FACULTY OF SCIENCE

KHWAJA MOINUDDIN CHISTI LANGUAGE UNIVERSITY,
LUCKNOW, U.P. (India)

B.Sc. (Hons.) - BIOTECHNOLOGY

Under Choice Based Credit System (CBCS)

Curriculum Structure

First, Second & Third Years

(I, II, III, IV, V & VI Semesters)

Effective from Session 2020-21

COURSE CURRICULUM

Semester	CORE COURSE(14)	Ability Enhancement Compulsory Course(AECC) (2)	Skill Enhancement Course (SEC) (2)	Discipline Specific Elective (DSE) (4)	GENERIC ELECTIVE: (GE) (4)
I	Biochemistry & Metabolism	Environmental Science			GE-1
	Cell Biology				
II	Mammalian Physiology	(English /MIL Communicatio n)/			GE-2
	Plant Physiology				
III	Genetics		SEC -1		GE-3
	General Microbiology				
	Chemistry - 1				
IV	Molecular Biology		SEC -2		GE-4
	Immunology				
	Chemistry -2				
V	Bioprocess Technology			DSE-1	
	Recombinant DNA Technology			DSE-2	
VI	Bio Analytical Tools			DSE -3	,
	Genomics and Proteomics			DSE-4	

SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	**Ability Enhancement Compulsory Course-I**	Environmental Science	2
	Core course-I	Biochemistry & Metabolism	4
	Core Course-I Practical	Biochemistry & Metabolism	2
	Core course-II	Cell Biology	4
	Core Course-II Practical	Cell Biology-Practical	2
	Generic Elective -1	GE-1	4/5
	Generic Elective -1 Practical/Tutorial	GE-1 Practical	2/1
II	**Ability Enhancement Compulsory Course-II**	English communications/ Environmental Science	2
	Core course-III	Mammalian Physiology	4
	Core Course-III Practical	Mammalian Physiology-Practical	2
	Core course-IV	Plant Physiology	4
	Core Course-IV Practical	Plant Physiology - Practical	2

	Generic Elective -2	GE-2	4/5
	Generic Elective -2 Practical/ Tutorial	GE-2 Practical	2/1
III	**Core course-V**	Genetics	4
	Core Course-V Practical	Genetics - Practical	2
	Core course-VI	General Microbiology	4
	Core Course-VI Practical	General Microbiology -Practical	2
	Core course-VII	Chemistry - 1	4
	Core Course-VII Practical	Chemistry-1 Practical	2
	Skill Enhancement Course-1	SEC-1	2
	Generic Elective -3	GE-3	4/5
	Generic Elective -3 Practical/ Tutorial	GE-3 Practical	2/1
IV	**Core course-VIII**	Molecular Biology	4
	Course-VIII Practical	Molecular Biology- Practical	2
	Core course-IX	Immunology	4
	Course-IX Practical	Immunology- Practical	2
	Core course-X	Chemistry -2	4
	Core Course- X Practical	Chemistry -2 Practical	2
	Skill Enhancement Course-2	SEC-2	2
	Generic Elective -4	GE-4	4/5
	Generic Elective - 4 Practical/Tutorial	GE-4 Practical	2/1

V	**Core course-XI**	Bioprocess Technology	4
	Core Course-XI Practical	Bioprocess Technology-Practical	2
	Core course-XII	Recombinant DNA Technology	4
	Core Course-XII Practical	Recombinant DNA Technology - Practical	2
	Discipline Specific Elective -1	DSE-1	4
	Discipline Specific Elective -1 Practical	DSE-1 Practical	2
	Discipline Specific Elective -2	DSE-2	4
	Discipline Specific Elective- 2 Practical/Tutorial	DSE-2 Practical	2
VI	**Core course-XIII**	Bio Analytical Tools	4
	Core Course-XIII Practical/Tutorial	Bio Analytical Tools - Practical	2
	Core course-XIV	Genomics and Proteomics	4
	Core Course-XIV Practical/Tutorial	Genomics and Proteomics - Practical	2
	Discipline Centric Elective -3	DSE-3	4
	Discipline Centric Elective-3 Practical/Tutorial	DSE-3 Practical	2
	Discipline Centric Elective-4	DSE-4	4
	Discipline Centric Elective -1 Practical/Tutorial	DSE-4 Practical	2
			Total: 140

Summary of Course Curriculum

SEMESTER I		SEMESTER II	
C1	Biochemistry & Metabolism	C3	Mammalian Physiology
C2	Cell Biology	C4	Plant Physiology
AECC1	EVS	AECC2	English/MIL communication
GE	GE1	GE	GE2

SEMESTER III		SEMESTER IV	
C5	Genetics	C8	Molecular Biology
C6	General Microbiology	C9	Immunology
C7	Chemistry – 1	C10	Chemistry -2
SEC	SEC1	SEC	SEC2
GE	GE3	GE	GE4

SEMESTER V		SEMESTER VI	
C11	Bioprocess Technology	C13	Bio Analytical Tools
C12	Recombinant DNA Technology	C14	Genomics and Proteomics
DSE	DSE1	DSE	DSE3
DSE	DSE2	DSE	DSE4

C: Core Courses; **GE:** Generic Elective; **AECC:** Ability Enhancement Compulsory Course; **SEC:** Skill Enhancement Courses; **DSE:** Discipline Specific Elective

Semester I
BIOCHEMISTRY AND METABOLISM

Course Objectives:

- To make students aware and to give them the basic knowledge of different macromolecules like carbohydrates, nucleic acids protein which are the basis of existence of the cell.
- To acquaint students with the concept of bioenergetics and various metabolic processes taking place inside the human body.
- Students can apply the reaction mechanisms in the domains of metabolism, enzyme technology, structural biology, molecular biology and bioinformatics

Course Outcomes

- Describe the structure and function of DNA and RNA in the cell
- Describe the structure of proteins, including the significance of amino acid R-groups and their impact on the three-dimensional structure of proteins.
- Students will have knowledge on biomolecules, like carbohydrates, lipids, enzymes and coenzymes besides their importance and Classification, forces stabilizing their structures, write and relate the role of them with day to day life.
- Develop an understanding of various metabolisms in cell
- Know the formation and the breakdown of different biomolecules and the places where it took place
- Various physiological and pathological aspects of by products of metabolic pathways and their regulations and relate with various industrial processes.

UNIT I:

Introduction to Biochemistry: A historical prospective. **(10 Periods)**

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.

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 II **(10 Periods)**

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 III **(20 Periods)**

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 IV **(20 Periods)**

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.

SUGGESTED READING

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. 6th Edition. W.H Freeman and Co.
2. Satyanarayana U. and Chakrapani U. (2008). Biochemistry, 5th Edition, Books & Allied Ltd (Elsevier)
3. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
4. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.

PRACTICALS

1. Introduction to Glasswares /Equipments & Pipetting Method
2. Qualitative tests for Carbohydrates, proteins and lipids
3. Preparation of buffers.
4. Standardization of pH meter
5. To study activity of any enzyme under optimum conditions.
6. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
7. Principles of Colorimetry**:** Beer's law
8. Estimation of blood glucose by colorimetric method.

CELL BIOLOGY

Course Objectives:

- Provide in depth knowledge involving the basic concepts of cell biology including cell signaling, Cell-matrix interactions with specific emphasis on the components that make up the cytoskeleton.
- The course also includes understanding various mechanisms that govern the growth and regulation of cancer cells including the method to culture such cells.

Course Outcomes

- Students develop an understanding of the Cytoskeleton and Cell Membrane & discuss the structure of Microtubules, microfilaments & can differentiate the organisms by its cell structure.
- Understand how the proteins synthesized in the cytosol are transported to different organelles.
- Understanding how cells co-operate and communicate with each other and the role of such signaling mechanisms in Cancer, Cell death and other pathological conditions.

UNIT I **(10 Periods)**

Cell: **I**ntroduction 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 **(15 Periods)**

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 **(20 Periods)**

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 **(15 Periods)**

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.
Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

PRACTICALS

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 Franci

ENVIRONMENTAL SCIENCE

Course Objectives:

- Articulate the interdisciplinary context of environmental issues.
- Develop critical thinking for shaping strategies (scientific, social, economic and legal)for environmental protection and conservation of biodiversity, social equity andsustainable development.
- Acquire values and attitudes towards understanding complex environmental and social challenges, and participating actively in solving current environmental problemsand preventing the future ones.
- Adopt sustainability as a practice in life, society and industry.

Course Outcomes:

After the completion of the course, students will be able:

- Understand the importance and become aware of the upcoming environmental issues and understand the importance of natural resources and can work for their conservation
- Gain knowledge about the various ecosystems existing in nature and their importance for conservation of nature.
- Learn about the biodiversity at local, national and global levels and the importance of wild life conservation.
- Gain knowledge about different types of environmental pollution, their effects and control of pollution for the benefit of mankind.
- Gain knowledge about the sustainable development, human rights and emerging environmental issues.

Unit 1 : Introduction to environmental studies& Ecosystems (15 Lectures)

Multidisciplinary nature of environmental studies;

- Scope and importance; Concept of sustainability and sustainable development.
- 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 :
  - Forest ecosystem
  - Grassland ecosystem
  - Desert ecosystem
  - Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 2 : Natural Resources : Renewable and Non---renewable Resources Biodiversity and Conservation (20 Lectures)

- Land resources and landuse 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 ground water, 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.

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 3: Environmental Pollution & Human Communities and the Environment (15 Lectures)

- 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.

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 4: Social Issue (10 Lectures)

Sustainable development, Environmental ethics: Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents, Waste and reclamation.

Suggested Readings:

1. Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R.1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.
3. Gleeson, B. and Low, N. (eds.) 1999.*Global Ethics and Environment*, London, Routledge.
4. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll.*Principles of Conservation Biology*. Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science,* 339: 36---37.
7. McCully, P. 1996. *Rivers no more: the environmental effects of dams*(pp. 29---64). Zed Books.
8. McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
9. Odum, E.P., Odum, H.T. & Andrews, J. 1971.*Fundamentals of Ecology*. Philadelphia: Saunders.

Semester II

MAMMALIAN PHYSIOLOGY

Course Objectives:

To understand the physiological organisation and functioning of human body

Course Outcomes

- Understand the organisation of human body
- Understand the functioning of human body as different system like, neuro-muscular, digestive, respiratory, circulatory, excretory, body fluids etc.
- Understand the variation in normal physiology.

UNIT I: Digestion and Respiration (15 Periods)

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 O_2 and CO_2, Oxygen dissociation curve, Chloride shift.

UNIT II: Circulation (15 Periods)

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: Muscle physiology and osmoregulation (15 Periods)

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: Nervous and endocrine coordination (15 Periods)

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters

Mechanism of action of hormones (insulin and steroids)

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

PRACTICALS

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.

PLANT PHYSIOLOGY

Course Objectives:

- The structure and functioning of Plant Cells and tissue.
- Morphology and physiology of plants.
- The course has been designed to make students aware of basic plant biotechnology techniques and their applications in plant growth and development, and large scale production of natural products from plant source.

Course Outcomes

- Study of the structure and functioning of Plant Cells and tissue
- Study of the morphology and physiology of plants
- Develop the the understanding of growth in plants.

UNIT I: Plant water relations and micro & macro nutrients (12 Periods)

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing.
Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport

UNIT II: Carbon and nitrogen metabolism (20 Periods)

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photophosphorylation, calvin cycle, CAM plants, photorespiration, compensation point, Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

UNIT III: Growth and development (18 Periods)

Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene) Physiological role and mode of action, seed dormancy and seed germination, concept of photo- periodism and vernalization

UNIT III: Biotechnological interventions (10 Periods)

Developing insect-resistance, disease-resistance, herbicide resistance; stress and senescence tolerance in plants, crop improvement in plants. Genetic manipulation of flower pigmentation, Developing quality of seed storage, Biofortification, Golden rice.

PRACTICALS

1. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.
2. Demonstration of plasmolysis by *Tradescantia* leaf peel.
3. Demonstration of opening & closing of stomata
4. Demonstration of guttation on leaf tips of grass and garden nasturtium.
5. Separation of photosynthetic pigments by paper chromatography.
6. Demonstration of aerobic respiration.
7. Preparation of root nodules from a leguminous plant.

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

Semester III

GENETICS

Course Objectives:

- Genetics is the study of heredity and genes. The aim of this course is to strengthen the Mendelian principles along with other molecular genetics topics like recombination, pedigree analysis, transposons.
- This course will help students to venture in to the different areas of biomedical sciences.

Course Outcomes

- To communicate the pivotal role of Mendelian concepts in the development of the science of genetics and also the fact that nature is full of examples that deviate from Mendelian laws starting from linkage groups.
- Understanding of genetics will provide a perception of how forward genetics has been used to understand the basis of continuity of information transfer that is applicable to not only to the simple life forms but also to humans.
- To understand the molecular basis of genotype to phenotype correlation.

UNIT I **(12 Periods)**

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 of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.

UNIT II **(18 Periods)**

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.

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 III **(15 Periods)**

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 IV **(15 Periods)**

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.

PRACTICALS

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.

GENERAL MICROBIOLOGY

Course Objectives:

- Introducing the microbial world with specific reference to the metabolic, physiological and morphological characteristics of microbes besides their classification.
- Course will provide practical knowledge about different types of bacteria, virus and fungi found in environment and Control of Microorganisms

Course Outcomes

- To expose students to the pioneers in microbiology and introducing their contributions.
- To detail the prokaryotic cell and related organelles and their functions.
- Students would be able to understand characteristics of viruses, classification and life cycles of viruses
- To introduce the concept of microscopy and to elaborate of few basic microscopy techniques.
- To elaborate on microbial nutrition and methods of determining growth curve.
- To introduce the basic principles of sterilization methods.

UNIT I **(10 Periods)**

Fundamentals, History and Evolution of Microbiology.
Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.
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 II **(10 Periods)**

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

UNIT III **(20 Periods)**

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 IV **(20 Periods)**

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.

PRACTICALS

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

CHEMISTRY I

Course Objectives:

- To Understand the relationship between concentration, volume and moles.
- To acquire knowledge about desalination of brackish water and treatment of municipal water.

Course Outcome:

- To examine and describe the difference between dilute, concentrated and saturated solutions. Investigate solubility in water and the effect of temperature on solubility.
- Develop innovative methods to produce soft water for industrial use and potable water at cheaper cost.

Unit I **(16 Periods)**

Need for wave mechanical picture of atomic structure [Photoelectric effect, de Brogile concept of matter waves], Derivation of Schrodinger wave equation as an example Particles moving in one-dimensional potential well

Chemical Bonding- Orbital concepts in bonding, Valence bond and Molecular Orbital theory, M.O.diagrams of homonuclear and heteronuclear diatomic molecules, Weak Interactions-Hydrogen bonding and Vander Waal's interactions

Unit II **(12 Periods)**

Introduction to bonding, Types of bonds with examples & factors affecting the bond formation, Biologically relevant coordination Compounds, Chelation & its applications, Oxidation & Reduction reactions, Nucleophilic addition & substitution reactions, Elimination reactions, Factors affecting these reactions

Unit III **(12 Periods)**

Solutions and its types, solubility & factors affecting solubility, solvation energy, mole concept, Normality, Molarity, Molality Equivalent & molecular mass, Preparation of Standard Solutions, Expression for concentration of solutions, solvents and its classification, Solvents other than water, Dilution factor, serial dilution, Solute–solvent interactions in solutions

Unit IV **(16 Periods)**

Properties of Water, Sources and nature of impurities, water treatment processes-Lime –soda, zeolite, ion-exchange resin, reverse osmosis, Role of Water in Biomolecular Structure and Function, Lowry-Bronsted and Lewis Concepts of acids & bases, Strong and Weak Acids and Bases - Ionic Product of Water - pH, pKa & pKb, Hydrolysis of Salts, Buffers & its Types, Henderson equation for Acidic and Basic buffers, Buffer action, Buffer capacity, pH of Buffer Solution, isoelectric pH

PRACTICALS

1. Preparation of a sample of p-nitroacetanilide
2. Preparation of Tris(Thiourea) Copper (I) Sulphate
3. Estimation of OD in given polluted and sample water
4. Determination of the partition coefficient of acetic acid between n-butanol and water

SUGGESTED READING

1. Physical chemistry, P. Atkins and J. Ded paul, International student edition, oxford university press
2. Principles of physical chemistry, B.R. Puri, L. R. Sharma & M.S. Pathania, Shoban Lal Nagin Chan & Co., Jalandhar
3. Organic chemistry, R.T. Morrison & R.N. Boyd, Prentice hall of India (P). Ltd. New Delhi
4. A text book of organic chemistry, Arun Bahl & B.S. Bahl, S. Chand publishers New Delhi
5. Concise inorganic chemistry, J.D. Lee, Chapman & Hall, London
6. Inorganic chemistry, J.E. Huyee, E.A. Keiter & R.L. Keiter

Semester IV

MOLECULAR BIOLOGY

Course Objectives:

- Introducing and strengthening the basic molecular processes that are common to all living organisms.
- DNA replication and regulation in prokaryotes and eukaryotes
- Transcription in prokaryotes and eukaryotes
- Translation in prokaryotes and eukaryotes
- Post translation and transcriptional mechanism
- Gene expression in prokaryotes using Lap operon and in Eukaryotes by Trp operon.

Course Outcomes

- Learn and understand the important discoveries that are made in the field of molecular biology.
- Understand the detailed structure of the double helical nature of DNA as proposed by scientists like Watson and Crick.
- To learn different levels of organizations that regulate the condensation of DNA that leads to the compact metaphase chromosome.
- To learn key molecular events that occur during the transcription and translation processes that leads the protein synthesis from specific genes.
- Understanding the mechanisms that regulate the regulation of gene expression in both prokaryotes and eukaryotes.
- Learn about the molecular events that happen during the replication of DNA prior to the cell division.

UNIT I: DNA structure and replication **(15 Periods)**

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA polymerases, replication, Bi-directional replication, 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 **(10 Periods)**

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 and RNA processing **(17 Periods)**

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 RNA splicing and processing: processing of pre-mRNA: 5’ cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

UNIT IV: Regulation of gene expression and translation **(18 Periods)**

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), 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.

PRACTICALS

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. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

IMMUNOLOGY

Course Objectives:

- The objective of this course is to familiarize students with the Immune system, hypersensitivity and vaccination, Immune Effector Mechanisms, hybridoma technology and various Immunotechniques and immunodiagnosis.
- The course will provide technical knowledge as to how different diseases are caused and various responses mediated by living cells to combat pathogen attack.
- The course will provide sound knowledge of how immune system deals with various pathogens, different processes and cell types involved in prevention of disease.
- Along with this the students will become aware about concept, synthesis and action mechanism of vaccines.

Course Outcomes:

- Understand immune response in our body, both innate and adaptive, to different pathogens, tissue injury and cancer.
- Understand what happens if our immune system overreact to foreign substances (hypersensitivities and allergies)
- Understand what happens if our body recognize self as non-self (autoimmunity)
- Understand the biology of different vaccines against infectious agents and cancer and solutions to produce better vaccines

UNIT I **(20 Periods)**

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

UNIT II **(15 Periods)**

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 III **(13 Periods)**

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, COVID-19

UNIT IV **(12 Periods)**

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, RT-PCR & Antigen/Antibody Tests for COVID-19**,** Immunotherapy

PRACTICALS

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. 6 th 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.

CHEMISTRY II

Course Objectives:

- To provide a broad and fundamental knowledge of the polymers and their chemical, physical and mechanical behaviour and knowledge of conducting polymers, bio-degradable polymers.
- To acquire knowledge about the methods of chromatographic separation; applications and uses of the different chromatographic techniques in the isolation of active constituents from medicinal plants.

Course Outcome:

- Substitute metals with conducting polymers and also produce cheaper biodegradable polymers to reduce environmental pollution.
- Demonstrate the fundamentals of different chromatographic techniques and their application.
- Demonstrate the principle of chromatographic techniques used in isolation, purification, identification analysis of natural products from medicinal plants.

Unit I **(16Periods)**

Isomerism and its types, Optical & geometrical isomerism, Tautomerism & its applications, Conformations & Configurations of a molecule, Difference between Configuration and Conformation, Chirality, Asymmetric Carbon Atom, Configuration & projection formula

Unit II **(16 Periods)**

Equilibrium constant, Le-Chatelier principle, Types of Titration, Acid –base titrations-Strong Acid *Vs* Strong Base, End Point, Equivalence Point, indicators in titrations, Solubility product & applications, ionic product, Condition for precipitation, Digestion of Precipitate. Co-Precipitation and Post-Precipitation, Washing, Drying and Ignition of Precipitate, Hydrolytic reactions

Unit III **(12 Periods)**

Classification of polymers, types of polymerization, application of industrially important polymers (Natural rubber, Buna, Nylon, Terylene, PVC, PVA), Use of organometallic compounds in polymerization and their environmental toxicity, Biopolymers and their types, important biopolymers and their uses.

Unit IV **(16 Periods)**

Methods of Separation: Precipitation, Filtration, Distillation and Solvent Extraction.
Chromatography: Definition, Principles, Types, Introduction to Paper Chromatography, Thin Layer Chromatography, Column Chromatography and its Applications.
Colorimetry: Principle, Beer-Lambert‘s Law, Measurement of Extinction, Derivation of E = kcl, Limitations of Beer-Lambart‘s Law, Filter Selection.
Tracer technique: Applications of radioisotopes in biotechnology, autoradiography.

PRACTICALS

1. Estimation of commercial caustic soda. Determination of the amount of sodium carbonate and sodium hydroxide present together in the given commercial caustic soda
2. Preparation of Bakelite
3. To separate the mixture of amino acids by paper chromatography and calculate the Rf value

SUGGESTED READING

7. Physical chemistry, P. Atkins and J. Ded paul, International student edition, oxford university press
8. Principles of physical chemistry, B.R. Puri, L. R. Sharma & M.S. Pathania, Shoban Lal Nagin Chan & Co., Jalandhar
9. Organic chemistry, R.T. Morrison & R.N. Boyd, Prentice hall of India (P). Ltd. New Delhi
10. A text book of organic chemistry, Arun Bahl & B.S. Bahl, S. Chand publishers New Delhi
11. Concise inorganic chemistry, J.D. Lee, Chapman & Hall, London
12. Inorganic chemistry, J.E. Huyee, E.A. Keiter & R.L. Keiter

Semester V

BIOPROCESS TECHNOLOGY

Course Objectives:

- The objective of this course is to understand the basic skills applied in fermentation technology and use of biological resources as input to biobased processes which are economically and environmentally sustainable.
- Develop the understanding of industrial aspects of bioprocess technology.

Course Outcomes:

- An introduction to fermentation process. Learn the history of fermentation process, types of fermentation, and examples of fermentation industry.
- Design of a fermenter. Understand basic design of a fermenter. Important parts and materials required for aseptic operation and containment practice in a fermenter.
- Types of Fermenter. Study the difference in design and functioning, besides advantages and disadvantages of different types of fermenters.
- Mode of fermenter operation. Covers the basic concepts of microbial growth kinetic in different bioreactor operational modes.
- Understand the process development, upstream and downstream processing & relate the skill of mass transfer and its application
- Understand the techniques involved in the extraction and purification of high quality fermentation products.
- Effluent treatment. Understand the importance of proper waste treatment plant for fermentation industry

UNIT I **(10 Periods)**

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 **(20 Periods)**

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 **(15 Periods)**

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 **(15 Periods)**

Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

PRACTICALS

1. Bacterial growth curve.
2. Calculation of 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.

RECOMBINANT DNA TECHNOLOGY

Course Objectives:

The course has been designed to make students aware of

- DNA manipulative enzymes and Gene cloning vectors
- Screening and selection of recombinants
- Techniques used as Polymerase chain reaction (PCR), Site directed mutagenesis (SDM), Nucleic acid sequencing
- Application of r-DNA techniques

Course Outcomes:

- Get proper knowledge about the DNA manipulative enzymes: Restriction enzymes and DNA ligases, and Gene cloning vectors.
- Gain knowledge about In vitro construction of recombinant DNA molecules, passenger and vector DNA, and Transformation
- Learn about the basics of Electrophoretic techniques, Polymerase chain reaction (PCR), Site directed mutagenesis (SDM), Nucleic acid sequencing: Blotting techniques.
- Knowledge of Application of r-DNA technique in human health, Production of Insulin, Production of recombinant vaccines: Hepatitis B, Production of human growth hormone.

UNIT I **(15 Periods)**

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 **(20 Periods)**

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 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 III **(10 Periods)**

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 IV **(15 Periods)**

Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and A. rhizogenes, 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.

PRACTICALS

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. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik 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, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

Semester VI

BIO-ANALYTICAL TOOLS

Course Objectives:

- The objective is to enrich students' knowledge about various techniques used in biological research and also their implementation in various fields of research.
- Develop the understanding of moden techniques: Basics of nanotechnology and overview of nanoscale materials and Biosensors

Course Outcomes:

- To introduce the concept of microscopy and to elaborate of few basic microscopy techniques
- Understand the concept of electromagnetic radiation, absorption spectrum, Beer's law and Lamberts law
- Familiarize the working principles of electrophoresis and UV/Vis and fluorescence spectroscopic techniques and application of the knowledge to get basic structural information of DNA & proteins
- Learn to apply important chromatographic techniques to purify biomolecules
- Understanding of Centrifugation and Electrophoresis-Principles and applications
- Knowledge and understanding of Nanomaterials & Biosensors

UNIT I **(10 Periods)**

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

UNIT II **(15 Periods)**

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

UNIT III **(15 Periods)**

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

UNIT IV **(20 Periods)**

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications.

PRACTICAL

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of rat liver cells.
4. Preparation of protoplasts from leaves.
5. Separation of amino acids by paper chromatography.
6. To identify lipids in a given sample by TLC.
7. 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.7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

GENOMICS & PROTEOMICS

Course Objectives:

The course has been designed to make students aware of

- Genome sequencing
- genome databases, Genome analysis
- Proteomics and Metabolomics

Course Outcomes:

- Get knowledge of Genome sequencing and Sequencing technology.
- Gain knowledge about Major genome databases, Genome analysis and Comparative genomics Functional genomics
- Learn about basic proteomics technology
- Have knowledge of Applications of genomics and proteomics

UNIT I **(15 Periods)**

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 **(10 Periods)**

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

UNIT III **(20 Periods)**

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 **(15 Periods)**

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

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

PRACTICALS

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.
5. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
6. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
7. 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). *i*Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applicationsof recombinant DNA. ASM Press, Washington.
6. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

SKILL ENHANCEMENT COURSE

INDUSTRIAL FERMENTATIONS

Course objectives:

- Understand the basic skills applied in fermentation biotechnology and use of biological resources as input to biobased processes which are economically and environmentally sustainable
- To give an insight and advanced learning of application of fermentation technology in research development in various field.

Course outcomes:

- Learn the history of fermentation process, types of fermentation, examples of fermentation industry and production of primary and secondary metabolites.
- Familiarize with microbial analysis of industrial production of food viz. cheese, bread etc., antibiotics, enzymes and biopharmaceuticals so that students can perform these things while they go to any industry further

UNIT I **(12 Periods)**

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 **(15 Periods)**

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.
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 III **(13 Periods)**

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 IV **(20 Periods)**

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.

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,

MOLECULAR DIAGNOSTICS

Course Objectives:

The objective of this course is to familiarize students with the various diagnostic tests for infectious non-infectious human diseases based on

a) enzyme Immunoassays like ELISA, Blotting & PCR
b) non-enzymatic ones like immunofluorescence, radioimmunoassay & electron microscopy

Course Outcomes:

Understand the principle, methods & application of the diagnostic assays involving biomolecules as biomarkers for diseases affecting lungs, liver, kidney & heart

Gain knowledge for identification of viral diseases like dengue, COVID-19 & non-communicable diseases like diabetes mellitus & cancer with the use of purified antigens or antibodies

UNIT I **(15 Periods)**

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 **(15 Periods)**

Molecular methods in clinical microbiology:
Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology
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 III **(18 Periods)**

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. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.

UNIT IV **(12 Periods)**

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

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 (editedby 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

ENZYMOLOGY

Course Objectives:

- To provide a detailed knowledge about enzymes, their chemical nature, kinetics, classifications, factors affecting the coenzymes and cofactors, velocity affecting velocity of enzymes, theories of enzyme action, enzyme regulation, inhibitions, isolation, purification & characterization of of enzymes, immobilisation of enzymes
- Differentiate between equilibrium and steady state kinetics and analyzed simple kinetic data and estimatee important parameter (Km. Vmax, Kcat etc).

Course Outcomes:

- Introduce the term “enzyme” , history and classification
- Learn about proteinaceous and non proteinaceous enzymes, their purification
- Learn about enzyme catalysis, Michaelis-Menton's constant.
- Familiarise on mechanism of enzyme action-theories of enzyme action.
- Learn how to define velocity/enzyme activity/rate of a reaction and specific activity
- Familiarise on factors affecting enzyme activity & enzyme Inhibitions

UNIT - I **(20 Periods)**

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 **(15 Periods)**

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, Iysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase.

Enzyme regulation: Product inhibition, feed backcontrol, covalent modification

UNIT – III **(13 Periods)**

Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative co-operativity 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 **(12 Periods)**

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.
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*.

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

DISCIPLINE CENTRIC SUBJECTS

MEDICAL MICROBIOLOGY

Course Objectives:

Introducing the normal microbial world of human body with that of disease causing microbes like gram positive & gram negative bacteria & viruses.

Course Outcomes:

Course will provide knowledge of different diseases caused by bacteria, virus and fungi

UNIT I **(18 Periods)**

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

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 II **(15 Periods)**

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 III **(12 Periods)**

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

UNIT IV **(15 Periods)**

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)

PRACTICALS

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 READINGS

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.

ANIMAL BIOTECHNOLOGY

Course Objectives:

- To acquaint students with the gene transfer methods & applications of genetic engineering in creating transgenic animals.
- The course will provide complete exposure as how biotechnology is used in overcoming animal diseases besides introduction & applications of stem cells technology.
- Also the course will provide awareness about gene therapy in medicine

Course Outcomes:

- Understand principles of animal culture, media preparation and can explain *in vitro* fertilization and embryo transfer technology.
- Students will have an insight in applications for recombinant DNA technology in production of therapeutic proteins
- Know how transgenic animals, cryopreservation, apoptosis, animal cloning, cell transformation, DNA microinjection.
- Use of stem cell & gene therapy in medicine alongwith problems & ethical issues.

UNIT I

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer. **(10 Periods)**

UNIT II

Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis. **(10 Periods)**

UNIT III

Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications. **(20 Periods)**

UNIT IV

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics. **(20 Periods)**

PRACTICALS

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 DNA-genes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

ENVIRONMENTAL BIOTECHNOLOGY

Course Objectives:

Develop the understanding of Environmental Biotechnology

- Bioremediation
- Waste Management
- Bioleaching
- Conventional and modern fuels

Course Outcomes:

- Have knowledge of the Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol.
- Gain insight on Bioremediation and Phytoremediation of soil & water contaminated with oil spills, heavy metals and detergents and use of microbes in degradation of lignin and cellulose using and of pesticides and other toxic chemicals by micro-organisms, Degradation of aromatic and chlorinated hydrocarbons and petroleum products.
- Have knowledge of treatment of municipal waste and Industrial effluents, Biofertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil, algal and fungal biofertilizers (VAM).
- Have basic understanding of Enrichment of ores by microorganisms (gold, copper, and Uranium), Environmental significance of Genetically modified microbes, plants and animals.

UNIT I **(18 Periods)**

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 **(20 Periods)**

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products.

UNIT III **(12 Periods)**

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 IV **(10 Periods)**

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

PRACTICALS

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

BIOSTATISTICS

Course Objectives: The subject aims to provide the student with:

- Mathematics Fundamental necessary to formulate, solve and analyse the Engineering Problems
- An Understanding of Probability and its distributions, Measures of Central tendency and Measures of Dispersion
- An understanding of Correlation Regression, ANOVA and Statistical Quality control chart.

Course Outcomes: The student after undergoing this course will be able to :

- Solve Problems in Engineering domain related to Measures of Central tendency and Dispersion.
- Analyse and solve problems related to Correlation and Regression and Chi-Square Test, T-Test.
- Analyse and solve problems related to ANOVA and Statistical Quality control Chart.

UNIT I **(12 Periods)**

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 **(18 Periods)**

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

UNIT III **(18 Periods)**

Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)

UNIT IV **(12 Periods)**

Correlation and Regression. Emphasis on examples from Biological Sciences.

PRACTICALS

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 Yield^{TM} 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.