VIDYASAGAR UNIVERSITY

Curriculum for 3-Year BSc (General)
in

Biochemistry

Under Choice Based Credit System (CBCS)
[w.e.f 2018-2019]

VIDYASAGAR UNIVERSITY

B Sc (General) in Biochemistry

[Choice Based Credit System]

Year	Semester	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
1	I	SEMESTER-I					CA	ESE	TOTAL
		Core-1 (DSC-1A)		**Biochemistry of Cell** **- Practical**	6	4-0-4	15	60	75
		Core-2 (DSC-2A)		Other Discipline (Discipline-2) /TBD	6	4-0-4/ 5-1-0	15	60	75
		Core-3 (DSC-3A)		Other Discipline(Discipline-3) /TBD	6	4-0-4/ 5-1-0	15	60	75
		AECC-1 (Elective)		English/MIL	2	1-1-0	10	40	50
				Semester - I : Total	**20**				**275**
	II	SEMESTER-II							
		Core-4 (DSC-1B)		**Proteins and Enzymes** **- Practical**	6	4-0-4	15	60	75
		Core-5 (DSC-2B)		Other Discipline(Discipline-2) /TBD	6	4-0-4/ 5-1-0	15	60	75
		Core-6 (DSC-3B)		Other Discipline(Discipline-3) /TBD	6	4-0-4/ 5-1-0	15	60	75
		AECC-2 (Elective)		Environmental Studies	4		20	80	100
				Semester - 2 : Total	**22**				**325**

Year	Semester	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
2	III	SEMESTER-III					CA	ESE	TOTAL
		Core-7 (DSC-1C)		**Intermediary Metabolism - Practical**	6	4-0-4	15	60	75
		Core-8 (DSC-2C)		Other Discipline(Discipline-2) /TBD	6	4-0-4/ 5-1-0	15	60	75
		Core-9 (DSC-3C)		Other Discipline(Discipline-3) /TBD	6	4-0-4/ 5-1-0	15	60	75
		SEC-1		SEC-1: Tools and Techniques in Biochemistry	2	1-1-0	10	40	50
				Semester - 3 : Total	**20**				**275**
	IV	SEMESTER-IV							
		Core-10 (DSC-1D)		**Gene organization, Expression and Regulation - Practical**	6	4-0-4	15	60	75
		Core-11 (DSC-2D)		Other Discipline(Discipline-2) /TBD	6	4-0-4/ 5-1-0	15	60	75
		Core-12 (DSC-3D)		Other Discipline(Discipline-3) /TBD	6	4-0-4/ 5-1-0	15	60	75
		SEC-2		SEC-2: Protein Purification Techniques	2	1-1-0	10	40	50
				Semester - 4 : Total	**20**				**275**

Year	Semester	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
3	V	SEMESTER-V					CA	ESE	TOTAL
		DSE-1A		Discipline-1(Biochemistry)	6	4-0-4/ 5-1-0	15	60	75
		DSE-2A		Other Discipline(Discipline-2) /TBD	6	4-0-4/ 5-1-0	15	60	75
		DSE-3A		Other Discipline(Discipline-3) /TBD	6	4-0-4/ 5-1-0	15	60	75
		SEC-3		SEC-3: Clinical Biochemistry	2	1-1-0	10	40	50
				Semester - 5 : Total	**20**				**275**
	VI	SEMESTER-VI							
		DSE-1B		Discipline-1(Biochemistry)	6	4-0-4/ 5-1-0	15	60	75
		DSE-2B		Other Discipline(Discipline-2) /TBD	6	4-0-4/ 5-1-0	15	60	75
		DSE-3B		Other Discipline(Discipline-3) /TBD	6	4-0-4/ 5-1-0	15	60	75
		SEC-4		SEC-4: Recombinant DNA Technology **Or** Bioinformatics and Biostatistics	2	1-1-0	10	40	50
				Semester - 6 : Total	**20**				**275**
				Total in all semester:	**122**				**1700**

CC = Core Course , **AECC** = Ability Enhancement Compulsory Course , **GE** = Generic Elective , **SEC** = Skill Enhancement Course , **DSE** = Discipline Specific Elective , **CA**= Continuous Assessment , **ESE**= End Semester Examination , **TBD**=To be decided , **CT** = Core Theory, **CP**=Core Practical , **L** = Lecture, **T** = Tutorial ,**P** = Practical , **MI**L = Modern Indian Language , **ENV**S = Environmental Studies ,

List of Core Courses and Electives

Core Course (CC)

DSC-1A: Biochemistry of Cell
DSC-1B: Proteins and Enzymes
DSC-1C: Intermediary Metabolism
DSC-1D: Gene Organization, Expression and Regulation

Discipline Specific Electives (DSE)

DSE-1: Nutritional Biochemistry
Or
DSE-1: Basic Microbiology
Or
DSE-1: Molecular Basis of Infectious Diseases
Or
DSE-1: Advanced Cell Biology

DSE-2: Molecular Basis of Non-Infectious Human Diseases
Or
DSE-2: Plant Biochemistry
Or
DSE-2: Molecular Diagnostics
Or
DSE-2: Project Work

Skill Enhancement Course (SEC)

SEC-1: Tools and Techniques in Biochemistry
SEC-2: Protein Purification Techniques
SEC-3: Clinical Biochemistry
SEC-4: Recombinant DNA Technology
Or
SEC-4: Bioinformatics and Biostatistics

Core Course (CC)

DSC-1A(CC-1) : Biochemistry of Cell **Credits: 06**

DSC1AT: Biochemistry of Cell (theory) **Credits : 04**

Course Contents:

Unit 1: Bio-molecules in their cellular environment
The cellular basis of life. Cellular structures – prokaryotes and eukaryotes. Chemical principles in bio-molecular structure. Major classes of bio-molecules. Role of water in design of bio-molecules.

Unit 2: Amino acids and peptides
Types of amino acids and their chemistry, derivatives of amino acids and their biological role. Introduction to biologically important peptides.

Unit 3: Sugars and polysaccharides
Basic chemistry of sugars, optical activity. Disaccharides, trisaccharides and polysaccharides - their distribution and biological role.

Unit 4: Nucleosides, nucleotides and nucleic acids
Structures and chemistry, DNA structures and their importance, different types of RNA. Unusual DNA structures, other functions of nucleotides.

Unit 5: Lipids
Various classes of lipids and their distribution, storage lipids, structural lipids in membranes, lipids as signals, cofactors and pigments.

Unit 6 :Vitamins, coenzymes and metal ions
Occurrence and nutritional role. Coenzymes and their role in metabolism. Metal ion containing bio-molecules - heme, porphyrins and cyanocobalamin; their biological significance.

Unit 7: Signaling molecules
Second messengers - cAMP, cGMP, IP3, diacyl glycerol, Ca2+, NO. Brief account of their importance and role in signalling and signal transduction.

DSC1AP: Biochemistry of Cell (Practical) **Credits: 02**

Practical

1. General safety procedures in a laboratory. Use of auto pipettes. Making solutions and buffer preparation - acetate and tris buffers.
2. Qualitative tests for bio-molecules - carbohydrates, lipids, amino acids, proteins, bases and nucleic acids.
3. Separation of amino acids by paper chromatography.
4. Separation of sugars/bases by TLC and their identification.
5. Estimation of ascorbic acid in fruit juices.

Suggested Readings:

- Lehninger: Principles of Biochemistry , 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York).
- Textbook of Biochemistry with Clinical Correlations ,7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York),

DSC1B(CC-2): Proteins and Enzymes **Credits: 06**

DSC1BT: Proteins and Enzymes (Theory) **Credits: 04**

Course Contents:

Unit 1: Introduction to proteins
Polypeptides and proteins. Subunit structures, conjugated proteins, diversity of function.

Unit 2: Isolation and analysis of proteins
Techniques to isolate and analyze proteins- salt fractionation, ion-exchange chromatography, gel permeation, HPLC, SDS-PAGE, IEF. Protein primary structure - sequencing by Edman degradation, use of enzymes and chemical reagents to obtain overlap peptides. Synthesis of peptides using Merrifeld method.

Unit 3: Introduction to protein three-dimensional structures
Secondary structure- helices and sheets, Ramachandran maps. Nature of non-covalent bonds and covalent bonds in protein folding. Tertiary and quaternary structures.

Unit 4: Myoglobin and haemoglobin - structure and function
Oxygen binding curves, cooperativity models for haemoglobin.

Unit 5: Introduction to enzyme catalysis
Features of enzyme catalysis, superior catalytic power. General mechanisms of catalysis. Nomenclature.

Unit 6: Enzyme kinetics
Principles of reaction rates, order of reactions and equilibrium constants. Derivation of Michaelis-Menten equation. Significance of Km and Vmax. Catalytic efficiency parameters. Competitive and mixed inhibitions. Kinetics and diagnostic plots. Types of irreversible inhibitors.

Unit 7: Mechanisms of enzyme action and regulation
Mechanism of action of chymotrypsin. Inhibitors of enzymes - antibiotics. Regulation of enzyme activity and its importance - aspartate transcarbamoylase.

Unit 8: Enzymes in medicine and industry
Enzymes used in clinical biochemistry as reagents, diagnostics and therapy. Role of immobilized enzymes in industry.

DSC1BP: Proteins and Enzymes (Practical) **Credits: 02**

Practical

1. Protein estimation by UV absorbance and Biuret method.
2. Protein assay by Lowry/Bradford method.
3. Ammonium sulphate fractionation of crude homogenate from germinated mung bean.
4. Setting up assay for acid phosphatase and activity measurements of the ammonium sulphate fractions (progress curve and effect of pH).
5. Determination of Km and Vmax of enzyme enriched fraction.
6. Inhibition of acid phosphatase activity by inorganic phosphate.

Suggested Readings:

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York),
- Fundamentals of Enzymology (1999) 3rd ed., Price, N.C and Stevens, L., Oxford University Press Inc., (New York),

DSC-1C(CC-3): Intermediary Metabolism **Credits: 06**

DSC1CT: Intermediary Metabolism (Theory) **Credits: 04**

Course Contents:

Unit 1: Basic concepts and design of metabolism
The nature of metabolism. Role of oxidation and reduction and coupling of these. ATP as energy currency.

Unit 2: Glycolysis and Gluconeogenesis
Glycolysis a universal pathway, fructose and galactose oxidation, anaerobic glycolysis, fermentation, gluconeogenesis, reciprocal regulation of glycolysis and gluconeogenesis.

Unit 3: The citric acid cycle
Pyruvate dehydrogenase complex, oxidation of acetyl CoA, amphibolic role, regulation and glyoxylate pathway.

Unit 4: Oxidative phosphorylation
The respiratory chain in mitochondria, proton gradient powering ATP synthesis, glycerol-3- phosphate and malate-aspartate shuttle, regulation of oxidative phosphorylation.

Unit 5: Photosynthesis, Calvin cycle and pentose phosphate pathway
The light reaction, chlorophyll, accessory pigments, reaction centres, two photo systems, generation of proton gradient and NADPH, Calvin cycle, synthesis of glucose, starch, sucrose, regulation, C4 pathway. Pentose phosphate pathway, importance and regulation.

Unit 6: Glycogen metabolism
Glycogenolysis, phosphorylase regulation, role of epinephrine and glucagon for glycogenolysis, glycogenesis; reciprocal regulation of glycogenesis and glycogenolysis.

Unit 7: Fatty acid synthesis and degradation

TAG as energy source, β oxidation of fatty acids in mitochondria and peroxisomes, ketone bodies. Biosynthesis of fatty acids - elongation and unsaturation of fatty acids. Regulation of fatty acid oxidation and synthesis.

Unit 8: Amino acid catabolism and anabolism
Protein degradation to amino acids, urea cycle, feeder pathways into TCA cycle. Nitrogen fixation, synthesis of non-essential amino acids.

Unit 9: Nucleotide metabolism
Biosynthesis - *de novo* and salvage pathways, regulation of nucleotide synthesis by feedback inhibition, degradation and excretion.

Unit 10: Integration of metabolism
Brief role of hormones - catecholamines, insulin, glucagon; metabolic shifts to provide fuel to brain during fasting and starvation, role of cortisol in signalling stress - increase in gluconeogenesis and muscle protein breakdown.

DSC1CP: Intermediary Metabolism (Practical) Credits : 02

Practical

1. Alcohol fermentation by yeast.
2. H2S production, indole production and ammonia production by bacteria.
3. Urea estimation.
4. Uric acid estimation.
5. Nitrogen fixation by cyanobacteria.

Suggested Readings

- Biochemistry (2012) 7th ed., Campbell, M.K. and Farrel, S.O. Brooks/Cole, Cengage Learning (Boston),

DSC-1D(CC-4): Gene Organization, Expression and Regulation

Credits : 06

DSC1DT: Gene Organization, Expression and Regulation (Theory) Credits : 04

Course Contents:

Unit 1: Structure of genes and chromosomes
Definition of a gene, chromosomal organization of genes in viruses, bacteria and eukaryotes. Supercoiling of DNA.

Unit 2: Replication of genomes
General features of DNA replication, properties of prokaryotic and eukaryotic DNA polymerases. Replication of DNA and teleomeres in linear chromosomes. Replication of RNA genomes.

Unit 3: Recombination of DNA
Homologous genetic recombination, Holliday model, proteins and enzymes mediating recombination.

Unit 4: Gene mutations and repair
Molecular basis of mutations, multiple repair systems, mismatch repair, base excision repair, nucleotide excision repair, direct repair and translesion DNA synthesis.

Unit 5: Transcription of genes
General features of gene transcription, procaryotic and eukaryotic RNA polymerases, stages of transcription, initiation, elongation and termination. Inhibitors of transcription.

Unit 6: RNA processing
Processing of eukaryotic mRNA, splicing of introns, alternate splicing and editing, ribosomal and tRNA processing.

Unit 7: Protein synthesis
Features of the genetic code, amino acylation of tRNAs, structure and assembly of ribosomes; three stages of protein synthesis - initiation, elongation and termination. Inhibitors of protein synthesis.

Unit 8: Regulation of gene expression
Regulation of transcription in prokaryotes, concept of operons. Lac operon - control by negative and positive regulatory proteins, Trp operon - control by attenuation. Regulation of transcription in eukaryotes, regulatory sequences - enhancers, silencers response elements, nucleosome alterations, DNA-protein interactions and RNA interference.

DSC1DP: Gene Organization, Expression and Regulation (Practical) Credits: 02

Practical:

1. Quantitative determination of DNA and RNA by absorbance at 260 nm and using A260/A280 ratio to distinguish between them.
2. To study the viscosity of DNA solutions.
3. Isolation of chromosomal DNA from *E. coli.*
4. Isolation of total RNA from yeast cells.

Suggested Readings:

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York),

Discipline Specific Electives (DSE)

DSE-1: Nutritional Biochemistry **Credits : 06**

DSE1T: Nutritional Biochemistry (Theory) **Credits : 04**

Course Contents:

Unit 1: Introduction to Nutrition and Energy Metabolism
Defining Nutrition, role of nutrients. Unit of energy, Biological oxidation of foodstuff .measurement of energy content of food, Physiological energy value of foods, SDA.Measurement of energy expenditure. Direct and Indirect Calorimetry, factors

affecting thermogenesis, energy utilization by cells, energy output – Basal and Resting metabolism, physical activity, factors affecting energy input - hunger, appetite, energy balance Energy expenditure in man. Estimating energy requirements, BMR factors Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.

Unit 2: Dietary carbohydrates and health

Review functions of carbohydrates. Digestion, absorption ,utilization and storage, hormonal regulation of blood glucose. Dietary requirements and source of carbohydrates, Dietary fiber, role of fibre in lipid metabolism, colon function, blood glucose level and GI tract functions.

Unit 3: Dietary lipid and health

Review of classification, sources, functions, digestion, absorption, utilization and storage. Essential Fatty Acids; Functions of EFA, RDA, – excess and deficiency of EFA. Lipotropic factors, role of saturated fat, cholesterol, lipoprotein and triglycerides. Importance of the following: a) Omega – fatty acids. Omega 3/ omega 6 ratio b) Phospholipids c) Cholesterol in the body d) Mono, Polyunsaturated and Saturated Fatty Acids. Dietary implications of fats and oils, Combination ratios of n6 and n3, MUFA, PUFA and SFA.

Unit 4: Dietary Proteins and Health

Review of functions of proteins in the body, Digestion and absorption. Essential and Nonessential amino acids. Amino Acid Availability Antagonism, Toxicity and Imbalance, Amino acid Supplementation. Effects of deficiency. Food source and Recommended Dietary Allowances for different age group. Amino acid pool. NPU, Biological Value , Nitrogen balance. PEM and Kwashiorkor.

Unit 5: Fat and water soluble Vitamins

Vitamin A, C, E,K and D Dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion(ADME), Deficiency. Role of Vitamin A as an antioxidant, in Visual cycle, dermatology and immunity. Role of Vitamin K in Gamma carboxylation. Role of Vitamin E as an antioxidant. Extra-skeletal role of Vitamin D and its effect on bone physiology. Hypervitaminosis. Vitamin C role as cofactor in amino acid modifications. Niacin-Metabolic interrelation between tryptophan, Niacin and NAD/ NADP. Vitamin B6-Dietary source, RDA, conversion to Pyridoxal Phosphate. Role in metabolism, Biochemical basis for deficiency symptoms. Vitamin B12 and folate; Dietary source, RDA, absorption, metabolic role Biochemical basis for deficiency symptoms.

Unit 6: Minerals

Calcium, Phosphorus and Iron - Distribution in the body digestion, Absorption, Utilization Transport, Excretion, Balance, Deficiency, Toxicity, Sources, RDA. Calcium: Phosphorus ratio, Role of iron in prevention of anemia. Iodine and iodine cycle. Iodine, Fluoride, Mg, Cu,Zn, Se, Manganese, Chromium, Molybdenum Distribution in the human body, Physiology,Function, deficiency, Toxicity and Sources

Unit 7: Assessment of Nutritional status

Anthropometric measurements; Z scores, BMI, skinfold, circumference ratios. Biochemical assessment; Basal metabolic panel, Comprehensive metabolic panel, CBC,

Urine Analysis, Assessment of Anemia, ROS assessment, GTT and glycosylated Hb, Differential diagnosis of B12 and folate.

Unit 8: Food and drug interactions and Nutriceuticals
Nutrient interactions affecting ADME of drugs, Alcohol and nutrient deficiency, Antidepressants, psychoactive drugs and nutrient interactions, Appetite changes with drug intakes and malnutrition. Food as medicine.

DSE1P: Nutritional Biochemistry (Practical) **Credits: 02**

Practical

1. Bioassay for vitamin B12/B1.
2. Homocystiene estimation.
3. Serum/ urine MMA estimation.
4. Anthropometric identifications for Kwashiorkor, Marasmus and Obesity.
5. Determination of oxidative stress: TBARS, antioxidant enzymes in hemolysate.
6. Vitamin A/E estimation in serum.
7. Bone densitometry /bone ultrasound test demonstration (visit to a nearby clinic)

Suggested Readings:

- Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York),
- Nutrition for health, fitness and sport (2013); Williams.M.H,Anderson,D.E, Rawson,E.S. McGraw Hill international edition
- Krause's Food and Nutrition Care process.(2012); Mahan, L.K Strings,S.E, Raymond,J. Elsevier's Publications.
- The vitamins, Fundamental aspects in Nutrition and Health (2008); G.F. Coombs Jr. Elsevier's Publications.
- Principles of Nutritional Assessment (2005) Rosalind Gibson. Oxford University Press.

Or

DSE-1: Basic Microbiology **Credits : 06**

DSE1T: Basic Microbiology (Theory) **Credits : 04**

Course Contents:

Unit 1: History of Development of Microbiology
Development of microbiology as a discipline, Spontaneous generation vs. biogenesis.Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Unit 2: Diversity of Microbial world
Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms. General characteristics of different groups: acellular microorganisms

(Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

Unit 3: Viruses, viroids and prions
An introduction to viruses with special reference to the structure and replication of the following: Poxvirus, Poliovirus, HIV, T4 and λ phage, lytic and lysogenic cycles.

Unit 4: Bacteria
An account of typical eubacteria, chlamydiae & rickettsiae (obligate intracellular parasites), mycoplasma, and archaebacteria (extremophiles). Applications of bacteria in industry, environment and food.

Unit 5: Algae
History of phycology; General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Applications of Algae in agriculture, industry, environment and food.

Unit 6: Fungi
Historical developments in the field of Mycology, significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic Importance of Fungi in Agriculture, environment, Industry, medicine, food, biodeterioration, mycotoxins

Unit 7: Protozoa
General characteristics with special reference to Amoeba

Unit 3: Scope of Microbiology

DSE1P : Basic Microbiology (Practical) **Credits: 02**

Practical

1. Microbiology Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter)
3. Preparation and sterilization of culture media for bacterial cultivation
4. Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides/ pictographs
5. Staining of bacteria using Gram stain
6. Isolation of pure cultures of bacteria by streaking method.
7. Estimation of CFU count.

Suggested Readings

- Atlas RM. (1997). Principles of Microbiology. 2nd edition. W M.T.Brown Publishers.

- Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company

Or

DSE-1: Molecular Basis of Infectious Diseases **Credits: 06**

DSE1T: Molecular Basis of Infectious Diseases (Theory) **Credits : 04**

Course Contents:

Unit 1: Classification of infectious agents
Bacteria, Viruses, protozoa and fungi. Past and present emerging and re-emerging infectious diseases and pathogens. Source, reservoir and transmission of pathogens, Antigenic shift and antigenic drift. Host parasite relationship, types of infections associated with parasitic organisms. Overview of viral and bacterial pathogenesis. Infection and evasion.

Unit 2: Overview of diseases caused by bacteria
Detailed study of tuberculosis: History, causative agent, molecular basis of host specificity, infection and pathogenicity, Diagnostics, Therapeutics, inhibitors and vaccines. Drug resistance and implications on public health. Other bacterial diseases including Typhoid,Diphtheria, Pertussis, Tetanus, Typhoid and Pneumonia.

Unit 3: Overview of diseases caused by Viruses
Detailed study of AIDS, history, causative agent, pathogenesis, Diagnostics, Drugs and inhibitors. Other viral diseases including hepatitis, influenza, rabies, chikungunya and polio.

Unit 4: Overview of diseases caused by Parasites
Detailed study of Malaria, history, causative agents, Vectors, life cycle, Host parasite interactions, Diagnostics, Drugs and Inhibitors, Resistance, Vaccine development. Other diseases including leishmaniasis, amoebiasis.

Unit 5: Overview of diseases caused by other organisms
Fungal diseases, General characteristics. Medical importance of major groups, pathogenesis, treatment.

DSE1P: Molecular Basis of Infectious Diseases (Practicals) **Credits: 02**

Practicals

1. Permanent slides of pathogens. Mycobacterium tuberculosis, Leishmania, Plasmodium falciparum
2. WIDAL test
3. Gram staining
4. Acid fast staining
5. PCR based diagnosis
6. Dot Blot ELISA

Suggested Readings:

- Prescott, Harley, Klein's Microbiology (2008) 7th Ed., Willey, J.M., Sherwood, L.M., Woolverton, C.J. Mc Graw Hill International Edition (New York) ISBN: 978-007- 126727.
- Mandell, Douglas and Bennett.S, Principles and practices of Infectious diseases, 7th edition, Volume, 2. Churchill Livingstone Elsevier.
- Sherris Medical Microbiology: An Introduction to Infectious Diseases by Kenneth J. Ryan, C. George Ray, Publisher: McGraw-Hill
- Medical Microbiology by Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller, Elsevier Health Sciences

Or

DSE-1: Advanced Cell Biology **Credits: 06**

DSE1T: Advanced Cell Biology (Theory) **Credits: 04**

Course Contents:

Unit 1: Plasma Membrane and Nuclear Transport

Properties and Composition of Cell Membrane; Structure of Nuclear Envelope; Nuclear Pore Complex; Transport Across Nuclear Envelope; Regulation of Nuclear Protein Import and Export.

Unit 2: Cell-Cell Interaction

Cell-Cell Interactions and Cell-Matrix Interactions; Components of Extracellular Matrix: Collagen and Non-Collagen Components; Tight Junctions; Gap Junctions; Desmosomes; Hemidesmosomes; Focal Adhesions And Plasmodesmata; Cell Wall; Role Of Cell Interaction In Development.

Unit 3: Cell Cycle and Programmed Cell Death

Overview of The Cell Cycle; Eukaryotic Cell Cycle; Events Of Mitotic Phase; Cytokinesis; Events Of Meiosis And Fertilization; Regulation Of Cell Division And Cell Growth; Apoptosis And Necrosis, Stem Cells And Maintenance of Adult Tissues, Hematopoiesis, Embryonic Stem Cells and Therapeutic Cloning.

Unit 4: Cancer Biology

Development and causes Of Cancer; Genetic Basis of Cancer; Oncogenes, Tumor Viruses; Molecular Approach to Cancer Treatment.

Unit 5: Advanced Methods in Cell Biology

Ultracentrifugation, Fluorescence Microscopy- FACS, Confocal Microscopy, Electron Microscopy, Plant and Animal Cell Culture, Immunohistochemistry.

DSE1P: Advanced Cell Biology (Practicals) **Credits: 02**

Practical

1. Isolation of organelles by sub-cellular fractionation.
2. Study of cell viability /death assay by use of trypan blue and MTT assay.
3. Study of apoptosis through analysis of DNA fragmentation patterns in mitochondria.

4. Identification and study of cancerous cells using permanent slides and photomicrographs.

Suggested Readings:

- Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Karp, G. 2010 Cell and Molecular Biology: Concepts and Experiments. 6 edition. John Wiley & Sons. Inc.
- Alberts, B., Johnson,A., Lewis, J., and Enlarge, M. 2008 Molecular Biology of the Cell. 5th ed., Garland Science (Princeton),
- Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell.
- J. 2012. Molecular Cell Biology. 7th ed., W.H. Freeman & Company (New York),
- 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.

DSE-2: Molecular Basis of Non-Infectious Human Diseases Credits: 06
DSE2T: Molecular Basis of Non-Infectious Human Diseases (Theory) Credits: 04

Course Contents:

Unit 1: Nutritional disorders

Overview of major and minor nutrient components in the diet. Balanced diet and the concept of RDA. Nutrient deficiencies; Kwashiorkor and Marasmus, Scurvy, beri beri, pellagra and B12 deficiency, Xerophthalmia and Night blindness, Vitamin D deficiency, Vitamin K deficiency. Discuss with relation to biochemical basis for symptoms.

Unit 2: Metabolic and Lifestyle disorders

Obesity and eating disorders like Anorexia nervosa and Bullemia. Diabetes mellitus A metabolic syndrome and the relationship with hypertension, obesity, hypothyroidism and stress. Cardio vascular disorders and Atherosclerosis-defining the broad spectrum of ailments that fall in this category, understanding the factors that contribute to the syndrome, stages of disorder and the management of the condition. Irritable bowel syndrome- biochemistry behind the disorder and the influence of diet, stress and environment on the condition.

Unit 3: Multifactorial complex disorders and Cancer

Understanding the definition of multifactorial diseases. Polygenic diseases and the relationship of environmental factors and genetic makeup in the onset of diseases. Cancer: characteristics of a transformed cell, causes and stages of Cancer, molecular basis for neoplastic growth and metastasis, Proto-oncogenes and tumor suppressor genes; Cancer causing mutations; Tumor viruses; Biochemical analysis of cancer; Molecular approaches to cancer treatment.

Disorders of mood : Schizophrenia, dementia and anxiety disorders. Polycystic ovarian syndrome, Parkinson’s disease, ALS.

Unit 4: Diseases due to misfolded proteins

Introduction to protein folding and proteosome removal of misfolded proteins; etiology and molecular basis for Alzheimer's, Prion diseases, Huntington's Chorea, sickle cell anemia, Thalassemia.

Unit 5: Monogenic diseases
In born errors in metabolism: PKU, Alkaptonuria, Maple syrup urine disease; Receptor and transport defects: Cystic fibrosis, Long QT syndrome, familial hypercholesterolemia, Achondroplasia. Hemoglobinopathies and clotting disorders.

DSE2P: Molecular Basis of Non-Infectious Human Diseases **Credits: 02**

Practical

1. Anthropometric measurements for normal and high risk individuals and identifications for Kwashiorkor, Marasmus and Obesity
2. Estimation of homocysteine levels in serum
3. Estimation of glycosylated hemoglobin
4. Permanent slides for different types of cancer
5. Diagnostic profile for assessment of CVS and Diabetes mellitus using case studies.
6. Bone densitometry test demonstration (visit to a nearby clinic)

Suggested Readings:

- Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
- Introduction to Human Physiology (2013) 8th edition; Lauralee Sherwood. Brooks/Cole, Cengage Learning.
- The World of the cell, 7th edition (2009)
- Genetics (2012) Snustad and Simmons,
- Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Or

DSE-2: Plant Biochemistry **Credits : 06**

DSE2T: Plant Biochemistry (Theory) **Credits : 04**

Course Contents:

Unit 1: Introduction to Plant cell structure
Plasma membrane, Vacuole and tonoplast membrane, cell wall, plastids and peroxisomes.

Unit 2: Photosynthesis and Carbon assimilation
Structure of PSI and PSII complexes, Light reaction, Cyclic and non cyclic photophosphorylation, Calvin cycle and regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration.

Unit 3: Respiration
Overview of glycolysis, Alternative reactions of glycolysis, Regulation of plant glycolysis, Translocation of metabolites across mitochondrial membrane, TCA cycle, Alternative NAD(P)H oxidative pathways; Cyanide resistant respiration.

Unit 4: Nitrogen metabolism
Biological Nitrogen fixation by free living and in symbiotic association, structure and function of enzyme Nitrogenase. Nitrate assimilation: Nitrate and Nitrite reductase.

Primary and secondary ammonia assimilation in plants; ammonia assimilation by Glutamine synthetase-glutamine oxoglutarate amino transferase (GS-GOGAT) pathway. Seed storage proteins in legumes and cereals.

Unit 5: Regulation of plant growth
Introduction to plant hormones and their effect on plant growth and development, Regulation of plant morphogenetic processes by light.

Unit 6: Secondary metabolites
Representatives alkaloid group and their amino acid precursors, function of alkaloids, Examples of major phenolic groups; simple phenylpropanoids, Coumarins, Benzoic acid derivatives, flavonoids, tannins and lignin, biological role of plant phenolics, Classification of terpenoids and representative examples from each class, biological functions of terpenoids.

Unit 6: Plant tissue culture
Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somoclonal variation.

DSE2P: Plant Biochemistry (Practicals) **Credits: 02**
Practical

1. Induction of hydrolytic enzymes proteinases /amylases/lipase during germination
2. Extraction and assay of Urease from Jack bean
3. Estimation of carotene/ascorbic acid/phenols/tannins in fruits and vegetables
4. Separation of photosynthetic pigments by TLC
5. Culture of plant plants (explants).

Suggested Readings:

- Plant Biochemistry (2008), Caroline Bowsher, Martin steer, Alyson Tobin, Garland science
- Biochemistry and molecular Biology of plant-Buchanan. (2005) 1 edition. Publisher: I K International.
- Plant Biochemistry by P.M Dey and J.B. Harborne (Editors) (1997) Publisher: Academic Press

Or

DSE-2 : Molecular Diagnostics **Credits 06**

DSE2T - Molecular Diagnostics **Credits 04**

Unit-1: Introduction to Biochemical Diagnostics
Evaluation of biochemical changes in diseases, basic hepatic, renal and cardiovascular physiology; Biochemical symptoms associated with disease and their evaluation; Diagnostic biochemical profile. Inborn errors of metabolism.

Unit-2: Diagnostic Enzymes

Principles of diagnostic enzymology; Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase, aldolase, lactate dehydrogenase, enzyme tests in determination of myocardial infarction, enzymes ofpancreatic origin and billiary tract.

Unit-3: Immunodiagnostics
Introduction, antigen-antibody binding and assays; Immunoassays –types [RIA,ELISA, Chemiluminescent IA, FIA] and specific applications; Immunohistochemistry-principle and techniques. Immunodiagnostics for detection of infectious agents, cancer, and autoimmune diseases; Immunosensors.

Unit-4: Molecular Diagnostics
Introduction to DNA based diagnostic techniques; Polymerase chain reaction in diagnostics and analysis; Analysis of DNA in forensic science and archaeology. Applications of DNA finger printing, Techniques of chromosome analysis.
Chromosome preparation from cultured lymphocytes, cell lines and solid tumors.
Karyotyping, chromosome banding and fluorescence In-situ hybridization techniques
Disease identification and Genetic tests for following disorders: Thalassemia, Fanconi anemia, Sickle Cell anemia, Fragile-X syndrome, Down Syndrome, Duchenne Muscular Dystrophy/Becker's Muscular Dystrophy, Sex-linked inherited disorders, Allelic susceptibility test for multifactorial disorders (Neural Tube Defect, Cleft Lip and Palate, Cardio Vascular Disorder, Male infertility)

DSE2P – Molecular Diagnostics Lab **Credits 02**

List of Practical

1. Gram staining and acid fast staining
2. Dot Blot ELISA for insulin
3. Lipid profile: triglycerides and total cholesterol.
4. Permanent slides (histology/cytology) for different types of cancer and comparison with slides from normal tissues

Suggested Readings:

- Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol. I (2010), Mukherjee, K.L., Tata Mc Graw–Hill Publishing Company Limited (New Delhi).
- Medical Biochemistry (2005) 2nd ed., Baynes, J.W. and Dominiczak, M.H., Elsevier Mosby Ltd. (Philadelphia),
- Recombinant DNA by Watson
- Harper's Biochemistry

Or

DSE-2: Project Work **Credits : 06**

Total Hours: 180

Course Contents:
This paper would focus on the project work / dissertation to be carried out by the students in the supervision of the teachers in the colleges. The topic of the project would be selected by each student in consultation with the teacher (Advisor). This would train the student to retrieve the literature and collate the information sufficient to make a

presentation; the collated literature would also prepare the base for initiating the research. The student would carry out experiments to achieve the planned objectives, collation and analysis of data, presentation of the result in the form of a Dissertation. The grading would be based on continuous evaluation that would include punctuality, hard work, record keeping, intellectual inputs, data presentation, interpretation etc.

Skill Enhancement Courses (SEC)

SEC-1: Tools and Techniques in Biochemistry **Credits: 02**

Course Contents:

Unit 1: Biochemical reagents and solutions
Safety practices in the laboratory. Preparation and storage of solutions. Concepts of solution concentration and storing solutions. Quantitative transfer of liquids. Concept of a buffer, Henderson-Hasselbach equation, working of a pH meter.

Exercise

- Preparation of a buffer of given pH and molarity.

Unit 2: Spectrophotometric Techniques

Principle and instrumentation of UV-visible and fluorescence spectroscopy.

Exercises

- Determination of the absorption maxima and molar extinction coefficient (of a relevant organic molecule).
- Measurement of fluorescence spectrum.
- Determination of concentration of a protein solution by Lowry/BCA method.

Unit 3: Introduction and importance of virtual labs in biochemistry

Suggested Readings:

- Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D., W.H. Freeman and Company (New York),
- An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi),

SEC-2: Protein Purification Techniques **Credits: 02**

Course Contents:

Unit 1: Purification and characterization of a protein from a complex mixture (native or heterologously expressed) involving the following methods/techniques

Exercises

- Preparation of the sample.
- Ion-exchange chromatography.
- Gel filtration chromatography.
- Affinity chromatography.
- Electrophoresis.

Unit 2: Demonstration of High Performance Liquid Chromatography (HPLC)

Suggested Readings:

- Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., WileyBlackwell (West Sussex),
- Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D., W.H. Freeman and Company (New York),
- An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi),

SEC-3: Clinical Biochemistry **Credits: 02**

Course Contents:

Unit 1: Introduction

Organization of clinical laboratory, Introduction to instrumentation and automation in clinical biochemistry laboratories safety regulations and first aid. General comments on specimen collection, types of specimen for biochemical analysis. Precision, accuracy, quality control, precautions and limitations.

Exercises

- Collection of blood and storage.
- Separation and storage of serum.

Unit 2: Evaluation of biochemical changes in diseases

Basic hepatic, renal and cardiovascular physiology. Biochemical symptoms associated with disease and their evaluation. Diagnostic biochemical profile.

Unit 3: Assessment of glucose metabolism in blood

Clinical significance of variations in blood glucose. Diabetes mellitus.

Exercises

- Estimation of blood glucose by glucose oxidase peroxidase method.

Unit 4: Lipid profile

Composition and functions of lipoproteins. Clinical significance of elevated lipoprotein.

Exercises

- Estimation of triglycerides.

Unit 5: Liver function tests

Exercises

- Estimation of bilirubin (direct and indirect).

Unit 6: Renal function tests and urine analysis

Use of urine strip / dipstick method for urine analysis.

Exercises

- Quantitative determination of serum Creatinine and Urea.

Unit 7: Tests for cardiovascular diseases

Involvement of enzymes in diagnostics of heart disease including aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin.

Exercises

- Estimation of Creatine kinase MB.

Suggested Readings:

- Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol. I (2010), Mukherjee, K.L., Tata Mc Graw–Hill Publishing Company Limited (New Delhi).
- Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests VoI. II (2010), Mukherjee, K.L., Tata Mc Graw – Hill Publishing Company Ltd. (New Delhi),
- Medical Biochemistry (2005) 2nd ed., Baynes, J.W. and Dominiczak, M.H., Elsevier Mosby Ltd. (Philadelphia),
- Experimental Biochemistry: A Student Companion (2005) Rao, B.S. and Deshpande, V., IK International Pvt. Ltd. (New Delhi),

SEC-4: Recombinant DNA Technology **Credits: 02**

Course Contents:

Unit 1: Work flow for *in silico* cloning

Unit 2: Preparation of media, antibiotic solution, culturing of *E. coli*, isolation of single colonies

Exercises

1. Preparation of LB broth and agar.
2. Inoculation of medium.
3. Preparation of glycerol stocks of bacterial strains.
4. Obtaining isolated colonies by streak plate method.
5. Preparation of stock solutions.

Unit 3 Overview of plasmid vectors and methods of isolation Exercises

1. Isolation of plasmid by alkaline lysis method.
2. Isolation of plasmid DNA using column chromatography (kit).

Unit 4: Characterization of plasmid by gel electrophoresis

Exercise
Digestion of plasmid DNA with restriction enzymes and analysis of the fragments.

Unit 5: Cloning of a gene in a vector and functional analysis
Polymerases chain reaction (parametric optimization, primer designing), ligation, introduction of DNA construct into host cells, selection of recombinants.

Exercises
1. Amplification of DNA segment/gene of interest by PCR.
2. Purification of PCR product, digestion of insert and vector by restriction enzymes for directional cloning, purification of insert and digested vector by gel extraction.
3. Ligation of vector and insert.
4. Preparation of competent cells of *E. coli* DH5α and transformation with the ligation mixture.
5. Functional selection of recombinants (blue/white selection and eGFP fluorescence).

Suggested Readings:
- Molecular Cloning: A laboratory Manual (2012) Vol. 1-3, 4th ed., Green M.R. and Sambrook J., Cold Spring Harbour Laboratory Press (New York).

Or

SEC-5: Bioinformatics and Biostatistics **Credits: 02**

Course Contents:

Unit 1: Introduction to bioinformatics
Computer Fundamentals – Programming languages in bioinformatics, Role of Super computer in biology. Historical background. Scope of bioinformatics – Genomics, Proteomics, Computer aided Drug Design (Structure based and ligand based approaches). Application of Bioinformatics.

Unit-2: Biological databases and data retrieval
Introduction to biological databases – Primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL,DDBJ,NDB), Protein databases (PIR, Swiss-Prot, TrEMBL, PDB)

Exercise:
Sequence retrieval (Protein and Gene) from NCBI.
Structures download (Protein and DNA) from PDB.

Unit-3: Sequence alignment
Similarity, identity and homology. Alignment – local and global alignment, pair wise and multiple sequences alignments, alignments algorithms, amino acid substitution matrices (PAM and BLOSUM), BLAST analysis.

Exercise:
BLAST suite of tools for pair wise alignment.

Unit-3: Biostatistics

Introduction to Biostatistics: Variable and attribute; population vs sample; Census vs sample survey; Arrangement of data; Frequency distribution.

Graphical Representation of Data: Line diagram, Bar diagram, Pie Chart, Histogram.

Measures of Central Tendency

Arithmetic mean, Mode, Median.

Measures of Dispersion

Variance, Standard deviation, Standard error of mean, standard score.

Testing Hypothesis and Goodness of fit

Null hypothesis, Level of significance, Probability, Normal distribution, Error of inference, Student's t-test, Paired t-test, Fisher's t-test, Chi-square test.