

# **CHOICE BASED CREDIT SYSTEM**

## **SYLLABUS FOR B.SC. WITH BIOTECHNOLOGY**



**JIS UNIVERSITY**

**81 NILGUNJ ROAD**

**KOLKATA 700109**

<b>Credit Distribution across the Course</b>				
<b>Course Type</b>	<b>Total Papers</b>	<b>Credit</b>		<b>Total Credit</b>
		<b>Theory</b>	<b>Practical</b>	
CC	14	14X4 = 56	14 × 2 = 28	56+28=84
DSE	4	4X4 = 16	4 × 2 = 08	16 + 8 = 24
GE	4	4X4=16	4X2=8	16+8=24
SEC	2	2x2=4		04
AECC	2	4x2=8		08
<b>TOTAL</b>				<b>144</b>
NON-CGPA				
SEMINAR/MOOKS/OTHER ACTIVITIES				06
SKILLX/NSS				06
<b>Grand Total Credit</b>				<b>= 156</b>
<b>Abbreviations used:</b>				
CC = CORE COURSES				
DSE = DISCIPLINE SPECIFIC ELECTIVES				
GE = GENERAL ELECTIVES				
SEC = SKILL ENHANCEMENT COURSES				
AECC = ABILITY ENHANCEMENT COMPULSORY COURSES				

<b>List of Core Courses</b> (14 Papers for the Students of Biotechnology)		<b>Semester</b>
CORE I	BIOCHEMISTRY & METABOLISM	<b>I</b>
CORE II	CELL BIOLOGY	
CORE III	MAMMALIAN PHYSIOLOGY	<b>II</b>
CORE IV	PLANT PHYSIOLOGY	
CORE V	GENETICS	<b>III</b>
CORE VI	MOLECULAR BIOLOGY	
CORE VII	CHEMISTRY I	
CORE VIII	IMMUNOLOGY	<b>IV</b>

CORE IX	BIOINFORMATICS	
CORE X	CHEMISTRY 2	
CORE XI	BIOPROCESS TECHNOLOGY	<b>V</b>
CORE XII	RECOMBINANT DNA TECHNOLOGY	
CORE XIII	BIostatISTICS	<b>VI</b>
CORE XIV	GENOMICS AND PROTEOMICS	

**Choices for DSE**

(2 Papers each to be selected by the Students of Biotechnology SemV and SemVI)

DSE_1	Animal Biotechnology
DSE_2	Medical Biotechnology
DSE_3	Ecology And Environmental Management
DSE_4	Environmental Biotechnology
DSE_5	Industrial Biotechnology
DSE_6	Plant Biotechnology
DSE_7	Food Biotechnology
DSE_8	Virology

**Choices for SEC**

(Any one per semester in semesters 3-4)

SEC_1	Biofertilizers and Biopesticides
SEC_2	Enzymology
SEC_3	Industrial Fermentations
SEC_4	Drug Designing
SEC_5	Basics of Forensic Biology
SEC_6	Molecular Diagnostics

**Choices for AECC**

(Any one per semester in semesters 3-4)

AECC_1	English
AECC_2	Environmental Science
AECC_3	Entrepreneurship Development
AECC_4	Values and Ethics

SEMESTER	COURSE OPTED	COURSE CODE	COURSE NAME	L	T	P	CREDIT	CONTACT HOURS	
I	CORE I	BBT-101	BIOCHEMISTRY & METABOLISM	3	1	0	4	4	
	CORE I LAB	BBT-191	BIOCHEMISTRY & METABOLISM LAB	0	0	3	2	3	
	CORE II	BBT-102	CELL BIOLOGY	3	1	0	4	4	
	CORE II LAB	BBT-192	CELL BIOLOGY LAB	0	0	3	2	3	
	GE I	BCS-101	GENERAL ELECTIVE SUBJECT	3	1	0	4	4	
	GE I LAB	BCS-191	GENERAL ELECTIVE SUBJECT LAB	0	0	3	2	3	
	AECC I	BHU-101	ENGLISH	2	0	0	2	2	
	<b>TOTAL</b>							<b>20</b>	<b>23</b>
	<b>NON-CGPA</b>								
		BSD-181	SEMINAR/MOOKS/OTHER ACTIVITIES	0	0	1	1	1	
	BSD-182	SKILLX/NSS	0	0	0	1	-		
<b>TOTAL</b>							<b>22</b>	<b>24</b>	

SEMESTER	COURSE OPTED	COURSE CODE	COURSE NAME	L	T	P	CREDIT	CONTACT HOURS	
II	CORE III	BBT-201	MAMMALIAN PHYSIOLOGY	3	1	0	4	4	
	CORE III LAB	BBT-291	MAMMALIAN PHYSIOLOGY LAB	0	0	3	2	3	
	CORE IV	BBT-202	PLANT PHYSIOLOGY	3	1	0	4	4	
	CORE IV LAB	BBT-292	PLANT PHYSIOLOGY LAB	0	0	3	2	3	
	GE II		GENERAL ELECTIVE	3	1	0	4	4	
	GE II LAB		GENERAL ELECTIVE LAB	0	0	3	2	3	
	AECC II	EVS-201 XBT2004	ENVIRONMENTAL SCIENCE	2	0	0	2	2	
	<b>TOTAL</b>							<b>20</b>	<b>23</b>
	<b>NON-CGPA</b>								
	SEMINAR II	BSD-201	SEMINAR/MOOKS/OTHER ACTIVITIES	0	0	1	1	1	
SKILL-X II	BSD-202	SKILLX/NSS	0	0	0	1	-		
<b>TOTAL</b>							<b>22</b>	<b>24</b>	

SEMESTER	COURSE OPTED	COURSE CODE	COURSE NAME	L	T	P	CREDITS	CONTACT HOURS	
III	CORE V	BBT-301	GENETICS	3	1	0	4	4	
	CORE V LAB	BBT-391	GENETICS LAB	0	0	3	2	3	
	CORE VI	BBT-302	MOLECULAR BIOLOGY	3	1	0	4	4	
	CORE VI LAB	BBT-392	MOLECULAR BIOLOGY LAB	0	0	3	2	3	
	CORE VII	BBT-303	CHEMISTRY I	3	1	0	4	4	
	CORE VII LAB	BBT-393	CHEMISTRY I LAB	0	0	3	2	3	
	GE III	BCS-301	GENERIC ELECTIVE SUBJECTS	3	1	0	4	4	
	GE III LAB		GENERIC ELECTIVE SUBJECTS	0	0	3	2	3	
	SEC I	BBT-303	SKILL ENHANCE COURSES	2	0	0	2	2	
	AECC III	BHU-301	ENTREPRENEURSHIP DEVELOPMENT	2	0	0	2	2	
	<b>TOTAL</b>							<b>28</b>	<b>32</b>
	<b>NON-CGPA</b>								
	SEMINAR III	BSD-301	SEMINAR/MOOKS/OTHER ACTIVITIES	0	0	1	1	1	
	SKILL-X III	BSD-302	SKILLX/NSS	0	0	1	1	-	
<b>TOTAL</b>							<b>30</b>	<b>33</b>	

SEMESTER	COURSE OPTED	COURSE CODE	COURSE NAME	L	T	P	CREDITS	CONTACT HOURS	
IV	CORE VIII	BBT-401	BIOINFORMATICS	3	1	0	4	4	
	CORE VIII LAB	BBT-491	BIOINFORMATICS LAB	0	0	2	2	3	
	CORE IX	BBT-402	IMMUNOLOGY	3	1	0	4	4	
	CORE IX LAB	BBT-492	IMMUNOLOGY LAB	0	0	2	2	3	
	CORE X	GCH-401	CHEMISTRY II	3	1	0	4	4	
	CORE X LAB	GCH-491	CHEMISTRY II LAB	0	0	2	2	3	
	GE 4		GENERIC ELECTIVE	3	1	0	4	4	
	GE 4 LAB		GENERIC ELECTIVE LAB	0	0	2	2	3	
	SEC II	BBT-403	SKILL ENHANCE COURSES	2	0	0	2	2	
	AECC IV	BBT-404	VALUES AND ETHICS	2	0	0	2	2	
	<b>TOTAL</b>							<b>28</b>	<b>32</b>
	<b>NON-CGPA</b>								
	SEMINAR IV	BSD-401	SEMINAR/MOOKS/OTHER ACTIVITIES	0	0	1	1	1	
	SKILL-X IV	BSD-402	SKILLX/NSS	0	0	0	1	-	
<b>TOTAL</b>							<b>30</b>	<b>33</b>	

SEMESTER	COURSE OPTED	COURSE CODE	COURSE NAME	L	T	P	CREDITS	CONTACT HOURS	
V	CORE XI	BBT-501	BIOPROCESS TECHNOLOGY	3	1	0	4	4	
	CORE XI LAB	BBT-591	BIOPROCESS TECHNOLOGY LAB	0	0	2	2	3	
	CORE XII	BBT-502	RECOMBINANT DNA TECHNOLOGY	3	1	0	4	4	
	CORE XII LAB	BBT-592	RECOMBINANT DNA TECHNOLOGY LAB	0	0	2	2	3	
	DSE I	BBT-503	DISCIPLINE CENTRIC SUBJECTS I	3	1	0	4	4	
	DSE I LAB	BBT-593	DISCIPLINE CENTRIC SUBJECTS I LAB	0	0	2	2	3	
	DSE II	BBT-504	DISCIPLINE CENTRIC SUBJECTS II	3	1	0	4	4	
	DSE II LAB	BBT-594	DISCIPLINE CENTRIC SUBJECTS II LAB	0	0	2	2	3	
	<b>TOTAL</b>							<b>24</b>	<b>28</b>
	<b>NON-CGPA</b>								
	SEMINAR V	BSD-501	SEMINAR/MOOKS/OTHER ACTIVITIES	0	0	1	1	1	
	SKILL-X V	BSD-502	SKILLX/NSS	0	0	0	1	-	
<b>TOTAL</b>							<b>26</b>	<b>29</b>	

SEMESTER	COURSE OPTED	COURSE CODE	COURSE NAME	L	T	P	CREDIT	CONTACT HOURS	
VI	CORE XV	BBT-601	BIOSTATISTICS	3	1	0	4	4	
	CORE XV LAB	BBT-691	BIOSTATISTICS LAB	0	0	2	2	3	
	CORE XVI	BBT-602	GENOMICS AND PROTEOMICS	3	1	0	4	4	
	CORE XVI LAB	BBT-692	GENOMICS AND PROTEOMICS LAB	0	0	2	2	3	
	DSE III	BBT-603	DISCIPLINE CENTRIC SUBJECTS III	3	1	0	4	4	
	DSE III LAB	BBT-693	DISCIPLINE CENTRIC SUBJECTS III LAB	0	0	2	2	3	
	DSE IV	BBT-604	DISCIPLINE CENTRIC SUBJECTS IV	3	1	0	4	4	
	DSE IV LAB	BBT-694	DISCIPLINE CENTRIC SUBJECTS IV LAB	0	0	2	2	3	
	<b>TOTAL</b>							<b>24</b>	<b>28</b>
	<b>NON-CGPA</b>								
	SEMINAR VI	BSD-601	SEMINAR/MOOKS/OTHER ACTIVITIES	0	0	0	1	1	
	SKILL-X VI	BSD-602	SKILLX/NSS	0	0	0	1	-	
<b>TOTAL</b>							<b>26</b>	<b>29</b>	

## **CORE COURSES**

### **Core I: BIOCHEMISTRY AND METABOLISM**

UNIT I: Introduction to Biochemistry:

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.

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:

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:

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<sup>+</sup>, NADP<sup>+</sup>, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate, lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions

UNIT IV:

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.  $\beta$ -oxidation of fatty acids.

## PRACTICALS

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,  $K_m$  value,  $V_{max}$  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.
5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co.

## **Core II: Cell Biology**

### UNIT I

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

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

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

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. 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<sup>th</sup> edition. Pearson Benjamin Cummings Publishing, San Francisco.

### **Core III: MAMMALIAN PHYSIOLOGY**

#### UNIT I: 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 O<sub>2</sub> and CO<sub>2</sub>, Oxygen dissociation curve, Chloride shift.

#### UNIT II: Circulation

Composition of blood, Plasma proteins & their role, blood cells, Haemopoiesis, 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

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

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. Hecourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley & sons,Inc.

### **Core IV: PLANT PHYSIOLOGY**

#### UNIT I: Anatomy

The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf)

#### UNIT II: Plant water relations and micro & macro nutrients

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 III: Carbon and nitrogen metabolism

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 IV: Growth and development

Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberellins, cytokinins, abscisic acid, ethylene)

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

#### 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 Benjamin/Cummings Publisher, USA.
6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4<sup>th</sup> 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, 4<sup>th</sup> edition, Sinauer Associates Inc .MA, USA

## Core V: GENETICS

### UNIT I

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

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

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, abnormalities– 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

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.

## **Core VI: MOLECULAR BIOLOGY**

### **UNIT I: DNA structure and replication**

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-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

### **UNIT II: DNA damage, repair and homologous recombination**

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**

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.

## **Core VII: CHEMISTRY 1**

### Section A: Inorganic Chemistry-1

#### Unit-1: Atomic Structure

Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of  $\psi$  and  $\psi^2$ , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers  $m_l$  and  $m_s$ . Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number ( $s$ ) and magnetic spin quantum number ( $m_s$ ). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

#### Unit-2: Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar,

tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO<sup>+</sup>. Comparison of VB and MO approaches.

## Section B: Organic Chemistry-1

### Unit-1: Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

### Unit-2: Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis –trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

### Unit-3: Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO<sub>4</sub>) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC<sub>2</sub> and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO<sub>4</sub>, ozonolysis and oxidation with hot alk. KMnO<sub>4</sub>.

## Recommended Books

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic
4. Chemistry, John Wiley & Sons.
5. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry:  
6. Principles of Structure and Reactivity, Pearson Education India, 2006.
7. Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
8. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India  
Edition, 2013.
9. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).

## Practical:

### Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with  $\text{KMnO}_4$ .
3. Estimation of water of crystallization in Mohr's salt by titrating with  $\text{KMnO}_4$ .
4. Estimation of Fe (II) ions by titrating it with  $\text{K}_2\text{Cr}_2\text{O}_7$  using internal indicator.
5. Estimation of Cu (II) ions iodometrically using  $\text{Na}_2\text{S}_2\text{O}_3$ .

### Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
2. Separation of mixtures by Chromatography: Measure the  $R_f$  value in each case (combination of two compounds to be given)
  - (a) Identify and separate the components of a given mixture of two amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography
  - (b) Identify and separate the sugars present in the given mixture by paper chromatography.

## Recommended Books

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

## **Core VIII: BIOINFORMATICS**

### UNIT I

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

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

### UNIT III

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 IV

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission.

Genome Annotation: Pattern and repeat finding, Gene identification tools.

### PRACTICALS

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, 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.

### **Core IX: IMMUNOLOGY**

#### UNIT I

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

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

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 IV

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

#### 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. 11<sup>th</sup> 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.

## **Core X: CHEMISTRY 2**

### Section A: Physical Chemistry-1

#### Unit-1: Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, 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-2: Chemical Equilibrium

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between  $\Delta G$  and  $\Delta G^\circ$ , Le Chatelier's principle. Relationships between  $K_p$ ,  $K_c$  and  $K_x$  for reactions involving ideal gases.

## Unit-3: Ionic Equilibria

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.

## Section B: Organic Chemistry-2

### Unit-1: Aromatic Hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

### Unit-2: Alkyl and Aryl Halides

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution ( $S_N1$ ,  $S_N2$  and  $S_Ni$ ) reactions. Preparation: from alkenes and alcohols. Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution. Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by OH group) and effect of nitro substituent. Benzyne Mechanism:  $KNH_2/NH_3$  (or  $NaNH_2/NH_3$ ). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

### Unit-3: Alcohols, Phenols and Ethers (Upto 5 Carbons)

Alcohols: Preparation: Preparation of  $1^\circ$ ,  $2^\circ$  and  $3^\circ$  alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk.  $KMnO_4$ , acidic dichromate, conc.  $HNO_3$ ). Oppeneauer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben-Hoesch Condensation, Schotten-Baumann Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde)

Preparation: from acid chlorides and from nitriles. Reactions – Reaction with HCN, ROH, NaHSO<sub>3</sub>, NH<sub>2</sub>-groups derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Ponndorf-Verley reduction.

#### Recommended Books

1. Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
2. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
3. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
4. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
5. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
6. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
7. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
8. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
9. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
10. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
11. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

Practical:

#### Section A: Physical Chemistry

##### Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.

4. Determination of integral enthalpy of solution of salts (KNO<sub>3</sub>, NH<sub>4</sub>Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of  $\Delta H$ . Ionic equilibria pH measurements
  1. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
  2. Preparation of buffer solutions:
    - (i) Sodium acetate-acetic acid
    - (ii) Ammonium chloride-ammonium hydroxide
  3. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

#### Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
  - (a) Bromination of Phenol/Aniline
  - (b) Benzoylation of amines/phenols
  - (c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

#### Recommended Books

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

## **Core XI: BIOPROCESS TECHNOLOGY**

### **UNIT I**

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**

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**

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**

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. 2<sup>nd</sup> edition, Elsevier Science Ltd.

## **Core XII: RECOMBINANT DNA TECHNOLOGY**

### **UNIT I**

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**

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**

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**

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-Appling 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, 7<sup>th</sup> edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3<sup>rd</sup> edition. Cold Spring Harbor Laboratory Press.

## Core XIII: BIOSTATISTICS

**Unit I:** Random Experiment, Outcome, Event, Mutually exclusive events, Equality like and exhaustive, Classical definition of probability, conditional probability and statistical independence. Sequential definition of probability. Baye's theorem and related problems. Axiomatic approach of probability. Exercise.

**Unit II:** Random variable. Probability space .Expectation. Theorems on Expectation. Joint distribution of two random variables.

**Unit III:** Probability distribution- Continuous and Discrete. Probability Density function. Probability Mass function. Binomial , Poisson, Normal and Rectangular distributions and their properties.

**Unit IV:** Elements of Statistical methods. Primary data and secondary data. Population and sample. Sample survey. Chart and diagram. Frequency distribution. Measure of central Tendencies- Mean , Median and Mode. Standard Deviation, Variance. Moment , Skewness and Kurtosis.

**Unit V:** Sampling distribution. Fundamental distributions- Standard normal distribution, Chi-square Distribution.

**Unit VI:** Bivariate Frequency Distribution. Correlation and Co-efficient. Regression lines. Curve fittings.

## Core XIV: GENOMICS & PROTEOMICS

## UNIT I

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

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

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 filtration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.

## UNIT IV

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). 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.

## **DISCIPLINE SPECIFIC ELECTIVES**

### **DSE\_1: ANIMAL BIOTECHNOLOGY**

#### UNIT I

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

#### 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.

#### UNIT III

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

#### UNIT IV

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

## 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.

## **DSE\_2: MEDICAL BIOTECHNOLOGY**

**Unit I: Gene therapy:** Background, types of gene therapy (ex vivo & in vivo), choosing targets for gene therapy, vectors in gene therapy, retroviruses, adenoviruses, adeno-associated viruses,

types of gene delivery, Weismann barrier (soma-to-germ line barrier), epigenetic inheritance, problems & ethics.

**Unit II: Gene Delivery methods:** Viral delivery (through Retroviral vectors, through Adenoviral vectors), Non-viral delivery, Antibody engineering.

**Unit III: Gene therapy Models:** Liver diseases, Lung diseases, Hematopoietic diseases, Circulated gene products, Cancer & Auto-immune diseases.

**Unit IV: Vaccines:** Vaccine vectors, nucleic acid vaccines, immuno-enhancing technology.

**Unit V: Synthetic therapy:** synthetic DNAs, therapeutic Ribozymes, synthetic drugs.

**Unit VI: Tissue Engineering:** Skin, Liver, Pancreas.

**Unit VII: Xenotransplantation:** terminology, technology behind it, organ donors, social & ethical issues.

**Unit VIII: Cell Adhesion-based therapy:** integrins, inflammation, cancer & metastasis.

**Unit IX: Drug delivery:** conventional & new approaches to drug delivery.

## **Practical:**

### **Medical Biotechnology Practical Lab.**

(LPT= 0-0-2)

1. Extraction and Quantification of genomic DNA/ plasmid DNA
2. Estimation of Protein samples
3. Detection of DNA damage by comet assay
4. Demonstration on RFLP
5. Cell culture technique
6. Demonstration of Karyotyping of normal & abnormal human chromosome sets
7. Demonstration of Human pedigree analysis

### **Test Books**

1. Albert Sasson. Medical Biotechnology: Achievements, Prospects and Perceptions. United Nations University Press, 2005.

2. Lee Yaun Kun. Microbial Biotechnology Principles and applications. World Science publications, 2004
3. Michels et al., Genetic techniques for Biological Research. Wiley Publications, 2002.
4. Glazer AN, Nikaido H. Microbial Biotechnology Fundamentals of Applied Microbiology WH Freeman, New York 1994.
5. Vyas. Methods in Biotechnology and Bioengineering, CBS publications, 2003.
6. Marshak et al., Stem cell Biology. CSHL publications, 2002.

### **DSE\_3: ECOLOGY AND ENVIRONMENTAL MANAGEMENT**

#### UNIT-I

Our Environment: Geological consideration of Atmosphere, Hydrosphere, Lithosphere Scope of Ecology. Development & Evolution of Ecosystem. Principles & Concepts of Ecosystem. Structure of ecosystem. Strata of an ecosystem. Types of ecosystem including habitats. Cybernetics & Homeostasis. Biological control of chemical environment.

#### UNIT II

Energy transfer in an Ecosystem. Food chain, food web, Energy budget, Production & decomposition in a system. Ecological efficiencies, Trophic structure & energy pyramids, Ecological energetic, principles pertaining to limiting factors, Bio-geochemical cycles (N,C,P cycles).

#### UNIT-III

Pollution & environmental Health related to Soil, Water, Air, Food, Pesticides, Metals, Solvents, Radiations ,Carcinogen, Poisons. Detection of Environmental pollutant. Indicators & detection systems. Bio-transformation, Plastic, Aromatics, Hazardous wastes Environmental cleanup: Case studies

#### UNIT-IV (10 Periods)

Environmental biotechnologies, Biotechnologies in protection and preservation of environment. Bioremediation, Waste disposal.

#### PRACTICALS

1. Study of all the biotic and abiotic components of any simple ecosystem- natural pond or terrestrial ecosystem or human modified ecosystem.
2. Determination of population density in a terrestrial community or hypothetical community by quad rate method and calculation of the Simpson's and Shannon- Weiner diversity index for the same community.
3. Principle of GPS (Global Positioning System).
4. Study of the life table and fecundity table, plotting of the three types of survivorship curves from the hypothetical data.
5. Study of the types of soil, their texture by sieve method and rapid tests for –pH, chlorides, nitrates, carbonates and organic carbon
6. Study any five endangered/ threatened species- one from each class.

#### SUGGESTED READING

1. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) Cambridge University Press.
2. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.
3. Ghosh, S.K., Singh, R. 2003. Social forestry and forest management. Global Vision Publishing House
4. Joseph, B., Environmental studies, Tata Mc Graw Hill.
5. Michael Allabay, Basics of environmental science, Routledge Press.
6. Miller, G.T. 2002. Sustaining the earth, an integrated approach. (5th edition) Books/Cole, Thompson Learning, Inc.
7. Mohapatra Textbook of environmental biotechnology IK publication.
8. Rana SVS, Environmental pollution – health and toxicology, Narosa Publication
9. Sinha, S. 2010. Handbook on Wildlife Law Enforcement in India. TRAFFIC, India.
10. Thakur, I S, Environmental Biotechnology, I K Publication.

## **DSE\_4: ENVIRONMENTAL BIOTECHNOLOGY**

### UNIT I

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

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 chlorinated hydrocarbons and petroleum products.

### UNIT III

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

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 Jeseff 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

## **DSE\_5: Industrial Biotechnology**

Unit I: Commercial Production of Microorganisms: Industrial Fermenters, Single-cell Protein.

Unit II: Bioconversions: Biomining and bioleaching of ores (Use of thermophilic microorganisms in industrial microbiology Bio-gas, Bio-leaching, Bio-diesel.

Unit III: Microorganisms & Agriculture: Microorganisms in Agricultural Waste water treatment, Vermiculture, Microbial pesticides.

Unit IV: Products from Microorganisms: Metabolites, Enzymes, Antibiotics.

Unit V: Bioremediation: Petroleum prospecting and formation of oil spills, Wastewater treatment, chemical degradation, heavy Metals.

Unit VI: Principles of Microbial growth: introduction, the ways of growing microorganisms, ways to increase yield of microbes, Batch, fed-batch and continuous cultures (definition and kinetics).

Unit VII: Downstream processing: extraction, separation, concentration, recovery & purification, operations (Insulin, Vitamins, Metabolites), Industrial production of Ethyl alcohol, Acetic Acid (Vinegar), Citric acid, lactic acid,  $\alpha$ -amylase, protease penicillin, tetracycline and vitamin B12, with reference to easily available raw materials, Production of herbal drugs. .

Unit VIII: Biological fuel generation: photosynthesis, sources of biomass, ethanol from biomass, methane from biomass, hydrogen, microbial recovery of petroleum.

### **PRACTICAL**

#### **Text Books**

1. Industrial Microbiology (1992): 4th edition-Prescott & Dunn.,CBS
2. Perspectives in Biotechnology and applied Microbiology. Elsevier Publication, Alani,D.I., and Murray Moo-Young (1986):
3. Applied Microbiology (1968)Cassida Jr. Tata McGraw hill. Microbiology- Concepts and applications (1994): Paula A.Ketchun
4. Fermentation Technology -(1998) Staneberry et al.
5. Molecular Biotechnology -Principles & applications of Recombinant DNA - Bernad R.Glick and JackJ.Pasternak.

## **DSE\_6: PLANT BIOTECHNOLOGY**

### **UNIT I**

Introduction, Cryo and organogenic differentiation, Types of culture: Seed , Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

### **UNIT- II**

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

### **UNIT - III**

Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation. Nomenclature, methods, applications basis and disadvantages.

### **UNIT - IV**

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

### **PRACTICALS**

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. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
4. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.

5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rd edition. Benjamin Co.
7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)
8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

## **DSE\_7: FOOD BIOTECHNOLOGY**

UNIT I: Methods for the microbiological examination of water and foods; Control of Microbiological quality and safety; Food borne illnesses and diseases

UNIT II: Microbial cultures for food fermentation, their maintenance, strain development; Production of organic acids (vinegar, lactic acid), alcoholic beverages (beer, wine, and distilled alcoholic beverages such as whiskey, rum, vodka), glycerol

UNIT III: Propagation of baker's yeasts; Microbial production of vitamins (B2 and B12), antibiotics (penicillin, streptomycin, tetracycline); Enzymatic production of glucose, fructose, starch, SCP and mushrooms

UNIT IV: Basics of microbial genetics – Gene, DNA, RNA; Replication, transcription, transformation, transduction, conjugation; Regulation of gene expression; Application in GM foods.

### **PRACTICAL**

1. Alcohol fermentation
2. Organic acid fermentation – Vinegar / citric / lactic acid production
3. Propagation of baker's yeast
4. Fermented dairy products
5. Production of antibiotics
6. Enzyme preparation
7. Amino acid production
8. Vitamin B12 production

Books:

1. Industrial Microbiology Prescott & Dunn, CBS Publishers
2. Modern Food Microbiology by Jay JM, CBS Publishers
3. Comprehensive Biotechnology by Murray & Mooyoung, Academic press
4. Industrial Microbiology by Casida L.R., New Age International Pvt. Ltd.
5. Food Microbiology; Frazier WC; 4th ed, Tata-McGrowhill Pub.
6. Microbiology by Pelczar, Chan, and Krieg, TMH
7. Fermentation Biotechnology, Principles, Processed Products by Ward OP, Open University Press.

## **DSE\_8: Virology**

Unit I: Classification and Morphology of Viruses: Cataloging the virus through virus classification schemes of ICTV / ICNV. Morphology and ultra-structure of viruses. Virus related agents, viroids and prions.

Unit II: Cultivation and assay of viruses: Cultivation of viruses using embryonated eggs, experimental animals and cell cultures (Cell-lines, cell strains and transgenic systems). Purification of viruses by adsorption, precipitation, enzymes, serological methods – haeme agglutination and ELISA.

Unit III: Assay of viruses: Physical and Chemical methods (Electron Microscopy and Protein and Nucleic acids studies.) Infectivity Assays (Plaque and end-point) Genetic analysis of viruses by classical genetic methods.

Unit IV: Viral Multiplication: Mechanism of virus adsorption and entry into the host cell including genome replication and mRNA production by animal viruses, mechanism of RNA synthesis, mechanism of DNA synthesis, transcription mechanism and post transcriptional processing, translation of viral proteins, assembly, exit and maturation of progeny virions, multiplication of bacteriophages.

Unit V: Pathogenesis of Viruses: Host and virus factors involved in pathogenesis, patterns of infection, pathogenesis of animal viruses Adenovirus, Herpes virus, Hepatitis virus, Picorna virus, Poxvirus and Orthomyxovirus, pathogenesis of plant [TMV] and insect viruses [NPV]. Host cell transformation by viruses and oncogenesis of DNA and RNA viruses.

Unit VI: Control of Viruses and Emerging Viruses: Control of viral infections through vaccines, interferons and chemotherapeutic agents. Structure, genomic organization, pathogenesis and control of Human immunodeficiency virus. Emerging viruses

## **SKILL ENHANCEMENT COURSES**

### **SEC\_1: MOLECULAR DIAGNOSTICS**

#### **UNIT I**

##### **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**

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**

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

#### **UNIT IV**

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 (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-Century-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

## **SEC\_2: ENZYMOLOGY**

### UNIT - I

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  $K_m$  and  $V_{max}$  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

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of  $K_i$ , 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

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 (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 & invivo.

#### 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 and Sons, 1995.
4. Biochemistry by Mary K.Campbell & Shawn O.Farrell, 5th Edition, Cengage 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

### **SEC\_3: INDUSTRIAL FERMENTATIONS**

#### UNIT I

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

Microbial products of pharmacological interest, steroid 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

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

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 ( $K_a$ ) 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. 2<sup>nd</sup> edition, Elsevier Science Ltd.
5. Salisbury, Whitaker and Hall. Principles of fermentation Technology,

## **SEC\_4: DRUG DESIGNING**

UNIT I: Introduction to The Drug Discovery/Development: Drug Discovery, Drug Development, Source of Drugs, Structural effects on drug action

UNIT II: Approaches to New Drug Discovery : Drugs Derived from Natural Products, Existing Drugs as a Source for New Drug Discovery, Using Disease Models as Screens for New Drug Leads, Physiological Mechanisms: the Modern “Rational Approach” to Drug Design.

Approaches to Lead Optimization:

1. Bioisosteric replacement
2. Conformation restriction
  - a. Increase selectivity, b. Increase affinity
3. Pharmacophore
4. Molecular dissection
5. Metabolic stabilization

UNIT III: Enzymes as Targets of Drug Design: Enzyme kinetics, Enzyme inhibition and activation, Approaches to the Rational Design of Enzyme Inhibitors

UNIT IV: Receptors as Targets of Drug Design: Receptor Theory, Receptor Complexes and Allosteric Modulators, Second and Third Messenger Systems, Molecular Biology of Receptors, Receptor Models and Nomenclature, Receptor Binding Assays, Lead Compound Discovery of Receptor agonists and antagonists

UNIT V: Prodrug Design and Applications: Definition, Applications, Prodrug Design Considerations, Prodrug Forms of Various Functional Groups, Ester prodrugs of compounds containing –COOH or –OH, Prodrugs of compounds containing amides, imides, and other acidic NH, Prodrugs of Amines, Prodrugs for compounds containing carbonyl groups

Drug release and activation mechanisms:

1. Simple one-step activation
2. Cascade release/activation systems

UNIT VI: Computer-Aided Drug Design: Docking and virtual screening, Molecular Dynamics and binding free energy methods

## **SEC\_5: BASICS OF FORENSIC SCIENCE**

## Unit I

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

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 III

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 IV

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.

## 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)

## **AECC\_1: ENGLISH**

### **Unit 1: Communication: Interface in a Globalized World**

- a. Definition of Communication & Scope of Communication
- b. Process of Communication—Models and Types
- c. Verbal—Non-Verbal Communication, Channels of Communication
- d. Barriers to Communication & surmounting them [to be delivered through case studies involving intercultural communication]

### **Unit 2: Vocabulary and Reading**

- a. Word origin—Roots, Prefixes and Suffixes, Word Families, Homonyms and Homophones
- b. Antonyms and Synonyms, One-word substitution
- c. Reading—Purposes and Skills
- d. Reading Sub-Skills—Skimming, Scanning, Intensive Reading
- e. Comprehension Practice (Fiction and Non-fictional Prose/Poetry)

#### Texts:

- (i) Isaac Asimov, I Robot (“Robbie” OR “Little Lost Robot”)
  - (ii) George Orwell, “Shooting an Elephant”
  - (iii) Ruskin Bond, “The Cherry Tree” OR “The Night Train at Deoli”
  - (iv) Robert Frost, “Stopping by the Woods on a Snowy Evening.”
- f. Precis Writing (Use of daily newspapers for reading practice is recommended)

### **Unit 3: Functional Grammar and Usage**

- a. Articles, Prepositions, Verbs
- b. Verb-Subject Agreement
- c. Comparison of Adjectives
- d. Tenses and their Use
- e. Transformation of Sentences (Singular-Plural, Active-Passive, Direct-Indirect, Degrees of Comparison)
- f. Error Correction

### **Unit 4: Business writing [10L]**

- a. Business Communication in the Present-day scenario
- b. Business Letters (Letters of Inquiry, Sales Letters, Complaint and Adjustment Letters, Job Application Letters)
- c. Drafting of a CV and Résumé
- d. Memo, Notice, Advertisement, Agenda, Minutes of Meetings
- e. E-mails (format, types, jargons, conventions)

## **AECC\_2: ENVIRONMENTAL SCIENCE**

### **UNIT 1. General**

1.1 Natural Resources: Forest Resource, water resource, mineral resource, energy resources (renewable, non-renewable, potentially renewable)

1.2 Population Growth: Exponential Growth, logistic growth, Maximum sustainable yield

1.3 Disaster Management: Types of disasters (Natural & Man-made), Floods, Earthquake, Tsunamis, Cyclones, landslides (cause, effect & control)

1.4 Ecology & Ecosystem: Elements of ecology, definition of ecosystem- components types and function, Food chain & Food web,

Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems

1.5 Environmental Management: Environmental impact assessment, Environmental laws and protection act of India, Different international environmental agreement.

### **UNIT 2. Air pollution and control**

2.1 Sources of Pollutants: point sources, nonpoint sources and manmade sources primary & secondary pollutant

2.2 Types of air pollutants: primary & secondary pollutant ; Suspended particulate matter, oxides of carbon, oxides of nitrogen, oxides of sulphur, particulate, PAN, Smog (Photochemical smog and London smog),

2.3 Effects on human health & climate: Greenhouse effect, Global Warming, Acid rain, Ozone Layer Depletion

2.4 Air pollution and meteorology: Ambient Lapse Rate, Adiabatic Lapse Rate, Atmospheric stability & Temperature inversion

2.5 control of air pollution (ESP, cyclone separator, bag house, catalytic converter, scrubber (ventury),

### **UNIT 3. Water Pollution**

3.1 Classification of water (Ground & surface water)

3.2 Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, heavy metals, pesticides, volatile organic compounds.

3.3 Surface water quality parameters: pH, DO, 5 day BOD test, BOD reaction rate constants, COD. Numerical related to BOD Lake: Eutrophication [Definition, source and effect].

3.4 Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only), ground water pollution (Arsenic & Fluoride; sources, effects, control)

3.5 Quality of Boiler fed water: DO, hardness, alkalinity, TDS and Chloride

3.7 Layout of waste water treatment plant (scheme only).

#### **UNIT 4. Land Pollution**

4.1 Types of Solid Waste: Municipal, industrial, commercial, agricultural, domestic, hazardous solid wastes (bio-medical), E-waste

4.2 Solid waste disposal method: Open dumping, Land filling, incineration, composting, recycling (Advantages and disadvantages).

#### **UNIT 5. Noise Pollution**

5.1 Definition of noise, effect of noise pollution on human health,

5.2 Average Noise level of some common noise sources

5.3 Definition of noise frequency, noise pressure, noise intensity, noise threshold limit value, equivalent noise level, L10 (18 hr Index) .

5.4 Noise pollution control.

### **AECC\_3: ENTREPRENEURSHIP DEVELOPMENT**

#### **UNIT I: INTRODUCTION**

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

#### **UNIT II: ESTABLISHING AN ENTERPRISE**

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

#### **UNIT III: FINANCING THE ENTERPRISE**

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**

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**

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

## **AECC\_4: VALUES AND ETHICS**

**Unit – 1:** Ethics and Human Values – Definition – Good Behaviour, Conduct and Character; Importance, Respects for Elders, Use and Relevance in Present-day Society.

**Unit – 2:** Indian Constitution and Values – Fundamental Rights and Duties -Freedom, Equality, Fraternity, Justice; Directive Principles of State Policy; Our National Emblem.

**Unit – 3:** Individual and Society – Desirable Basic Human Characters - Honesty, Truthfulness, Respect, Punctuality, Responsibility, Courtesy, Discipline, Kindness, courage, Character, Forgiveness, Friendship, Compassion, Consideration, Contentedness, Simplicity, Empathy, Avoiding Greed; Family responsibilities; Duties as a Member of the Society; Social Concerns – Evils of Dowry, Caste System, Racial Discrimination; Participation in NCC, NSS, Scouts & Guides, NGC.

**Unit – 4:** Life Skills – Goal-setting; Self-esteem and Self-Confidence; Problem Solving; Decision Making; Time Management; Stress Management; Positive Thinking; Assertiveness; Teamwork; Interpersonal Relationships; Coping with Life Stresses; Suicidal Tendencies; Peer Pressure; Substance Abuse and Addiction.

**Unit – 5:** Environmental Concerns – Respect for Natural Environment – Land, Trees, Air, Water, Animals; Unethical Practices – Depletion of Natural Resources (Soil Erosion, Pollution, Mining, Deforestation); Use of Plastics and Pesticides; EcoClubs.

**Unit – 6:** Professional Ethics–Need and Importance – Goals – Dignity of Labour – Ethical Values in Different Professions – Management, Business, Teaching, Civil Services, Politics, Medicine, Policing, Judiciary.

**Unit – 7:** Ethics, Values and Thinking–Right Thinking, Right Understanding, Reflective Thinking, Rational / Critical Thinking, Creative Thinking.