B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
Three-Year (6 Semester) Full Time Degree Programme

B.Sc. (Hons.) Biotechnology – First Year

Semester – I

S. No.	Subject Code	Subject	Subject area	Periods			Credit
				L	T	P	
1	49CH101	Biochemistry & Metabolism	C1	4	-	-	4
2	49BT102	Cell Biology	C2	4	-	-	4
3	49SD103	English communication	AECC1	2	-	-	2
4	49BT104	Biotechnology and Human Welfare	GE-1	4	-	-	4
5	49CH151	Biochemistry & Metabolism (Lab)	C1P	-	-	4	2
6	49BT152	Cell Biology(Lab)	C2P	-	-	4	2
7	49BT153	Biotechnology and Human Welfare (Lab)	GEP-1			4	2
			TOTAL	**14**	**-**	**12**	**20**

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –I
C-1: BIOCHEMISTRY AND METABOLISM (THEORY)
TOTAL HOURS: 60 CREDITS: 4

UNIT I: Introduction to Biochemistry: **No. of Hours: 12**

A historical prospective.

Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.

UNIT II **No. of Hours: 10**

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions.

UNIT III **No. of Hours: 14**

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA.

UNIT IV **No. of Hours: 12**

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD+ , NADP+, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate,lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions.

UNIT V **No. of Hours: 12**

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids.

C-1: BIOCHEMISTRY AND METABOLISM (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. To study activity of any enzyme under optimum conditions.
2. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
3. Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.
4. Estimation of blood glucose by glucose oxidase method.
5. Principles of Colorimetry:
    (i) Verification of Beer's law, estimation of protein.
    (ii) To study relation between absorbance and % transmission.
6. Preparation of buffers.
7. Separation of Amino acids by paper chromatography.
8. Qualitative tests for Carbohydrates, lipids and proteins

SUGGESTED READING

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –I
C-2: CELL BIOLOGY (THEORY)
TOTAL HOURS: 60 CREDITS: 4

UNIT I **No. of Hours: 12**

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation.

Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

UNIT II **No. of Hours: 13**

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.

Endoplasmic reticulum: Structure, function including role in protein segregation.

Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III **No. of Hours: 13**

Lysosomes: Vacuoles and micro bodies: Structure and functions

Ribosomes: Structures and function including role in protein synthesis.

Mitochondria: Structure and function, Genomes, biogenesis.

Chloroplasts: Structure and function, genomes, biogenesis

Nucleus: Structure and function, chromosomes and their structure.

UNIT IV **No. of Hours: 12**

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.

UNIT V **No. of Hours: 10**

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

C-2: CELL BIOLOGY (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
5. Study of structure of any Prokaryotic and Eukaryotic cell.
6. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
7. Cell division in onion root tip/ insect gonads.
8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

SUGGESTED READING

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
ABILITY ENHANCEMENT COMPULSORY COURSE
SEMESTER –I
ENGLISH COMMUNICATION

TOTAL HOURS: 50 **CREDITS: 2**

Preamble:

The purpose of this course is to introduce students to the theory, fundamentals and tools of communication and to develop in them vital communication skills which should be integral to personal, social and professional interactions. One of the critical links among human beings and an important thread that binds society together is the ability to share thoughts, emotions and ideas through various means of communication: both verbal and non-verbal. In the context of rapid globalization and increasing recognition of social and cultural pluralities, the significance of clear and effective communication has substantially enhanced.

The present course hopes to address some of these aspects through an interactive mode of teaching-learning process and by focusing on various dimensions of communication skills. Some of these are:

Language of communication, various speaking skills such as personal communication, social interactions and communication in professional situations such as interviews, group discussions and office environments, important reading skills as well as writing skills such as report writing, note taking etc.

While, to an extent, the art of communication is natural to all living beings, in today's world of complexities, it has also acquired some elements of science. It is hoped that after studying this course, students will find a difference in their personal and professional interactions.

The recommended readings given at the end are only suggestive; the students and teachers have the freedom to consult other materials on various units/topics given below. Similarly, the questions in the examination will be aimed towards assessing the skills learnt by the students rather than the textual content of the recommended books.

1. **Introduction**: Theory of Communication, Types and modes of Communication
2. **Language of Communication**:

   Verbal and Non-verbal

   (Spoken and Written)

   Personal, Social and Business

   Barriers and Strategies

   Intra-personal, Inter-personal and Group communication

3. **Speaking Skills**:

   Monologue

   Dialogue

   Group Discussion

   Effective Communication/ Mis- Communication

   Interview

   Public Speech

4. **Reading and Understanding**

   Close Reading

   Comprehension

   Summary Paraphrasing

   Analysis and Interpretation

   Translation (from Indian language to English and vice-versa)

   Literary/Knowledge Texts

5. **Writing Skills**

   Documenting

   Report Writing

   Making notes

   Letter writing

SUGGESTED READING

1. Fluency in English - Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (forthcoming) ed. Dr. Gauri Mishra, Dr Ranjana Kaul, Dr Brati Biswas

GENERIC ELECTIVE SUBJECTS
SEMESTER –I
GE-1: BIOTECHNOLOGY AND HUMAN WELFARE (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

UNIT I **No. of Hours: 12**

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

UNIT II **No. of Hours: 12**

Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT III **No. of Hours: 12**

Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB..

UNIT IV **No. of Hours: 12**

Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

UNIT V **No. of Hours: 12**

Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E.coli,* human genome project.

GE-1: BIOTECHNOLOGY AND HUMAN WELFARE (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Perform of ethanolic fermentaion using Baker's yeast
2. Study of a plant part infected with a microbe
3. To perform quantitative estimation of residual chlorine in water samples
4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)

SUGGESTED READING

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
Three-Year (6 Semester) Full Time Degree Programme

B.Sc. (Hons.) Biotechnology – First Year

Semester – II

S.No.	Subject Code	Subject	Subject area	Periods			Credit
				L	T	P	
1	49BT201	Mammalian Physiology	C3	4	-	-	4
2	49BT202	Plant and Microbial Physiology	C4	4	-	-	4
3	49EV203	Environmental Science	AECC2	2	-	-	2
4	49EN204	Entrepreneurship Development	GE-2	4	-	-	4
5	49BT251	Mammalian Physiology(Lab)	C3P	-	-	4	2
6	49BT252	Plant Physiology(Lab)	C4P	-	-	4	2
7	49EN253	Entrepreneurship Development (Project Viva voce)	GEP-2	-	-	-	2
			TOTAL	**14**	**-**	**12**	**20**

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –II
C-3: MAMMALIAN PHYSIOLOGY (THEORY)
TOTAL HOURS: 60 CREDITS: 4

UNIT I: **No. of Hours: 12**

Digestion and Respiration Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice

Respiration: Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift.

UNIT II: **No. of Hours: 12**

Circulation Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism of coagulation of blood.

Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

UNIT III: **No. of Hours: 12**

Muscle physiology and osmoregulation Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction.

Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

UNIT IV: **No. of Hours: 12**

Nervous and endocrine coordination Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters

UNIT V: **No. of Hours: 12**

Mechanism of action of hormones (insulin and steroids)

Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

C-3: MAMMALIAN PHYSIOLOGY PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Demonstration of action of an enzyme
6. Determination of Haemoglobin

SUGGESTED READING

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley & sons,Inc.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –II
C-4: PLANT AND MICROBIAL PHYSIOLOGY (THEORY)
TOTAL HOURS: 60 CREDITS: 4

UNIT I: **No. of Hours: 12**

Nutritional classification of microorganisms based on carbon, energy and electron sources, Metabolite Transport, Diffusion: Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron.

UNIT II: **No. of Hours: 12**

Effect of the environment on microbial growth

Temperature- temperature ranges for microbial growth, classification based on temperature ranges and adaptations, pH-classification based on pH ranges and adaptations, solutes and water activity, oxygen concentration, radiation and pressure. Chemolithotrophic metabolism, Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogenoxidizing bacteria and methanogens.

UNIT III: **No. of Hours: 12**

Photosynthesis- Photosynthesis pigments, anoxygenic and oxygenic photosynthesis, concept of two photo systems, photosynthetic pigments photphosphorylation, , physiology of bacterial photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation. Carbon dioxide fixation, calvin cycle, CAM plants, photorespiration, compensation point.

UNIT IV: **No. of Hours: 12**

Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

Growth and development: Definitions, phases of growth, growth curve,

UNIT V: **No. of Hours: 12**

Growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene)

Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization

C-4: PLANT AND MICROBIAL PHYSIOLOGY (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Separation of photosynthetic pigments by paper chromatography.
2. Demonstration of aerobic respiration.
3. Preparation of root nodules from a leguminous plant.
4. To study and plot the growth curve of E coli using turbidometric method and to calculate specific growth rate and generation time.
5. To study and plot the growth curve of *Aspergillus niger* by radial growth measurements.
6. To study the effect of pH on the growth of E. coli
7. To study the effect of temperature of *Aspergillus niger* by dry weight method.
8. Demonstration of the thermal death time and decimal reduction time of E. coli.

SUGGESTED READING

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
5. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.
6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4th edition, W.H. Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
8. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th edition, Sinauer Associates Inc .MA, USA

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
ABILITY ENHANCEMENT COMPULSORY COURSE
SEMESTER –II
ENVIRONMENTAL STUDIES

TOTAL HOURS: 50 **CREDITS: 2**

UNIT I **No. of Hours: 8**

Introduction to environmental studies

- Multidisciplinary nature of environmental studies;
- Scope and importance; Concept of sustainability and sustainable development.

UNIT II **No. of Hours: 6**

Ecosystems

- What is an ecosystem? Structure and Function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems:

a) Forest ecosystem
b) Grassland ecosystem
c) Desert ecosystem
d) Aquatic ecosystems (ponds, streams, lakes, rivers,oceans, estuaries)

UNIT III **No. of Hours: 8**

Natural Resources:

Renewable and Non---renewable Resources

- Land resources and land use change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water: Use and over---exploitation of surface and groundwater, floods, droughts, conflicts over water (international& inter---state).
- Energy resources: Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

UNIT IV **No. of Hours: 8**

Biodiversity and Conservation

- Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega---biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity: Habitat loss, poaching of wildlife, man---wildlife conflicts, biological invasions; Conservation of biodiversity: In---situ and Ex---situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic And Informational value.

UNIT V **No. of Hours: 8**

Environmental Pollution

- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution

- Nuclear hazards and human health risks
- Solid waste management : Control measures of urban and industrial waste.
- Pollution case studies.

UNIT VI **No. of Hours: 7**

Environmental Policies & Practices

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture
- Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).
- Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

UNIT VII **No. of Hours: 6**

Human Communities and the Environment

- Human population growth: Impacts on environment, human health and welfare.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management: floods, earthquake, cyclones and landslides.
- Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

UNIT VIII **No. of Hours: 5**

Field work

- Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
- Visit to a local polluted site---Urban /Rural /Industrial /Agricultural.
- Study of common plants, insects, birds and basic principles of identification.
- Study of simple ecosystems---pond, river, Delhi Ridge, etc.

SUGGESTED READING

1. Odum, E.P., Odum, H.T. & Andrews, J. 1971. Fundamentals of Ecology Philadelphia: Saunder
2. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press
3. Raven P.H., Hassenzahl, D.M., & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons
4. Rosencranz, A., Divan, S., & Noble, M. L. 2001 Environmental law and policy in India Tripathi 1992
5. Singh, J.S., Singh, S.P. & Gupta, S.R. 2014 Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
GENERIC ELECTIVE SUBJECTS
SEMESTER –II
GE-3: ENTREPRENEURSHIP DEVELOPMENT (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

UNIT I INTRODUCTION **No. of Hours: 12**

Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

UNIT II ESTABLISHING AN ENTERPRISE **No. of Hours: 12**

Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility.

UNIT III FINANCING THE ENTERPRISE **No. of Hours: 12**

Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.

UNIT IV MARKETING MANAGEMENT **No. of Hours: 12**

Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product like cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.

UNIT V ENTREPRENEURSHIP AND INTERNATIONAL BUSINESS **No. of Hours: 12**

Meaning of International business, Selection of a product, Selection of a market for international business, Export financing, Institutional support for exports.

Project Report on a selected product should be prepared and submitted.

SUGGESTED READING

1. Holt DH. Entrepreneurship: New Venture Creation.
2. Kaplan JM Patterns of Entrepreneurship.
3. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand & Sons.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
Three-Year (6 Semester) Full Time Degree Programme

B.Sc. (Hons.) Biotechnology – Second Year

Semester – III

S.No.	Subject Code	Subject	Subject area	Periods			Credit
				L	T	P	
1	49BT301	Genetics	C5	4	-	-	4
2	49MB302	General Microbiology	C6	4	-	-	4
3	49CH303	Chemistry - 1	C7	4	-	-	4
Choose any one from number 4				2	-	-	2
4	49BT304	Industrial Fermentation	SEC-1				
	49FS305	Basics of Forensic Science	SEC-2				
5	49BT306	Bioethics and Bio-safety	GE-3	4	-	-	4
6	49BT351	Genetics (Lab)	C5P	-	-	4	2
7	49MB352	General Microbiology (Lab)	C6P	-	-	4	2
8	49CH353	Chemistry – 1 (Lab)	C7P	-	-	4	2
9	49BT354	Bioethics and Bio-safety (Lab)	GEP-3	-	-	4	2
			TOTAL	**18**	**-**	**16**	**26**

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –III
C-5: GENETICS (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

UNIT I **No. of Hours: 12**

Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance.

Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms.

Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept o f dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.

UNIT II **No. of Hours: 12**

Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.

Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA.

UNIT III **No. of Hours: 12**

Genetic organization of prokaryotic and viral genome.

Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

UNIT IV **No. of Hours: 12**

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abonormalities– Aneuploidy and Euploidy.

Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

UNIT V **No. of Hours: 12**

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping.

Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting.

Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

C-5: GENETICS (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Mendelian deviations in dihybrid crosses
4. Demonstration of - Barr Body -Rhoeo translocation.
5. Karyotyping with the help of photographs
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of polyploidy in onion root tip by colchicine treatment.

SUGGESTED READING

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –III
C-6: GENERAL MICROBIOLOGY (THEORY)
TOTAL HOURS: 60 CREDITS: 4

UNIT I **No. of Hours: 12**

Fundamentals, History and Evolution of Microbiology.

Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.

UNIT II **No. of Hours: 12**

Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT III **No. of Hours: 12**

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

UNIT IV **No. of Hours: 12**

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways

Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

UNIT V **No. of Hours: 12**

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents

Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.

Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

C-6: GENERAL MICROBIOLOGY (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.

SUGGESTED READING

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition. John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). *Modern Food Microbiology*. 7thedition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –III
C-7: CHEMISTRY-1 (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

UNIT I Stereochemistry **No. of Hours: 18**

Writing of Fischer projection, Newmann and Sawhorse projection and Wedge formulae. Interconversion of one type of structural representation into another type. Conformations: Restricted rotation about single bonds, Various conformations of ethane, butane, ethane-1,2-diol and cyclohexane. Relative stability of different conformations in terms of energy difference is to be discussed for all these compounds. Geometrical Isomerism: Requirements for a molecule to show geometrical isomerism, CisTrans and E/ Z notation along with CIP rules for geometrical isomers. Optical Isomerism: Optical activity, specific and molar rotation, chirality, enantiomerism, diastereoisomerism, racemic mixtures and their resolution by salt formation method. Relative and absolute configuration: D / L nomenclature system for configuration of carbohydrates (difference between d/l and D/L notations). Threo and Erythro designation. Rand S- configuration (upto two chiral centres).

UNIT II Addition Reaction **No. of Hours: 10**

Alkenes and Alkynes: Hydrogenation, addition of halogens, Hydrohalogenation (Markovnikov's and anti-Markovnikov's addition), hydration, hydroxylation (cis and trans), oxymercuration-demercuration, hydroboration-oxidation, ozonolysis. Reactivity of alkenes vs alkynes. Aldehydes and ketones: (formaldehyde, acetaldehyde, benzaldehyde, acetone) Addition of sodium bisulphite, hydrogen cyanide and alcohols. Addition- elimination reactions with ammonia and its derivatives Name reactions: Aldol, cross Aldol, Claisen, Knoevengel, Cannizzaro, cross Cannizzaro

UNIT III Substitution Reactions **No. of Hours: 15**

Free radical substitution reactions: Halogenation of alkanes, allylic compounds and alkyl benzenes. 34 Nucleophilic substitution reactions: Alkyl, allyl and benzyl halides – substitution of halogen by some common nucleophiles. Mechanism of SN1 and SN2 reactions (stereochemistry, nature of substrate, nucleophile and leaving group) Benzene diazonium chloride: Replacement of diazo group Alcohols, amines and phenols: Substitution of active hydrogen, replacement of hydroxyl group in alcohols (using PCl5, SOCl2 and HI) Carboxylic acid derivatives: Hydrolysis Ethers: Cleavage by HI Electrophilic Substitution Reactions (aromatic compounds): General mechanism of electrophilic substitution reactions (nitration, halogenation, sulphonation, Friedel Crafts alkylation and acylation), directive influence of substituents.

UNIT IV Elimination Reactions **No. of Hours: 6**

Alkyl halides (dehydrohalogenation, Saytzeff's rule), vicinal dihalides (dehalogenation), alcohols (dehydration), Quaternary ammonium salts (Hofmann's elimination). Mechanism of E1 and E2 reactions (nature of substrate and base), elimination vs substitution

UNIT V Oxidation & Reduction **No. of Hours: 11**

Oxidation: Aromatic side chain: Oxidation with potassium permanganate, potassium dichromate Alcohols: Oxidation with potassium permanganate, potassium dichromate, catalytic dehydrogenation and Oppenauer oxidation. Oxidation of 1,2–diols with periodic acid and lead tetraacetate. Aldehydes: Oxidation with potassium permanganate, chromic acid and Tollen's reagent Ketones: Oxidation with potassium permanganate, sodium hypoiodite (iodoform reaction) and Baeyer–Villiger oxidation

Reduction: Aldeydes and Ketones: Catalytic hydrogenation, reduction with sodium borohydride, lithium aluminium hydride, Clemmensen, Wolff-Kishner Carboxylic acids and their derivatives: Lithium aluminium hydride, sodium-ethanol and Rosenmund reduction. 35 Nitro compounds: Acidic, alkaline and neutral reducing agents, lithium aluminium hydride and electrolytic reduction.

C-7: CHEMISTRY-1 (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Purification of organic compounds by crystallization using the following solvents: a. Water b. Alcohol
2. Determination of the melting points of organic compounds (by Kjeldahl method and electrically heated melting point apparatus).
3. Determination of optical activity by using polarimeter Organic preparations: Carry out the following preparations using 0.5 - 1 g of starting compound. Recrystallize the product and determine the melting point of the recrystallized sample.
4. To prepare acetanilide by the acetylation of aniline.
5. To prepare p-bromoacetanilide.
6. Benzolyation of aniline or β-naphthol by Schotten-Baumann reaction
7. Hydrolysis of benzamide or ethyl bezoate.
8. Semicarbazone derivative of one the following compounds: acetone, ethyl methyl ketone, diethylketone, cyclohexanone, benzaldehyde.
9. Nitration of nitrobenzene.
10. Oxidation of benzaldehyde by using alkaline potassium permanganate.

SUGGESTED READING

1. I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
2. R. T. Morrison & R. N. Boyd: Organic Chemistry, Pearson Education.
3. Arun Bahl and B. S. Bahl : Advanced Organic Chemistry, S. Chand
4. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
5. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
6. T. W. Graham Solomon's Organic Chemistry, John Wiley and Sons.
7. P.S. Kalsi, Stereochemistry, Conformation and Mechanism, John Wiley and Sons.
8. D. Nasipuri, Stereochemistry of Organic Compounds, New Age International Publishers.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
GENERIC ELECTIVE SUBJECTS
SEMESTER –III
GE-2: BIOETHICS AND BIOSAFETY (THEORY)
TOTAL HOURS: 60 CREDITS: 4

Unit-I **No. of Hours: 12**

Biosafety: Introduction, Historical prospective, objectives, risk assessment in biotechnological research and their regulation, physical and biological contaminants, field trial and planned introduction of GMOs, Biosafety guidelines in India, Biosafety levels for plant, animal and microbial researches.

Unit-II **No. of Hours: 12**

Bioethics: Introduction, Ethical issues related to biotechnology, legal and socioeconomic impacts of biotechnology, health and safety issues, possible benefits of successful cloning, Ethical concerns of gene cloning, hazards of environmental engineering, Ethical issues in Human Cloning and stem cell research.

Unit-III **No. of Hours: 12**

Intellectual Property Right: Introduction, intellectual property: trade secret, patent, copyright, plant variety protection, WIPO, GATT, TRIPs, plant breeder's rights, protection of plant varieties and former's right act (2001), Choice and management of IPRs, advantage and limitations of IPRs.

Unit-IV **No. of Hours: 12**

Patents and patent processing: Introduction, Essential requirements, International scenario of patents, patenting of biological materials, significance of patents in India, Patent application, Procedures and granting, protection of biotechnological inventions, Patent Act (1970), Patent (Amendments) Act (2002).

Unit-V **No. of Hours: 12**

Regulatory framework in Biotechnology: Regulation of RDT research, Regulation of food and food ingredients, Regulatory framework in India governing GMOs, Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic Plants (1998), Prevention Food Adulteration Act (1955), Food Safety and Standards Bill (2005),

GE-2: BIOETHICS AND BIOSAFETY (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Proxy filing of Indian Product patent
2. Proxy filing of Indian Process patent
3. Planning of establishing a hypothetical biotechnology industry in India
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women health ethics.
6. Case study on medical errors and negligence.
7. Case study on handling and disposal of radioactive waste

SUGGESTED READING

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers
3. The law and strategy of Biotechnological patents by Sibley. Butterworth publications.
4. Intellectual property rights – Ganguli – Tat McGraw-Hill
5. Biotechnology-B. D. Singh- Kalyani Publications

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SKILL ENHANCEMENT COURSE
SEMESTER III
SEC-2: INDUSTRIAL FERMENTATIONS (THEORY)
TOTAL HOURS: 30 CREDITS: 2

UNIT I **No. of Hours: 6**

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, microbial electricity, starch conversion processes; Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti cancer agents, amino acids.

UNIT II **No. of Hours: 6**

Microbial products of pharmacological interest, steriod fermentations and transformations. Over production of microbial metabolite, Secondary metabolism – its significance and products. Metabolic engineering of secondary metabolism for highest productivity.

UNIT III **No. of Hours: 6**

Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

UNIT IV **No. of Hours: 6**

Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products.
Experimental model for design of fermentation systems, Anaerobic fermentations.

UNIT V **No. of Hours: 6**

Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

PRACTICAL

1. Comparative analysis of design of a batch and continuous fermenter.
2. Calculation of Mathematical derivation of growth kinetics.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.

4. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase etc.)

SUGGESTED READING

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
5. Salisbury, Whitaker and Hall. Principles of fermentation Technology,

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SKILL ENHANCEMENT COURSE
SEMESTER –III
SEC-2: BASICS OF FORENSIC SCIENCE (THEORY)

TOTAL HOURS: 30 **CREDITS: 2**

UNIT I **No. of Hours: 6**

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science,

UNIT II **No. of Hours: 6**

Causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

UNIT III **No. of Hours: 6**

Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

UNIT IV **No. of Hours: 6**

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification,

UNIT V **No. of Hours: 6**

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

PRACTICALS

1. Documentation of crime scene by photography, sketching and field notes.
2. a. Simulation of a crime scene for training.
   b. To lift footprints from crime scene.
3. Case studies to depict different types of injuries and death.
4. Separation of nitro compounds (explosives)/ ink samples by thin layer chromatography.
5. Investigate method for developing fingerprints by Iodine crystals.
6. PCR amplification on target DNA and DNA profiling,
7. E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Recovering deleted evidences, Password Cracking

SUGGESTED READING

1. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001).
3. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).
5. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).
6. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
7. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
Three-Year (6 Semester) Full Time Degree Programme

B.Sc. (Hons.) Biotechnology – Second Year

Semester – IV

S.No.	Subject Code	Subject	Subject area	Periods			Credit
				L	T	P	
1	49BI401	Molecular Biology	C8	4	-	-	4
2	49BT402	Immunology	C9	4	-	-	4
3	49CH403	Chemistry -2	C10	4	-	-	4
Choose any one from number 4				2	-	-	2
4	49BT404	Molecular Diagnostics	SEC-3				
	49BT405	Enzymology	SEC-4				
5	49BI406	Developmental Biology	GE-4	4	-	-	4
6	49BI451	Molecular Biology(Lab)	C8P	-	-	4	2
7	49BT452	Immunology(Lab)	C9P	-	-	4	2
8	49CH453	Chemistry -2(Lab)	C10P	-	-	4	2
9	49BI454	Developmental Biology (Lab)	GEP	-	-	4	2
			TOTAL	**18**	**-**	**16**	**26**

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –IV
C-8: MOLECULAR BIOLOGY (THEORY)
TOTAL HOURS: 60 CREDITS: 4

UNIT I: DNA structure and replication **No. of Hours: 12**

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT II: DNA damage, repair and homologous recombination **No. of Hours: 12**

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.

UNIT III: Transcription **No. of Hours: 12**

RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation

UNIT IV: RNA processing and Regulation of gene expression **No. of Hours: 12**

RNA splicing and processing: processing of pre-mRNA: 5’ cap formation, polyadenylation, splicing, rRNA and tRNA splicing. Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system),

UNIT V: Regulation of translation **No. of Hours: 12**

Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation.,Posttranslational modifications of proteins.

C-8: MOLECULAR BIOLOGY (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA
5. Preparation of restriction enzyme digests of DNA samples
6. Demonstration of AMES test or reverse mutation for carcinogenicity

SUGGESTED READING

1. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
2. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
3. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
4. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –IV
C-9: IMMUNOLOGY (THEORY)
TOTAL HOURS: 60 CREDITS: 4

UNIT I **No. of Hours: 12**

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T-lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells),

UNIT II **No. of Hours: 12**

T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

UNIT III **No. of Hours: 12**

Regulation of immunoglobulin gene expression – clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.

UNIT IV **No. of Hours: 12**

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

UNIT V **No. of Hours: 12**

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA.

C-9: IMMUNOLOGY (PRACTICAL)

TOTAL HOURS: 60 **CREDITS2**

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Double immunodiffusion test using specific antibody and antigen.
8. ELISA.

SUGGESTED READING

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley- Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –IV
C-10: CHEMISTRY-2 (THEORY)
TOTAL HOURS: 60 CREDITS: 4

UNIT I The covalent bond and the structure of molecules **No. of Hours: 10**

Valence bond approach, Concept of resonance in various organic and inorganic compounds, Hybridization and structure, equivalent and non-equivalent hybrid orbitals, Bent's rule and its applications, VSEPR model for predicting shapes of molecules and ions containing lone pairs, sigma and pi bonds.

UNIT II Molecular Orbital Approach **No. of Hours: 18**

LCAO method, symmetry and overlap for s-s ,s-p and p-p combinations, MO treatment of homonuclear diatomic molecules of 2nd period (B2, C2 ,N2, O2 , F2) and heteronuclear diatomic molecules (CO, NO) and their ions.

Intermolecular forces: van der Waals forces, Hydrogen bonding and its applications, effects of these forces on melting point, boiling point and solubility.

UNIT III Transition Elements (3d series) **No. of Hours: 12**

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu. Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

UNIT IV Coordination Chemistry **No. of Hours: 10**

Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature. Coordination compounds in biological systems: Fe, Cu, Co, Mn, Ni, Zn and heavy metal ions.

UNIT V Crystal Field Theory **No. of Hours: 10**

Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for Oh and Td complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.

C-10: CHEMISTRY-2 (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

Titrimetric Analysis: Preparations of standard solutions (concept of primary and secondary standards), Different units of concentration (molarity, molality, normality and formality)

(A) Titrations involving Acids-Bases: Principles of acid-base titrations, Principle behind selection of an appropriate indicator.

1. Standardization of NaOH solution (standard solution of oxalic acid to be prepared)
2. Determination of concentration of carbonate and hydroxide present in a mixture.
3. Determination of concentration of carbonate and bicarbonate present in a mixture.
4. Determination of concentration of free alkali present in soaps/detergents/shampoos.

(B) Titrations involving redox reactions: Concept of electrode potential, principle behind selection of an appropriate indicator.

5. Standardization of KMnO4 solution (standard solution of Mohr's salt to be prepared).
6. Determination of concentration of Fe(II) in Mohr's salt and/or K2Cr2O7 using diphenylamine/ N-phenylanthranilic acid as internal indicator (standard solution of K2Cr2O7 and /or Mohr's salt to be prepared).
7. Determination of iron content in ores / alloys using appropriate redox titration.

(C) Complexometric Titrations Principles of complexometric titrations

8. Determination of concentration of Mg (II) & Zn (II) by titrimetric method using EDTA.
9. Determination of concentration of Ca/Mg in drugs or in food samples.
10. Determination of concentration of total hardness of a given sample of water by complexometric titration.

(At least 2 experiments from each set.)

SUGGESTED READING

1. James E. Huheey, "Inorganic Chemistry: Principles of structure and reactivity", Prentice Hall, IV Edition.
2. D. S. Shriver and P.A. Atkins, "Inorganic Chemistry", Oxford University Press, IV Edition.
3. Alan G. Sharpe, "Inorganic Chemistry", University of Cambridge, III Edition.
4. J. D. Lee, "A New Concise Inorganic Chemistry", ELBS IV Edition
5. Grey L. Miessler and Donald A. Tarr, "Inorganic Chemistry", Prentice Hall, III Edition.
6. B. Douglas, D. H. McDaniel and J. J. Alexander, "Concepts and Models of Inorganic Chemistry", John Wiley and Sons, III Edition.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
GENERIC ELECTIVE SUBJECTS
SEMESTER –IV
GE-4: DEVELOPMENTAL BIOLOGY (THEORY)

TOTAL HOURS: 60 CREDITS: 4

UNIT I Gametogenesis **No. of Hours: 12**

Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis

UNIT II Fertilization **No. of Hours: 12**

Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk

UNIT III: Early embryonic development **No. of Hours: 12**

Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos

UNIT IV: Embryonic Differentiation **No. of Hours: 12**

Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT V: Organogenesis **No. of Hours: 12**

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals

GE-4: DEVELOPMENTAL BIOLOGY (PRACTICAL)

TOTAL HOURS: 60 CREDITS: 2

1. Identification of developmental stages of chick and frog embryo using permanent mounts
2. Preparation of a temporary stained mount of chick embryo
3. Study of developmental stages of *Anopheles*.
4. Study of the developmental stages of *Drosophila* from stock culture/ photographs..
5. Study of different types of placenta.

SUGGESTED READING

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.

Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SKILL ENHANCEMENT COURSE
SEMESTER –IV
SEC-1: MOLECULAR DIAGNOSTICS (THEORY)

TOTAL HOURS: 30 **CREDITS: 2**

UNIT I **No. of Hours: 6**

Enzyme Immunoassays:

Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology.

UNIT II **No. of Hours: 6**

Molecular methods in clinical microbiology:

Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology

UNIT III **No. of Hours: 6**

Laboratory tests in chemotherapy:

Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

UNIT IV **No. of Hours: 6**

Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Antiidiotypes and molecular mimicry and receptors. Epitope design and applications. mmunodiagnostic tests. Immuno florescence. Radioimmunoassay.

UNIT V **No. of Hours: 6**

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting.

Transgenic animals.

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Perform/demonstrate RFLP and its analysis
2. Kirby-Bauyer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture
3. A kit-basd detection of a microbial infection (Widal test)
4. Study of Electron micrographs (any four).
5. Perform any one immuno diagnostic test (Typhoid, Malaria, Dengue)

SUGGESTED READING

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
2. Bioinstrumentation, Webster
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic
4. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.
5. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
6. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.
7. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. Appleton Centuary-Crofts publication.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
9. Microscopic Techniques in Biotechnology, Michael Hoppert

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SKILL ENHANCEMENT COURSE
SEMESTER –IV
SEC-1: ENZYMOLOGY (THEORY)

TOTAL HOURS: 30 **CREDITS: 2**

UNIT I **No. of Hours: 6**

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis.

Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin).

Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of Km and Vmax and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy.

UNIT II **No. of Hours: 6**

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, suicide inhibitor.

Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, chemical modification of active site groups, specific examples-: chymotrypsin, lysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase.

Enzyme regulation: Product inhibition, feed backcontrol, covalent modification.

UNIT III **No. of Hours: 6**

Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative cooperativity and half site reactivity. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes. Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase.

UNIT IV **No. of Hours: 6**

Enzyme Technology: Methods for large scale production of enzymes.

Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry. Enzyme electrodes.

UNIT V **No. of Hours: 6**

Thermal stability and catalytic efficiency of enzyme, site directed mutagenesis and enzyme engineering– selected examples, Delivery system for protein pharmaceuticals, structure function relationship in enzymes, structural motifs and enzyme evolution.

Methods for protein sequencing. Methods for analysis of secondary and tertiary structures of enzymes. Protein folding *invitro* & i*nvivo.*

PRACTICALS

1. Purification of an enzyme from any natural resource
2. Quantitative estimation of proteins by Bradford/Lowry's method.
3. Perform assay for the purified enzyme.
4. Calculation of kinetic parameters such as Km, Vmax, Kcat

SUGGESTED READING

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGrawHill, 2009.
3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley andSons, 1995.
4. Biochemistry by Mary K.Campbell & Shawn O.Farrell, 5th Edition, Cenage Learning,2005.
5. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999
6. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004
7. Practical Enzymology Hans Bisswanger Wiley–VCH 2004
8. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic Press 2002

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
Three-Year (6 Semester) Full Time Degree Programme

B.Sc. (Hons.) Biotechnology – Third Year

Semester – V

S.No.	Subject Code	Subject	Subject area	Periods			Credit
				L	T	P	
1	49BT501	Bioprocess Technology	C11	4	-	-	4
2	49BT502	Recombinant DNA Technology	C12	4	-	-	4
Choose any one from number 3			DSE-1	4	-	-	4
3	49CH503	Chemistry 3	DSE				
	49BT504	Animal Biotechnology	DSE				
Choose any one from number 4			DSE-2	4	-	-	4
4	49BT505	Bioinformatics	DSE				
	49MB506	Medical Microbiology	DSE				
5	49BT551	Bioprocess Technology(Lab)	C11P	-	-	4	2
6	49BT552	Recombinant DNA Technology(Lab)	C12P	-	-	4	2
Choose any one from number 7 (as per theory subject)			DSEP-1	-	-	4	2
7	49CH553	Chemistry 3 (Lab)					
	49BT554	Animal Biotechnology (Lab)					
Choose any one from number 8 (as per theory subject)			DSEP-2	-	-	4	2
8	49BT555	Bioinformatics (Lab)					
	49MB556	Medical Microbiology (Lab)					
			TOTAL	**16**	**-**	**16**	**24**

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –V
C-11: BIOPROCESS TECHNOLOGY (THEORY)
TOTAL HOURS: 60 CREDITS: 4

UNIT I **No. of Hours: 12**

Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

UNIT II **No. of Hours: 12**

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization.

UNIT III **No. of Hours: 12**

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

UNIT IV **No. of Hours: 12**

Introduction to downstream processing, product recovery and purification. Effluent treatment.

UNIT V **No. of Hours: 12**

Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

C-11: INDUSTRIAL FERMENTATIONS (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Calculation of bacterial growth curve.
2. Calculation thermal death point (TDP) of a microbial sample.
3. Production and analysis of ethanol.
4. Production and analysis of amylase.
5. Production and analysis of lactic acid.
6. Isolation of industrially important microorganism from natural resource.

SUGGESTED READING

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –V
C-12: RECOMBINANT DNA TECHNOLOGY (THEORY)
TOTAL HOURS: 60 CREDITS: 4

UNIT I **No. of Hours: 12**

Molecular tools and applications -restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR

UNIT II **No. of Hours: 12**

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription,. Genome mapping, DNA fingerprinting, Applications of Genetic Engineering

UNIT III **No. of Hours: 12**

Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each)

UNIT IV **No. of Hours: 12**

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

UNIT V **No. of Hours: 12**

Genetic engineering in plants: Use of Agrobacterium tumefaciens and Arhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

C-12: RECOMBINANT DNA TECHNOLOGY (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from E.coli
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of competent cells.
8. Demonstration of PCR

SUGGESTED READING

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pasternik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
DISCIPLINE CENTRIC SUBJECTS
SEMESTER –V
DSE-1: CHEMISTRY 3 (THEORY)

TOTAL HOURS: 60 CREDITS: 4

UNIT I Chemical Energetics **No. of Hours: 10**

Review of the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formation, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

UNIT II Chemical & Ionic Equilibrium **No. of Hours: 20**

Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔGo , Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

Ionic Equilibrium: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

UNIT III Chemical Kinetics **No. of Hours: 08**

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero and first order reactions. Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Enzyme kinetics.

UNIT IV Spectroscopy **No. of Hours: 16**

Introduction to spectroscopy: Electromagnetic radiation, fundamental definitions, electromagnetic spectrum, introduction to concepts of absorption and emission spectroscopy, Beer-Lambert law. 43 IR Spectroscopy: Fundamental and non-fundamental molecular vibrations,

IR spectrum, fingerprint and group frequency regions and their significance, Hooke's law and vibrational frequency. Factors affecting vibrational frequency. Characterization of functional groups: alkanes, alkenes, alkynes (only alicyclic systems), aldehydes, ketones, carboxylic acids and their derivatives, hydroxy compounds and amines. Study of hydrogen bonding. Electronic Spectroscopy: Electronic transitions, singlet and triplet states, dissociation and predissociation. UV spectroscopy: Types of electronic transitions, UV spectrum, λmax, εmax, chromophores, auxochromes, bathochromic shift, hypsochromic shift (definitions and elementary examples) and solvent effect. Characteristic UV transitions in common functional groups. General applications of UV spectroscopy including distinction between cis-trans isomers. Woodward rules for calculating λmax in the following systems:

- Conjugated dienes: alicyclic, homoannular, heteroannular.
- α,β-Unsaturated aldehydes and ketones.
- Extended conjugated systems: dienes, aldehydes and ketones.

PMR spectroscopy: Basic principles of NMR spectroscopy, PMR scale, chemical shifts (concept of shielding and deshielding), factors influencing chemical shifts, simple spin-spin couplings, coupling constant, chemical shift equivalence, anisotropic effects in alkenes, alkynes, aldehydes and aromatics. Interpretation of PMR spectra of simple compounds. Application of UV, IR and PMR in solving structures of simple molecules.

UNIT V Photochemistry **No. of Hours: 06**

Laws of photochemistry. Fluorescence and phosphorescence. Quantum efficiency and reasons for high and low quantum yields. Primary and secondary processes in photochemical reactions. Photochemical and thermal reactions.

DSE-1: CHEMISTRY 3 (PRACTICAL)

TOTAL HOURS: 60 CREDITS: 2

(I) Thermochemistry

1. Determination of heat capacity of a calorimeter for different volumes.
2. Determination of the enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of integral enthalpy of solution of salts (endothermic and exothermic).

(II) pH-metric and potentiometric measurements

4. Preparation of sodium acetate-acetic acid buffer solutions and measurement of their pH.
5. Potentiometric titrations of

i. strong acid vs strong base
ii. weak acid vs strong base

6. Determination of dissociation constant of a weak acid.

(III) Study the kinetics of the following reactions:

2. Initial rate method: Iodide-persulphate reaction
3. Integrated rate method:
   i. Acid hydrolysis of methyl acetate with hydrochloric acid.
   ii. Saponification of ethyl acetate

(V) Colourimetry

4. Verification of Lambert-Beer's Law for potassium dichromate/ potassium permanganate solution.
5. Determination of pK (indicator) for phenolphthalein.
6. Study the kinetics of interaction of crystal violet with sodium hydroxide colourimetrically.

SUGGESTED READING

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 9th Ed., Oxford University Press (2011).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
5. Chang, R. Physical Chemistry for the Biosciences. University Science Books (2005).
6. Khosla, B.D.; Garg, V.C.; Gulati, A. & Chand, R. Senior Practical Physical Chemistry, New Delhi.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
DISCIPLINE CENTRIC SUBJECTS
SEMESTER –V
DSE-1: ANIMAL BIOTECHNOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

UNIT I **No. of Hours: 12**

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.

UNIT II **No. of Hours: 12**

Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Conservation Biology – Embryo transfer techniques.

UNIT III **No. of Hours: 12**

Animal propagation – Artificial insemination, Animal Clones. Introduction to Stem Cell Technology and its applications.

UNIT IV **No. of Hours: 12**

Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.

UNIT V **No. of Hours: 12**

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

DSE-1: ANIMAL BIOTECHNOLOGY (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium
5. Isolation of lymphocytes for culturing
6. DNA isolation from animal tissue
7. Quantification of isolated DNA.
8. Resolving DNA on Agarose Gel.

SUGGESTED READING

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.
3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.
4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNAgenes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
DISCIPLINE CENTRIC SUBJECTS
SEMESTER –V
DSE-2: BIOINFORMATICS (THEORY)

TOTAL HOURS: 60 CREDITS: 4

UNIT I **No. of Hours: 12**

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT II **No. of Hours: 12**

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web.

UNIT III **No. of Hours: 12**

Introduction of Data Generating Techniques and Bioinformatics problem posed by them Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

UNIT IV **No. of Hours: 12**

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT V **No. of Hours: 12**

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

DSE-2: BIOINFORMATICS (PRACTICAL)

TOTAL HOURS: 60 CREDITS: 2

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene,
2. Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.

SUGGESTED READING

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
DISCIPLINE CENTRIC SUBJECTS
SEMESTER –V
DSE-2: MEDICAL MICROBIOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

UNIT I **No. of Hours: 12**

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels.

UNIT II **No. of Hours: 12**

Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: S.aureus, S.pyogenes, B.anthracis, C.perferinges, C.tetani, C.botulinum, C.diphtheriae M.tuberculosis, M. leprae.

UNIT III **No. of Hours: 12**

Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: E.coli, N. gonorrhoea, N. meningitidis, P. aeruginosa, S. typhi, S. dysenteriae, Y. pestis, B. abortus, H. influenzae, V. cholerae, M. pneumoniae, T. pallidum M. pneumoniae, Rickettsiaceae, Chlamydiae.

UNIT IV **No. of Hours: 12**

Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

UNIT V **No. of Hours: 12**

Fungal and Protozoan infections. Dermatophytoses (Trichophyton, Microsporun and Epidermophyton) Subcutaneous infection (Sporothrix, Cryptococcus), systemic infection (Histoplasma, Coccidoides) and opportunistic fungal infections (Candidiasis, Aspergillosis), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

DSE-2: MEDICAL MICROBIOLOGY (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Identification of pathogenic bacteria (any two) based on cultural, morphological and biochemical characteristics.
2. Growth curve of a bacterium.
3. To perform antibacterial testing by Kirby-Bauer method.
4. To prepare temporary mounts of Aspergillus and Candida by apprpriate staining.
5. Staining methods: Gram's staining permanent slides showing Acid fast staining, Capsule staining and spore staining.

SUGGESTED READING

1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier. .
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)

Three-Year (6 Semester) Full Time Degree Programme

B.Sc. (Hons.) Biotechnology – Third Year

Semester – VI

S.No.	Subject Code	Subject	Subject area	Periods			Credit
				L	T	P	
1	49BT601	Bio Analytical Tools	C13	4	-	-	4
2	49BT602	Genomics and Proteomics	C14	4	-	-	4
Choose any one from number 3			DSE-3	4	-	-	4
3	49BT603	Plant Biotechnology	DSE				
	49BT604	Environmental Biotechnology	DSE				
Choose any one from number 4			DSE-4				
4	49BT605	Biostatistics	DSE	4	-	-	4
	49CH606	Chemistry 4	DSE	4	-	-	4
	49BT651	Project work	DSE	-	-	6	6
5	49BT652	Bio Analytical Tools(Lab)	C13P	-	-	4	2
6	49BT653	Genomics and Proteomics(Lab)	C14P	-	-	4	2
Choose any one from number 7 (as per theory subject)			DSEP	-	-	4	2
7	49BT654	Plant Biotechnology (Lab)	DSEP				
	49BT655	Environmental Biotechnology (Lab)	DSEP				
Choose any one from number 8 (as per theory subject), if not choose Project work			DSEP				
8	49BT656	Biostatistics (Lab)	DSEP				
	49CH657	Chemistry 4 (Lab)	DSEP	-	-	4	2
			TOTAL	**16**		**16**	**24**

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –VI
C-13: BIO-ANALYTICAL TOOLS (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

UNIT I **No. of Hours: 12**

Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

UNIT II **No. of Hours: 12**

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III **No. of Hours: 12**

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT IV **No. of Hours: 12**

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarosegel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing,

UNIT V **No. of Hours: 12**

Western blotting. Introduction to Biosensors and Nanotechnology and their applications.

C-13: BIO-ANALYTICAL TOOLS (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

5. Native gel electrophoresis of proteins
6. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
7. Preparation of the sub-cellular fractions of rat liver cells.
8. Preparation of protoplasts from leaves.
9. Separation of amino acids by paper chromatography.
10. To identify lipids in a given sample by TLC.
11. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.

SUGGESTED READING

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7^{th} edition. Pearson Benjamin Cummings Publishing, San Francisco.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
SEMESTER –VI
C-14: GENOMICS & PROTEOMICS (THEORY)
TOTAL HOURS: 60 CREDITS: 4

UNIT I **No. of Hours: 12**

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

UNIT II **No. of Hours: 12**

Managing and Distributing Genome Data: Web based servers and software's for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

UNIT III **No. of Hours: 12**

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.

UNIT IV **No. of Hours: 12**

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution.

UNIT V **No. of Hours: 12**

Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. *De novo* sequencing using mass spectrometric data.

C-14: GENOMICS & PROTEOMICS (PRACTICAL)

TOTAL HOURS: 60 **CREDITS:2**

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Proteomics 2D PAGE database
5. Softwares for Protein localization.
6. Hydropathy plots
7. Native PAGE
8. SDS-PAGE

SUGGESTED READING

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
4. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
5. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
6. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
6. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
DISCIPLINE CENTRIC SUBJECTS
SEMESTER –VI
DSE-3: PLANT BIOTECHNOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

UNIT I **No. of Hours: 12**

Introduction, Cryo and organogenic differentiation, Types of culture: Seed , Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation,

UNIT II **No. of Hours: 12**

Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT III **No. of Hours: 12**

In vitro haploid production Androgenic methods: Anther culture, Microspore culture andogenesis Sgnificance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

UNIT IV **No. of Hours: 12**

Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identifiation and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations.

Somaclonal variation Nomenclautre, methods, applications basis and disadvantages.

UNIT V **No. of Hours: 12**

Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria.

DSE-3: PLANT BIOTECHNOLOGY (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid.
2. Preparation of complex nutrient medium (Murashige & Skoog's medium)
3. To selection, Prune, sterilize and prepare an explant for culture.
4. Significance of growth hormones in culture medium.
5. To demonstrate various steps of Micropropagation.

SUGGESTED READING

1. 1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. 2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. 3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
4. 4. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
5. 5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
6. 6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rdedition. Benjamin Co.
7. 7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)
8. 8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
DISCIPLINE CENTRIC SUBJECTS
SEMESTER –VI
DSE-3: ENVIRONMENTAL BIOTECHNOLOGY (THEORY)

TOTAL HOURS: 60 CREDITS: 4

UNIT I **No. of Hours: 12**

Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol

UNIT II **No. of Hours: 12**

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation.

UNIT III **No. of Hours: 12**

Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products.

UNIT IV **No. of Hours: 12**

Treatment of municipal waste and Industrial effluents. Bio-fertilizers

Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)

UNIT V **No. of Hours: 12**

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

DSE-3: ENVIRONMENTAL BIOTECHNOLOGY (PRACTICAL)

TOTAL HOURS: 60 CREDITS: 2

1. Calculation of Total Dissolved Solids (TDS) of water sample.

2. Calculation of BOD of water sample.
3. Calculation of COD of water sample.
4. Bacterial Examination of Water by MPN Method.

SUGGESTED READING

1. Environmental Science, S.C. Santra
2. Environmental Biotechnology, Pradipta Kumar Mohapatra
3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter
4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
5. Agricultural Biotechnology, S.S. Purohit
6. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer
7. Introduction to Environmental Biotechnology, Milton Wainwright
8. Principles of Environmental Engineering, Gilbert Masters
9. Wastewater Engineering – Metcalf & Eddy

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
DISCIPLINE CENTRIC SUBJECTS
SEMESTER –VI
DSE-4: BIOSTATISTICS (THEORY)

TOTAL HOURS: 60 CREDITS: 4

UNIT I **No. of Hours: 12**

Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

UNIT II **No. of Hours: 12**

Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT III **No. of Hours: 12**

Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test.

UNIT IV **No. of Hours: 12**

Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)

UNIT V **No. of Hours: 12**

Correlation and Regression. Emphasis on examples from Biological Sciences.

DSE-4: BIOSTATISTICS (PRACTICAL)

TOTAL HOURS: 60 CREDITS: 2

1. Based on graphical Representation
2. Based on measures of Central Tendency & Dispersion
3. Based on Distributions Binomial Poisson Normal
4. Based on t, f, z and Chi-square

SUGGESTED READING

1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High YieldTM Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

B.Sc. (HONOURS) BIOTECHNOLOGY (CBCS STRUCTURE)
DISCIPLINE CENTRIC SUBJECTS
SEMESTER –VI
DSE-4: CHEMISTRY 4 (THEORY)

TOTAL HOURS: 60 CREDITS: 4

UNIT I Carbohydrate **No. of Hours: 10**

Classification of carbohydrates, reducing and non-reducing sugars, General properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosachharides, structure of disachharides (sucrose, maltose, lactose) and polysachharides (starch and cellulose) excluding their structure elucidation.

UNIT II Amino Acids, Peptides and Proteins **No. of Hours: 12**

Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.

UNIT III Enzymes and correlation with drug action **No. of Hours: 12**

Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity), Enzyme inhibitors and their importance, phenomenon of inhibition (competitive and noncompetitive inhibition including allosteric inhibition). Drug action - receptor theory. Structure – activity relationships of drug molecules, binding role of –OH group, -NH2 group, double bond and aromatic ring.

UNIT IV Nucleic Acids & Lipid **No. of Hours: 18**

Nucleic Acids: Components of Nucleic acids: Adenine, guanine, thymine and cytosine (structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

Lipid: Introduction to lipids, classification. 38 Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

UNIT V Concept of Energy in Biosystems **No. of Hours: 08**

Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy. Outline of catabolic pathways of Carbohydrates - Glycolysis, Fermentation, Krebs Cycle. Overview of catabolic pathways of fats and proteins. Interrelationships in the metabolic pathways of proteins, fats and carbohydrates.

DSE-4: CHEMISTRY 4 (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Separation of amino acids by paper chromatography
2. To determine the concentration of glycine solution by formylation method.
3. Study of titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. To determine the saponification value of an oil/fat.
7. To determine the iodine value of an oil/fat
8. Differentiate between a reducing/nonreducing sugar.
9. Extraction of DNA from onion/ cauliflower
10. To synthesize aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC.

SUGGESTED READING

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.
5. Berg, J. M., Tymoczko, J. L. & Stryer, L. Biochemistry 7th Ed., W. H. Freeman.
6. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. Vogel's Textbook of Practical Organic Chemistry, ELBS.
7. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.