

Vidyasagar University

Curriculum for B.Sc. Honours in Biotechnology [Choice Based Credit System]

Semester-I

Sl.No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
C1	C1T: Biochemistry & Metabolism	Core Course-1		4	0	0	6	75
	C1P: Biochemistry & Metabolism (Practical)	Core Course1 [Practical]		0	0	4		
C2	C2T: Cell Biology	Core Course-2		4	0	0	6	75
	C2P: Cell Biology(Practical)	Core Course-2 [Practical]		0	0	4		
GE-1	GE-1	GE					4/5	75
	GE-1	GE					2/1	
AECC	English	AECC					2	50
				Total Credits =20				

L=Lecture, T=Tutorial, P=Practical

AECC- Ability Enhancement Compulsory Course: English /Modern Indian Language

Interdisciplinary/ Generic Elective (GE) from other Department

[Four papers are to be taken and each paper will be of 6 credits]:

[Papers are to be taken from any of the following discipline] **Physics/Chemistry/Mathematics/Statistics /Microbiology/Zoology/Boany/Physiology/Economics/Nutrition/Geology/Computer Sc**

Semester-1
Core Courses

Core-1

CC-1 : BIOCHEMISTRY AND METABOLISM **Credits 06**

C1T : BIOCHEMISTRY AND METABOLISM (Theory) **Credits 04**

UNIT I: Introduction to Biochemistry: **(10 Periods)**

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 **(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. β -oxidation of fatty acids.

C1 P : BIOCHEMISTRY AND METABOLISM (Practical) **Credits 02**

1. To study activity of any enzyme under optimum conditions.
2. To study the effect of pH, temperature on the activity of salivary amylase enzyme.

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

SUGGESTED READING

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

CC – 2: CELL BIOLOGY

Credits 06

C2T2: CELL BIOLOGY (theory)

Credits 04

UNIT I

(10 Periods)

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

(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.

C2P: CELL BIOLOGY (Practical)

Credits 02

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

SUGGESTED READING

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

Generic Elective Syllabus

GE-1 [Interdisciplinary for other department]

GE-1 : BIOTECHNOLOGY AND HUMAN WELFARE (Theory) **credits 06**

GE-1 T: BIOTECHNOLOGY AND HUMAN WELFARE (Theory) **Credits 04**

UNIT I **(10 Periods)**

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

UNIT II **(10 Periods)**

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

UNIT III **(15 Periods)**

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

UNIT IV **(12 Periods)**

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

UNIT V**(13 Periods)**

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

GE-1 P: BIOTECHNOLOGY AND HUMAN WELFARE (Practical)**Credits 02**

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

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

SUGGESTED READING

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

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Semester-II

Sl. No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
C3	C3T : Mammalian Physiology	Core Course-3		4	0	0	6	75
	C3P : Mammalian Physiology (Practical)	Core Course-3 [Practical]		0	0	4		
C4	C4T : Plant Anatomy and Physiology	Core Course-4		4	0	0	6	75
	C4P : Plant Anatomy and Physiology (Practical)	Core Course-4 [Practical]		0	0	4		
GE-2	GE-2	GE					4/5	75
	GE-2	GE					2/1	
AEC C-2	Environmental Studies	AECC					4	100
				Total Credits =22				

L=Lecture, T=Tutorial, P=Practical

AECC- Ability Enhancement Compulsory Course: Environmental Studies.

Interdisciplinary/ Generic Elective (GE) from other Department

[Four papers are to be taken and each paper will be of 6 credits]:

[Papers are to be taken from any of the following discipline]

Physics/Chemistry/Mathematics/Statistics/Microbiology/Zoology/Botany/Physiology

/Economics/Nutrition/Geology/Computer Sc

Semester-II

Core Courses

Core-3

CC-3: MAMMALIAN PHYSIOLOGY

Credits 06

C3T: MAMMALIAN PHYSIOLOGY

Credits 04

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 O₂ and CO₂, 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.

C3P: Practicals

Credits 02

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.

Core-4

CC-4: PLANT ANATOMY AND PHYSIOLOGY	Credits 06
C4T: PLANT ANATOMY AND PHYSIOLOGY	Credits 04

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 (dorsiventral and isobilateral leaf)

UNIT II: 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 III: 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 IV: Growth and development **(18 Periods)**

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 photo-periodism and vernalization

C4P: Practicals **Credits 02**

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, 4thedition, 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

Generic Elective(GE)

GE-2 [Interdisciplinary for other department]

GE-2 : ENTERPRENEURSHIP DEVELOPMENT

Credits 06

GE-2T : ENTERPRENEURSHIP DEVELOPMENT

UNIT I : INTRODUCTION

(10 Periods)

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

UNIT II : ESTABLISHING AN ENTERPRISE

(12 Periods)

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

UNIT III : FINANCING THE ENTERPRISE

(15 Periods)

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

(13 Periods)

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 (10 Periods)

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

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

Suggested Reading:

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

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Semester-III

Course	Course Code	Name of the Subjects	Course Type/ Nature	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
CC-5		C1T: General Microbiology	Core Course - 5	4	0	0	6	75
		C1P: General Microbiology		0	0	4		
CC-6		C2T:Genetics	Core Course - 6	4	0	0	6	75
		C2P: Genetics		0	0	4		
CC-7		C3T: Chemistry –I (Physical Chemistry)	Core Course - 7	4	0	0	6	75
		C3P: Chemistry –I (Physical Chemistry)		0	0	4		
GE-3		TBD	Generic Elective -3				6	75
SEC-1		SEC1T: Enzymology SEC1P: Enzymology Or SEC1T:Industrial Fermentation SEC1P:Industrial Fermentation	Skill Enhancement Course-1	1	0	0	2	50
				0	0	2		
Semester Total							26	350

L=Lecture, **T**= Tutorial, **P**=Practical, **CC** = Core Course, **GE**= Generic Elective, **SEC** = Skill Enhancement Course, **TBD** = to be decided

Generic Elective (GE) (Interdisciplinary) from other Department [**Four papers are to be taken and each paper will be of 6 credits**] Papers are to be taken from any of the following discipline:**Physics/Chemistry/Mathematics/Statistics/Microbiology/Zoology/Boany/Physiology/Economics/ Nutrition/Geology/Computer Sc**

Modalities of selection of Generic Electives (GE): A student shall have to choose **04** Generic Elective (GE1 to GE4) strictly from **02** subjects / disciplines of choice taking exactly **02** courses from each subjects of disciplines. Such a student shall have to study the curriculum of Generic Elective (GE) of a subject or discipline specified for the relevant semester.

Semester-III
Core Course (CC)

CC-5: GENERAL MICROBIOLOGY	Credits 06
C5T: General Microbiology	Credits 04

UNIT I

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

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

UNIT III

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

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.

C5P: General Microbiology**Credits 02****Practical:**

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 Readings:

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*. 7th edition, 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.

CC-6: GENETICS**Credits 06****C6T: Genetics****Credits 04****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.

C6P: Genetics**Credits 02****Practical:**

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
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.

CC- 7 : CHEMISTRY-I (PHYSICAL CHEMISTRY)**Credits 06****C7T : Chemistry-I(Physical Chemistry)****Credits 04****Theory**

1. Thermodynamics- Concept of energy, heat and work; thermodynamics functions- internal energy, entropy, enthalpy and free energy; bioenergetics- spontaneity equation in terms of entropy and concept of equilibrium; transport across membranes- Donnan equilibrium
2. Radioactivity- Alpha, beta, gamma radiation, law of radioactive decay, unit of radioactivity, idea of artificial. Radioactivity, application-radiolabelling
4. Electrochemistry- Electrolytic dissociation and conduction, ionic equilibrium, pH, indicator, acid base neutralization curve, buffer action, Bronsted acid, Henderson-Hasselbalch equation, preparation of buffer, buffer capacity
5. Properties of molecules- Structure of atom, Electronic theory of valency, dipole moment, hydrogen bonds, Van der Waals' interactions, Electrostatic interactions, Hydrophobic interactions;
6. Chemical Kinetics- Transition State theory, Arrhenius equation. preliminary ideas about

zero, 1st and 2nd order reactions with examples,

C7P : Chemistry-I (Physical Chemistry)

Credits 02

Practical

1. Experiments on Physical Chemistry

- i) Equilibrium constant of the reaction $KI + I_2 = KI_3$.
- ii) Solubility/solubility product in presence/absence of common ions and/or neutral electrolytes (e.g. Na- oxalate, Mg-carbonate, K-hydrogen tartarate, etc).
- iii) Conductometric and potentiometric titrations of an acid or a base (acid may be monobasic/ dibasic, and similarly for the base)
- iv) Kinetics of decomposition of H_2O_2 and hydrolysis of an ester.
- v) Verification of Beer's law and finding strengths of unknown solutions by colorimetry; (also, colour matching principle to find unknown concentrations)

Skill Enhancement Course (SEC)

SEC-1: ENZYMOLOGY

Credits 02

SEC1T: Enzymology

Credits 01

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

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

UNIT – III

Allosteric enzymes with special reference to aspartate transcarbamylase 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

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*.

SEC1P: Enzymology

Credits 01

Practical:

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

Suggested Readings:

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

OR

SEC-1: INDUSTRIAL FERMENTATIONS	Credits 02
SEC1T: Industrial Fermentation	Credits 01

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 (Ka) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

SEC1P: Industrial Fermentations	Credits 01
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Practical:

1. Comparative analysis of design of a batch and continuous fermenter.
2. Calculation of Mathematical derivation of growth kinetics.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.
4. Perform an enzyme assay demonstrating its hydrolytic activity (protease/ peptidase/ glucosidase etc.)

Suggested Reading:

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

Generic Elective Syllabus GE-3 [Interdisciplinary for other department]

GE-3: DEVELOPMENTAL BIOLOGY **Credits 06**

GE3T: Developmental Biology **Credits 04**

UNIT I: Gametogenesis and Fertilization

Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

UNIT II: Early embryonic development

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

UNIT III: Embryonic Differentiation

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

UNIT IV: Organogenesis

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

Practical:

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

Suggested Readings :

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.