathology, Tissue Culture & Mushroom production technology: Aneja K.R, .2001, 3RD Edition, New Age International Publishers, New Delhi.

2. Microbiology –A Lab manual, Cappuccino J. & Sheeman N, 2000, 4th Edition, Addison Wesley California .

NOTE. :

A College must offer 70% of the above listed exp. The remaining 30% exp. may be modified by college according to facilities available.

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 3RD SEM

BT- 217 F

BIOCHEMISTRY LAB

Periods/week L:0 T:0 P: 3

Duration of Ext. Exam: 3 Hrs

MAX. MARKS : 100

Sessional: 50

External: 50

1. Units, Volume/Weight measurements, concentration units, pH measurements and preparation of buffers.
2. Qualitative estimation of amino acids.
3. Spectrophotometric estimation of amino acids by Ninhydrin method.
4. Qualitative and quantitative estimation of proteins.
5. Qualitative and quantitative estimation of lipids.
6. Qualitative and quantitative estimation of Carbohydrates.
7. Estimation of alpha-amylase from saliva and effect of temperature and pH on its activity.
8. Biochemical analysis of normal and abnormal constituents of urine.
9. Determination of Km and Vmax for salivary amylase.
10. To study the Isozyme pattern by gel electrophoresis.
11. Quantitative determination of DNA and RNA by spectrophotometric method.
12. Determination of T_m value from thermal denaturation characteristics.

List of Reference Books

1. Principal and techniques of Practical Biochemistry : K. Wilson and J. Walker (1994), Cambridge University Press, Cambridge.
2. Introductory Practical Biochemistry by S.K. Sawhney and Randhir singh (2000), Norosa Publishing House, New Delhi.
3. An Introduction to practical biochemistry by David T.Plummer (1988), McGraw-Hill, Book Company ,UK.

NOTE. :

A College must offer 70% of the above listed exp. The remaining 30% exp. may be modified by college according to facilities available.

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 3RD SEM

BT-219 F

FUNDAMENTAL OF LIFE SCIENCES LAB.

Periods/week L: 0 T: 0 P: 2
100

MAX. MARKS:

Duration of Ext. Exam: 2 Hrs

Sessional: 50

External: 50

1. Study of specimens from Animal kingdom (vertebrates).
2. Histology of animal tissues and organ systems (Nervous, Digestive, Reproductive, Respiratory and Circulatory system).
3. Study of specimens from Plant kingdom (as mentioned in theory syllabus).
4. Histology of plant tissues and organs: dicots and monocots.
5. Microtomy: preparation of permanent slides.

TEXT / REFERENCES BOOKS

1. Cultler DF, Botha T, Stevenson DW, Plant Anatomy: An Applied Approach, 2008, Wiley-Blackwell
2. Guyton, A.C. and Hall, J.E., 2000, A Text Book of Medical Physiology, Xth Edition, W.B. Saunders Company.

NOTE. :

A College must offer 70% of the above listed exp. The remaining 30% exp. may be modified by college according to facilities available.

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 4TH SEM

BT - 202 F

MOLECULAR BIOLOGY

Periods/week L:4 T:1

Duration of Ext. Exam: 3 Hrs

MAX. MARKS :150

Sessional:50

External:100

Instructions for setting of paper: Nine questions are to be set in total. First question will be short answer question covering whole syllabus and will be compulsory to attempt. Next eight questions will comprise of two questions each from the four sections. Student will be required to attempt four questions selecting one from each section. Each question will be of 20 marks.

SECTION A

DNA: Introduction, structure, properties: physical and chemical, biological significance of double strand, DNA bending, DNA super coiling, cruciform and ZDNA structure, DNA Triplex, DNA protein interactions, organization of chromosomes, euchromatin and heterochromatin packaging in nucleosomes, chromosome organization in cell. Denaturation and renaturation of DNA-T_m values and cot curves analysis. C-value paradox, Repetitive and non repetitive DNA and its relevance to plants and animals, inverted and tandem repeats. Gene, split genes, housekeeping genes.

SECTION B

DNA Replication: Origin of replication, DNA polymerase, mechanism of DNA replication in prokaryotes and eukaryotes, DNA replication models, DNA damage, DNA repair.

Transcription: Mechanism in prokaryotes and eukaryotes, RNA polymerase, sigma factor, regulation of transcription, transcriptional factors, post transcriptional processing (5' and capping and 3' polyadenylation), Zinc finger motifs, helix loop helix, leucine Zippers.

RNA splicing: Intron and exon, splicing mechanism for mRNA, tRNA, spliceosome, lariat formation, Ribozymes, cis splicing and trans splicing.

SECTION C

Operon model: Regulation of gene expression in prokaryotes and eukaryotes; Lactose and Tryptophan operon, inducible and repressible systems; positive and negative control.

Protein synthesis: Genetic code, Wobble hypothesis, Component of protein synthesis-ribosomes, tRNA, mRNA, rRNA, mechanism of protein synthesis, regulation of protein synthesis, post transitional modification, chaperones, transport of protein, degradation of protein.

SECTION D

Transposons: The dynamic genome: Mobile genetic elements in prokaryotes-insertion sequences, composite and non composite transposones, replicative and conservative transposition, retrotransposon, eukaryotic jumping genes-relevance to plants.

List of Text/ Reference Books:

1. DNA structure and function: Richard R Sindex, Academic Press.
2. Genes VII, Lewin B, Oxford University Press
3. Molecular Cell Biology: Bruce Alberts, James D.Watson, Garland Publishing.
4. The Cell-a molecular approach,. Cooper, A.S.M Press
5. Cell & Molecular Biology, concepts & experiments, Gerald Karp, John Wiley & Sons
6. Essential of Molecular Biology: Malacinski,, Freifelder Jones, Bartlet Publisher 3rd ed.
7. Cell & Molecular Biology: E.D.P. Robertis. 8th ed.
8. Genomes: T.A. Brown, John Wiley & Sons Pvt. LTS

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 4TH SEM

BT - 204 F

IMMUNOLOGY

Periods/week L:3 T:1

Duration of Ext. Exam: 3 Hrs

MAX. MARKS :150

Sessional:50

External:100

Instructions for setting of paper: Nine questions are to be set in total. First question will be short answer question covering whole syllabus and will be compulsory to attempt. Next eight questions will comprise of two questions each from the four sections. Student will be required to attempt four questions selecting one from each section. Each question will be of 20 marks.

SECTION A

Basic Immunology : Types of immunity: innate and acquired: cells and organs of immune system B-Lymphocytes and T- Lymphocytes, Primary and secondary lymphoid organs, humoral and cell mediated immune response.

SECTION B

Immune System : Antigens, immunoglobulins : structure and function, antigenic determinants : Isotype, allotype & idio type; Monoclonal Ab , Hybridoma technology Organization and expression of immunoglobulin genes, Generation of Ab. Diversity, class switching , and Ab. Engg.

SECTION C

Generation of B-Cell and T-Cell Responses : Major histocompatibility complex , Peptide binding by class I and class II molecules , Ag. Processing presentation, T-Cell receptor ,T-cell maturation , activation & differentiation , Positive & negative selection, signaling pathways.

Immunological Techniques : ELISA , Radio immunoassay , immuno-precipitation reactions.

SECTION D

Immune Effector Responses : Cytokines properties , The complement system, Role of T- helper cells in cytokine production , cell mediated effector responses .

Immune system in Health & Disease : Hypersensitive reaction, auto immunity, and immune response to infectious disease, tumor immunity, tissue and organ transplant , vaccines & peptide vaccines.

TEXT / REFERENCE BOOKS

1. **Kuby,s Immunology** (4th edition) R.A. Goldsby ,T. J. Kindt, B.A. Osborne, W.H.Freeman & company, New York.
2. **Essential Immunology** (10th edition), Ivon Roitt, Peter Delves, Blackswell, Scientific Publications. Oxford.
3. **Fundamental of immunology** . Paul W.E.(Eds) Raven press ,New York.
4. **Immunology** by Presscot .

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 4TH SEM

BT - 206 F INDUSTRIAL MICROBIOLOGY

Periods/week L:3 T:1

MAX. MARKS :150

Duration of Ext. Exam: 3 Hrs

Sessional:50

External:100

Instructions for setting of paper: Nine questions are to be set in total. First question will be short answer question covering whole syllabus and will be compulsory to attempt. Next eight questions will comprise of two questions each from the four sections. Student will be required to attempt four questions selecting one from each section. Each question will be of 20 marks.

SECTION A

Basics of industrial microbiology:

Introduction: An overview, history, scope and applications of industrial microbiology.

Fermentation: Basic principle, component, range and types of fermentation.

Strain development:

Isolation and screening methods of industrially important microorganisms.

Improvement of industrial microorganisms using classical and recombinant DNA approaches.

SECTION B

Production of microbial metabolites I:

Industrial production of alcohols (ethanol, butanol), organic acids (citric acid, acetic acid) enzymes (amylases, proteases, cellulases) and alcoholic beverages (beer,wine)

SECTION C

Production of microbial metabolites II:

Industrial production of amino acids (glutamic acid, lysine, tryptophan), vitamins (vitamin B12, Riboflavin) and antibiotics (penicillin, Steptomycin, tetracycline).

SECTION D

Bioproducts specific to agricultural and food industries:

Biopesticide, biofertilizers, biopolymers (dextran, xanthan & PHB), prebiotics & Probiotics, single cell protein.

Fermentation Economics:

Introduction to fermentation economics, production decisions, cost and investment decisions, market potential, case studies.

List of References Books :

1. Biotechnology: a handbook of Industrial Microbiology: W. Cruger & , second edition, Panima
2. Industrial Microbiology: L.E Casida, Wiley Eastern Ltd(1989)
3. Principles of fermentation technology, p F Stanbury and A Whitaker, Pergamon Press (1986)
4. Industrial Microbiology: Prescott & Dunn, CBS Publisher (1987)
5. Biology of microorganisms, eighth edition, M.T.Madigan; J.M. Martinko; J.Parker, Prentice Hall International
6. Microbial technology: fermentation technology, second edition, peppler & Perlman, Elsevier Publications (2004)

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 4TH SEM

BT - 208 F BIOPROCESS ENGINEERING-I

Periods/week L:3 T:1

Duration of Ext. Exam: 3 Hrs

MAX. MARKS :150

Sessional:50

External:100

Instructions for setting of paper: Nine questions are to be set in total. First question will be short answer question covering whole syllabus and will be compulsory to attempt. Next eight questions will comprise of two questions each from the four sections. Student will be required to attempt four questions selecting one from each section. Each question will be of 20 marks.

SECTION A

Introduction to bioprocess engineering: Microbial and biochemical interaction with chemical engineering. Comparison of chemical and biochemical engineering, and role of bioprocess engineering in biotechnology.

Fluid Mechanics: Principle of microbial nutrition, formulation of culture media, selective media, factors influencing the choice of various carbon and nitrogen sources, vitamins, minerals, precursors and antifoam agents, importance of pH. Classification of fluids and Bernoulli's equation.

SECTION B

Sterilization: Introduction , Batch sterilization ,Continuous sterilization ,Sterilized media for microbiology ,Sterilization of media for stoke cultures , Sterilization of bacterial media ,Sterilize Petri dishes ,Dry heat sterilization, Sterilization with filtration, Microwave sterilization, Electron beam sterilization ,Chemical sterilization.

SECTION C

Extraction of fermentation products: Removal of solids: filtration, centrifugation, coagulation, flocculation, foam fractionation, whole broth treatment. Primary product isolation: cell disruption, liquids extraction etc. Purification of products, product isolation: crystallization, drying process.

SECTION D

Mass and heat transfer in bioprocess: Molecular diffusion, role of diffusion in Bioprocessing, convective mass transfer, liquid-solid mass transfer, liquid-liquid mass transfer, gas-liquid mass transfer, oxygen uptake in cell culture, factor affecting cellular oxygen demand, oxygen transfer in fermenter, measurement of $k_L a$.

Basic concepts of heat transfer in bioreactor, mechanism and general principle.

An overview of material and energy balance.

List of References Books :

1. Bioprocess engineering Basic concepts M.A Shuler, Fikiret Kargi, PHI, India
2. Priciples of fermentation technology, PF stanbury and A Whitaker, Pergamon press
3. Process Engineering in Biotechnology, AT Jackson
4. Bioprocess Engineering Principle
5. Coulson & Richardson's Chemical Engineering- Volume 3 (Chemical and Biochemical Reactors and process controls) ed. Richardson, J.F., Peacock, D.G., First Indian ed. Asian Books Pvt. Ltd. 1998

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 4TH SEM

BT - 210 F BIOANALYTICAL TECHNIQUES

Periods/week L:3 T:1

MAX. MARKS :150

Duration of Ext. Exam: 3 Hrs

Sessional:50

External:100

Instructions for setting of paper: Nine questions are to be set in total. First question will be short answer question covering whole syllabus and will be compulsory to attempt. Next eight questions will comprise of two questions each from the four sections. Student will be required to attempt four questions selecting one from each section. Each question will be of 20 marks.

SECTION A

Microscopy: Principle, Sample Preparation, technical arrangement and working of instrument: Light Microscopy- Bright Field, Dark Field and Phase Contrast microscopy, Fluorescence microscopy, Electron microscopy- Scanning & Transmission.

SECTION B

Centrifugation: Principles of Sedimentation, types of centrifuges and their applications, Differential, and Density Gradient centrifugation, Ultracentrifugation, Sub-Cellular Fractionation, Marker enzymes.

SECTION C

Chromatography: General principles, Adsorption, Partition. Ion-exchange, Molecular Exclusion, Affinity Chromatography, High Pressure Liquid Chromatography, Gas Chromatography, Paper Chromatography and thin layer Chromatography(one and two dimensional), selection of chromatographic systems.

Electrophoresis:

Principles of Electrophoresis, electrophoresis of proteins and nucleic acids immuno-electrophoresis, Isoelectric Focusing, Two-dimensional gel Electrophoresis, Capillary Electrophoresis, Microchip electrophoresis.

SECTION D

Spectroscopy: Basic Concepts, U.V/ Visible Spectroscopy, X-ray Spectroscopy, Spectrofluorimetry, Circular Dichroism Spectroscopy, Turbidimetry and Infra Red and Raman Spectroscopy, Nuclear Magnetic resonance.

Radioisotope Techniques: Nature of radioactivity, properties of α , β and γ rays, detection and measurement of radioactivity, Geiger Muller and Scintillation counting, Double labeling, instruments for monitoring radioactivity, Auto-radiography, Radio-immunoassay, Safety aspects and radio-waste management.

List of Reference Books:

1. **Principles and techniques of practical Biochemistry:** K. Wilson and J. Walker (1994), Cambridge University Press, Cambridge
2. **Physical BioChemistry**, 2nd edition by D. Friefelder, W.H. Freeman and company, U.S.A
3. **Introduction to instrumental analysis:** Robert. D. Braun (1987). McGraw Hill International Edition. Chemistry Series.
4. **Physical Biochemistry**, 2nd edition by K.E. Vanholde (1985), Prentice Hall Inc., New Jersey
5. **Biological Spectroscopy:** Campbell and Durek.

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 4TH SEM

BT - 212 F

BIostatISTICS

Periods/week L:3 T:1

MAX. MARKS :150

Duration of Ext. Exam: 3 Hrs

Sessional:50

External:100

Instructions for setting of paper: Nine questions are to be set in total. First question will be short answer question covering whole syllabus and will be compulsory to attempt. Next eight questions will comprise of two questions each from the four sections. Student will be required to attempt four questions selecting one from each section. Each question will be of 20 marks.

SECTION A

Introduction to Biostatistics:

Definition, types of data and Application, data collection, random and non random, Data representations, Bar, Histogram, Frequency Polygon, frequency curve, relative frequency curve, pie chart (with merits and demerits).

Descriptive Statistics:

Introduction to basic quantities methods, Measure of central tendency, mean, mode, median, Harmonic mean, Geometrical mean, Partitions, measure of dispersion, Range, Quartile deviation, mean deviation, standard deviation and, coefficient of variation, Lorentz's curve, difference between dispersion and skewness, measures of skewness and kurtosis (with merits and demerits).

SECTION B

Probability Distributions:

Introduction to probability and types of probability with applications in biostatistics, expected value of a random variable (discrete and continuous). Probability Distributions function, moment of generating function, properties and application of binomial, poisson and Normal distributions.

SECTION C

Sampling:

Introduction to sampling, Types of sampling, errors, standard error, confidence limits, large sample test, single probability test, deference of probability, single mean difference of mean difference of standard deviation, tests of significance of small samples, Student's t-distribution (applications only), Chi-square test of goodness of fit, comparisons of several means: A prior tests, Posteriori tests two ways Variance.

Anova and Nonparametric Test:

Introducing to F-test, Z-test, Introduction, Types of Anova-one way, two ways, Nonparametric methods, Advantages and Disadvantages of Non parametric and parametric method.

SECTION D

Correlation and regression:

Introduction to correlation, Rank's Correlation methods, Introduction to regression lines, linear and nonlinear fitting (least squares methods). Multiple regressions. Advantages and disadvantages of Correlation and regression.

List of Text / Reference Books:

1. Mathematical Statistics: S C Gupta and V K Kapoor, Sultan Shand & Sons
2. Fundamentals of Biostatistics: Bernard A. Rosner, Published by Thomson Brooks/ Cole
3. Statistics-An Introductory Analysis: Taro Yamane, Harper and Row Publisher.
4. Biostatistical Methods: J H Zar.
5. Biostatistical Methods: Khan & Khanum, Unkar Publication Hyderabad.
6. Text Book of Biostatistics II : A.K. Sharma, Discovery Publishing House

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 4TH SEM

BT - 214 F MOLECULAR BIOLOGY LAB.

Periods/week L:0 T:0 P:3

Duration of Ext. Exam: 3 Hrs

MAX. MARKS :100

Sessional: 50

External: 50

LIST OF EXPERIMENTS/PRACTICALS

1. Isolation of Prokaryotic genomic DNA
2. Isolation of Prokaryotic plasmid DNA
3. Isolation of DNA from Eukaryotes
4. To purify given DNA sample
5. Molecular weight characterization of a given DNA sample using Agarose Gel Electrophoresis
6. To perform the technique of Gel Extraction of DNA.
7. To study and perform the basic scheme of Polymerase Chain Reaction
8. To carry out the Simultaneous extraction of RNA, DNA and proteins
9. Isolation of protein fraction from different sources.
10. To study the technique of SDS-PAGE
11. To perform native PAGE of protein
12. To perform and compare different staining methods of proteins
13. To study and perform the technique of Restriction mapping.
14. To study DNA Sequencing Data Analysis.

List of References/Suggestive Books.

1. Molecular Cloning-a laboratory manual; 3rd edition vol.1-3 (2001), J. Sambrook and D.W Russell, Cold Spring Harbor Laboratory press, New York

NOTE. :

A College must offer 70% of the above listed exp. The remaining 30% exp. may be modified by college according to facilities available.

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 4TH SEM

BT - 216 F

IMMUNOLOGY LAB.

Periods/week L:0 T:0 P:3

MAX. MARKS :100

Duration of Ext. Exam: 3 Hrs

Sessional: 50

External: 50

LIST OF EXPERIMENTS/PRACTICALS

1. Handling and study of anatomy of the experimental model-mice / rabbit
2. To determine the concentration and partial purification of serum immunoglobulins by precipitation with ammonium sulphate and polyethylene glycol.
3. Planning of immunization schedule and preparation of adjuvants
4. Preparation of antigen
5. To perform immuno-diffusion by Ouchterlony method. (qualitative method)
6. To perform precipitation reaction by quantitative method
7. To perform immuno-diffusion by RIA method
8. To perform Immuno-electrophoresis with a given antigen-antibody system.
9. To perform DOT ELISA
10. To perform Indirect ELISA
11. To Perform Sandwich ELISA
12. To Identify different IgG isoforms

List of References:

1. Practical Immunology, Edition 4, by Frank C., Hay Ollwyn M R, Paul N, Nelson Lelie Hudson, Publisher Blackwell Science.
2. Practical & Clinical Immunology, Talwar G P, Gupta S K, CBS Publisher

NOTE. :

A College must offer 70% of the above listed exp. The remaining 30% exp. may be modified by college according to facilities available.

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 4TH SEM

BT - 218 F INDUSTRIAL MICROBIOLOGY LAB.

Periods/week L:0 T:0 P:3

MAX. MARKS :100

Duration of Ext. Exam: 3 Hrs

Sessional: 50

External: 50

LIST OF EXPERIMENTS/PRACTICALS

1. Isolation and identification of industrially important microbes.
2. To plot a growth curve of the given bacterial culture.
3. To plot a growth curve of yeast culture.
4. Isolation of antibiotic resistant mutants by replica plate technique.
5. Isolation of antibiotic resistant mutants by gradient plate technique.
6. Isolation and production of UV induced auxotrophic mutants by replica plate technique.
7. To isolate antibiotic producing microorganisms from soil.
8. To determine the antimicrobial spectrum of the isolated antibiotic producing microorganism.
9. To isolate amylase producing microorganisms from soil.
10. To compare the amylase activity of different isolates.
11. Production of alcohol from molasses.
12. To carry out the distillation of alcohol.
13. Penicillin Production and testing of antimicrobial activity.
14. Industrial Visit (to study the role of yeast in baking industry).

List of References/Suggestive Books:

1. Microbiology Lab. Manual: Cappuccino J. & Sheeman N.,2004,4th Edition & Addison Wesley, California.

NOTE. :

A College must offer 70% of the above listed exp. The remaining 30% exp. may be modified by college according to facilities available.

MAHARSHI DAYANAND UNIVERSITY
B. TECH. BIOTECH. 4TH SEM

BT - 220 F BIOANALYTICAL TECHNIQUES LAB.

Periods/week L:0 T:0 P:2
Duration of Ext. Exam: 2 Hrs

MAX. MARKS :100
Sessional: 50
External: 50

LIST OF EXPERIMENTS/PRACTICALS

1. Study of Phase Contrast Microscopy Technique.
2. Study of Density Gradient Centrifugation Technique.
3. Separation of biomolecules by paper chromatography.
4. Extraction of biomolecules from plant tissues and their separations using TLC.
5. Separation of biomolecules using two-dimensional TLC.
6. Partial Purification of an enzyme/protein by Ion exchange chromatography.
7. Desalting of protein by Gel filtration.
8. Determination of molecular weight of an enzyme/protein by Gel filtration.
9. Isolation and estimation of biomolecules by HPLC.
10. To purify protein by Affinity chromatography.
11. Separation of proteins by SDS-PAGE.
12. Separation of proteins by Isoelectric Focussing.
13. To determine the molar extinction coefficient of NADH.
14. To prepare an absorption spectrum of NADH.

LIST OF REFERENCE BOOKS:

1. **Principles & techniques of practical Biochemistry:** K.Wilson & J.Walker (1994), Cambridge University Press, Cambridge.
2. **Introductory Practical Biochemistry** by S.K. Sawhney & Randhir Singh (2000) Narosa Publishing House, New Delhi.
3. **An Introduction to practical biochemistry** by David T. Plummer (1988), McGraw-Hill, Book Company,UK.

NOTE. :

A College must offer 70% of the above listed exp. The remaining 30% exp. may be modified by college according to facilities available.