



UNIVERSITY OF CALCUTTA

GURUPADA SAREN

SECRETARY

COUNCILS FOR UNDERGRADUATE STUDIES,
UNIVERSITY OF CALCUTTA.

Ref.No : CUS/ 80 (Cir.) /18

Dated the 16th February, 2018

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To
The Principals/T.I.C.
of all the Undergraduate Colleges
offering B.Sc. (Honours & General) in Bio-Chemistry
affiliated to the University of Calcutta

Sir/Madam,

The undersigned is to inform you that the proposed **revised semesterised draft Syllabus for Generic Electives of Bio-Chemistry** Courses of Studies under **CBCS** has been uploaded in the **Calcutta University website (www.caluniv.ac.in)**.

The said syllabus has been prepared by the **U.G. Board of Studies in Bio-Chemistry, C.U.**, suppose to be implemented from the academic session 2018-2019

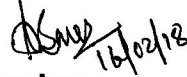
You are requested kindly to go through it and send your feedback within 28th February, 2018.

In this regard you may send your observation/ suggestion to the **Department of U.G. Councils, C.U.** or through email (u.g.councilsc.u@gmail.com), and you also may contact **Prof. Anirban Siddhanta**, Department of Bio-Chemistry through e-mail (asiddhanto@yahoo.com).

Your cooperation in this regard will be highly appreciated. Kindly treat the matter as urgent.

Thanking you,

Yours faithfully,


Secretary

BIOCHEMISTRY GENERIC ELECTIVES
(Semesters I-IV)
[To be chosen by students studying other Hons subjects]
(CBCS STRUCTURE)

B.Sc.
GE-1: BIOCHEMISTRY OF CELL (THEORY)
SEMESTER - I

TOTAL HOURS: 60

CREDITS: 4

Unit 1 Biomolecules in their cellular environment

No. of Hours : 6

The cellular basis of life. Cellular structures – prokaryotes and eukaryotes. Chemical principles in biomolecular structure. Major classes of biomolecules. Role of water in design of biomolecules.

Unit 2 Amino acids and peptides

No. of Hours : 10

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

No. of Hours : 10

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

Unit 4 Nucleosides, nucleotides and nucleic acids

No. of Hours : 10

Structures and chemistry, DNA structures and their importance, different types of RNA. Unusual DNA structures, other functions of nucleotides.

Unit 5 Lipids

No. of Hours : 10

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

No. of Hours : 8

Occurrence and nutritional role. Coenzymes and their role in metabolism. Metal ion containing biomolecules - heme, porphyrins and cyanocobalamin; their biological significance.

Unit 7 Signalling molecules

No. of Hours : 6

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

GE-1 : BIOCHEMISTRY OF CELL (PRACTICALS)
SEMESTER - I

TOTAL HOURS : 60

CREDITS: 2

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

SUGGESTED READINGS

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13; 978-1-4641-0962-1 / ISBN:10-14641-0962-1.
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

B.Sc.
GE-2: PROTEINS AND ENZYMES (THEORY)
SEMESTER – II

Total Hours : 60

CREDITS: 4

Unit 1 Introduction to proteins

No. of Hours : 4

Polypeptides and proteins. Subunit structures, conjugated proteins, diversity of function.

Unit 2 Isolation and analysis of proteins

No. of Hours : 12

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 Merrifield method.

Unit 3 Introduction to protein three-dimensional structures

No. of Hours : 10

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

No. of Hours : 4

Oxygen binding curves, cooperativity models for haemoglobin.

Unit 5 Introduction to enzyme catalysis

No. of Hours : 8

Features of enzyme catalysis, superior catalytic power. General mechanisms of catalysis. Nomenclature.

Unit 6 Enzyme kinetics

No. of Hours : 10

Principles of reaction rates, order of reactions and equilibrium constants. Derivation of Michaelis-Menten equation. Significance of K_m and V_{max} . Catalytic efficiency parameters. Competitive and mixed inhibitions. Kinetics and diagnostic plots. Types of irreversible inhibitors.

Unit 7 Mechanisms of enzyme action and regulation

No. of Hours : 6

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

No. of Hours : 6

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

GE-2: PROTEINS AND ENZYMES (PRACTICALS)
SEMESTER – II

Total Hours : 60

CREDITS: 2

- (I) Protein estimation by UV absorbance and Biuret method.
- (J) Protein microassay by Lowry/Bradford method.
- (K) Ammonium sulphate fractionation of crude homogenate from germinated mung bean.
- (L) Setting up assay for acid phosphatase and activity measurements of the ammonium sulphate fractions (progress curve and effect of pH).
- (M) Determination of K_m and V_{max} of enzyme enriched fraction.
- (N) Inhibition of acid phosphatase activity by inorganic phosphate.

SUGGESTED READINGS

3. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10-14641-0962-1.
4. Fundamentals of Enzymology (1999) 3rd ed., Price, N.C and Stevens, L., Oxford University Press Inc., (New York), ISBN:13: 978-0-19-806439-8.

B.Sc.

**GE-3: INTERMEDIARY METABOLISM (THEORY)
SEMESTER - III**

Total Hours : 60

CREDITS: 4

Unit 1 Basic concepts and design of metabolism

No. of Hours : 4

The nature of metabolism. Role of oxidation and reduction and coupling of these. ATP as energy currency.

Unit 2 Glycolysis and gluconeogenesis

No. of Hours : 6

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

Unit 3 The citric acid cycle

No. of Hours : 6

Pyruvate dehydrogenase complex, oxidation of acetyl CoA, amphibolic role, regulation and glyoxylate pathway.

Unit 4 Oxidative phosphorylation

No. of Hours : 6

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

No. of Hours : 8

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

No. of Hours : 6

Glycogenolysis, phosphorylase regulation, role of epinephrine and glucagon for glycogenolysis, glycogenesis; reciprocal regulation of glycogenesis and glycogenolysis.

Unit 7 Fatty acid synthesis and degradation

No. of Hours : 6

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

No. of Hours : 6

Protein degradation to amino acids, urea cycle, feeder pathways into TCA cycle. Nitrogen fixation, synthesis of non-essential amino acids.

Unit 9 Nucleotide metabolism

No. of Hours : 6

Biosynthesis - *de novo* and salvage pathways, regulation of nucleotide synthesis by feedback inhibition, degradation and excretion.

Unit 10 Integration of metabolism

No. of Hours : 6

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.

GE-3: INTERMEDIARY METABOLISM (PRACTICALS)
SEMESTER - III

Total Hours : 60

CREDITS: 2

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

1. Biochemistry (2012) 7th ed., Campbell, M.K. and Farrel, S.O. Brooks/Cole, Cengage Learning (Boston), ISBN: 13:978-1-111-42564-7.

B.Sc.
GE-4: GENE ORGANIZATION, EXPRESSION AND REGULATION
(THEORY)
SEMESTER - IV

Total Hours : 60

CREDITS: 4

Unit 1 Structure of genes and chromosomes

No. of Hours : 8

Definition of a gene, chromosomal organization of genes in viruses, bacteria and eukaryotes. Supercoiling of DNA.

Unit 2 Replication of genomes

No. of Hours : 12

General features of DNA replication, properties of prokaryotic and eukaryotic DNA polymerases. Replication of DNA and telomeres in linear chromosomes. Replication of RNA genomes.

Unit 3 Recombination of DNA

No. of Hours : 4

Homologous genetic recombination, Holliday model, proteins and enzymes mediating recombination.

Unit 4 Gene mutations and repair

No. of Hours : 6

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

No. of Hours : 10

General features of gene transcription, prokaryotic and eukaryotic RNA polymerases, stages of transcription, initiation, elongation and termination. Inhibitors of transcription.

Unit 6 RNA processing

No. of Hours : 4

Processing of eukaryotic mRNA, splicing of introns, alternate splicing and editing, ribosomal and tRNA processing.

Unit 7 Protein synthesis

No. of Hours : 10

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

No. of Hours : 6

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.

**GE-4: GENE ORGANIZATION, EXPRESSION AND
REGULATION (PRACTICALS)
SEMESTER - IV**

Total Hours : 60

CREDITS: 2

7. Quantitative determination of DNA and RNA by absorbance at 260 nm and using A_{260}/A_{280} ratio to distinguish between them.
8. To study the viscosity of DNA solutions.
9. Isolation of chromosomal DNA from *E. coli*.
10. Isolation of total RNA from yeast cells.

SUGGESTED READINGS

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13; 978-1-4641-0962-1 / ISBN:10-14641-0962-1.

B.Sc.
GE-5: FUNDAMENTALS OF CELL BIOLOGY AND IMMUNOLOGY
(THEORY)
SEMESTER - IV

Total Hours : 60

CREDITS: 4

Unit 1 Cells and organelles

No. of Hours : 6

Prokaryotic and eukaryotic cells. Plasma membrane, the nucleus, intracellular membranes and organelles, mitochondria, chloroplast, endoplasmic reticulum, Golgi complex, lysosome, peroxisome, cytoskeleton, extracellular matrix, cell wall. Mitosis and meiosis.

Unit 2 Membrane structure and function

No. of Hours : 8

Composition of membranes, membrane lipids, membrane proteins, isolation and characterization. Integral, peripheral and lipid anchored protein. Transport across membranes, simple and facilitated diffusion, active transport.

Unit 3 Endoplasmic reticulum and Golgi complex

No. of Hours : 6

The two types of endoplasmic reticulum, rough and smooth. The Golgi complex. Role of Golgi in protein glycosylation and protein trafficking.

Unit 4 Signalling mechanisms, messengers and receptors

No. of Hours : 8

Chemical signals and cellular receptors. G-protein linked receptors, protein kinase associated receptors. Hormonal signalling, cell signals and apoptosis.

Unit 5 Cell cycle and its regulation

No. of Hours : 4

Overview of the cell cycle. Regulation of the cell cycle, cyclin dependent kinases.

Unit 6 Overview of the immune system

No. of Hours : 4

Self versus nonself. Humoral and cellular immunity. Innate and adaptive immunity. Cells of the immune system, primary and secondary lymphoid tissues and organs. Cellular and humoral responses.

Unit 7 Innate immunity

No. of Hours : 8

Defensins. Non-immunological barriers. Cells and soluble mediators of innate immunity. Acute phase proteins. Cytokines. Complement system.

Unit 8 Humoral B cell response

No. of Hours : 8

Structure of antibodies, types of immunoglobulins, generation of antibody diversity, B cell activation, theory of clonal selection, formation of plasma and memory cells; T-independent B-response; antigens, haptens carriers and adjuvants.

Unit 9 Cell mediated immunity

No. of Hours : 8

T-cell development, MHC locus. Structure, function and distribution of MHC glycoproteins. Antigen processing and presentation. Cell mediated immune responses by different T-cell sub populations. Hypersensitive reactions. Concept of autoimmunity.

**GE-5: FUNDAMENTALS OF CELL BIOLOGY AND
IMMUNOLOGY (PRACTICALS)
SEMESTER - IV**

Total Hours : 60

CREDITS: 4

1. Visualization of animal and plant cell by methylene blue.
2. Identification of different stages of mitosis in onion root tip.
3. Isolation of organelles by sub-cellular fractionation.
4. Isolation of IgG from serum by ion exchange chromatography.
5. Antigen-antibody interaction by Ouchterlony double diffusion.

SUGGESTED READINGS

2. The World of the Cell (2009), 7th ed., Becker W.M., Kleinsmith, L.J., Hardin., J., Bertoni, and G.P., Pearson Benjamin Cummings (CA), ISBN: 978-0-321-55418-5.
3. 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.
4. Molecular Cell Biology (2013) 7th Ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., Macmillan International Edition (New York), ISBN:13: 978-1-4641-0981-2.
5. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York), ISBN:13: 978-0-7167-8590-3 / ISBN: 10:0-7617-8590-0.
6. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.

B.Sc.
GE-6: FUNDAMENTALS OF GENETIC ENGINEERING (THEORY)
SEMESTER - IV

Total Hours : 60

CREDITS: 4

Unit 1 Introduction to recombinant DNA technology

No. of Hours : 8

Overview of recombinant DNA technology. Plasmids and bacteriophage DNA as cloning vectors, pBR322, pUC8. Purification of plasmid and bacteriophage DNA. Enzymes used in manipulating DNA, separation by electrophoresis.

Unit 2 Cloning vectors for prokaryotes and eukaryotes

No. of Hours : 12

Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on *E. coli* plasmids, pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage. Vectors for yeast, higher plants and animals.

Unit 3 Construction, selection and identification of recombinants

No. of Hours : 12

Ligation of DNA molecules. Transformation and electroporation, selection for transformed cells. Identification for recombinants, blue-white selection. Identification of recombinant phages. Direct selection, marker rescue. Gene libraries. Identification of a clone from gene library, colony and plaque hybridization probing, methods based on detection of the translation product of the cloned gene.

Unit 4 Polymerase chain reaction and DNA sequencing

No. of Hours : 8

Fundamentals of polymerase chain reaction, designing primers for PCR. Analysis of PCR products. DNA sequencing by Sanger's method and automated DNA sequencing.

Unit 5 Expression of cloned genes

No. of Hours : 10

Vectors for expression of foreign genes in *E. coli*, cassettes and gene fusions. Challenges in producing recombinant protein in *E. coli*. Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins.

Unit 6 Applications of genetic engineering in biotechnology

No. of Hours : 10

Expression of cloned genes. Vectors for expression of foreign genes in *E. coli*, cassettes and gene fusions. Production of recombinant pharmaceuticals such as insulin. Gene therapy. Genetically modified plants such as herbicide resistant crops.

GE-6: FUNDAMENTALS OF GENETIC ENGINEERING (PRACTICALS)
SEMESTER – IV

Total Hours : 60

CREDITS: 4

1. Ultraviolet absorption spectrum of DNA and RNA.
2. Isolation of plasmid DNA and restriction digestion.
3. Amplification of a DNA fragment by PCR
4. Virtual lab exercise on recombinant DNA techniques.

SUGGESTED READINGS

1. Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold Spring Harbor (New York), ISBN:0-321-50781 / ISBN: 978-0-321-50781-5.
2. Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell Publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
3. Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose, S. B., and Twyman, R. M., Blackwell publishing (Oxford) ISBN: 13: 978-1-4051-3544-3.
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).

B.Sc.
GE-7: BIOCHEMICAL CORRELATIONS IN DISEASES (THEORY)
SEMESTER - IV

Total Hours : 60

CREDITS: 4

Unit 1 Inborn errors of metabolism

No. of Hours : 8

Alkaptonuria, Phenylketonuria, Glycogen and Lipid storage diseases, SCID, Clotting disorders.

Unit 2 Nutritional deficiency based diseases

No. of Hours : 8

Kwashiorkar, Marasmus, Beri-beri, Scurvy, Pellagra, Anaemia, Night blindness, Rickets, Osteomalacia, Osteoporosis, Wilson's disease.

Unit 3 Life style diseases

No. of Hours : 8

Obesity, Cardiovascular diseases, Atherosclerosis, Diabetes mellitus-II. Inflammatory Bowel Disease (IBD).

Unit 4 Hormonal Imbalances

No. of Hours : 8

Outline of hormone action and imbalances leading to disease - precocious puberty, hyper and hypopituitarism. Hyper and hypothyroidism.

Unit 5 Autoimmune diseases

No. of Hours : 6

Concepts in immune recognition - self and non self discrimination, organ specific autoimmune diseases – Hashimoto's thyroiditis, Grave's disease, myasthenia gravis; Systemic diseases - SLE, rheumatoid arthritis; Diabetes Mellitus-I.

Unit 6 Diseases caused due to misfolded proteins

No. of Hours : 8

Alzheimer's, Huntington's disease, Kuru, Creutzfeldt-Jakob disease, Sickle cell anaemia, Thalassemia.

Unit 7 Infectious diseases

No. of Hours : 16

Viral infection (polio, measles, mumps, influenza, HIV); Bacterial infections (tetanus, diphtheria, tuberculosis, typhoid, cholera); Protozoan (*Plasmodium* and *Trypanosoma*) and parasitic infections. Vaccines against diseases. General strategies in the design and development of vaccines.

GE-7: BIOCHEMICAL CORRELATIONS IN DISEASES (PRACTICALS)
SEMESTER - IV

Total Hours : 60

CREDITS: 2

1. Glucose tolerance test.
2. Lipid profile: triglycerides and total cholesterol.
3. Obesity parameters.
4. RBC counting and haemoglobin estimation.
5. Blood pressure measurements.
6. Bone density measurements (visit to a nearby clinic).
7. T₄/TSH assays.

SUGGESTED READINGS

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley & sons, Inc (New Jersey), ISBN: 978-0-470-08158-7
3. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer, L., W.H Freeman and Company (New York), ISBN: 13:978-1-4292-7635-1.
4. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore),

Structure of B.Sc. (General) Life Sciences with Biochemistry as one of the three (3) core subjects under CBCS

	CORE COURSE(12)	Ability Enhancement Compulsory Courses (2)	Skill Enhancement Courses (SEC) (2)	Discipline Specific Elective DSE (4)
I	CC-Biochemistry I	English communication		
	CC-Subj A-I			
	CC-Subj B-I			
II	CC-Biochemistry II	Environmental Science		
	CC-Subj A-II			
	CC-Subj B-II			
III	CC-Biochemistry III		SEC-I	
	CC-SubjA-III			
	CC-SubjA-III			
IV	CC-Biochemistry IV		SEC-II	
	CC-SubjA-IV			
	CC-SubjA-IV			
V			SEC-III	DSE-Biochemistry I
				DSE- Subj. A_ I
				DSE- Subj. B_ I
VI			SEC-IV	DSE-Biochemistry II
				DSE- Subj. A_ II
				DSE-3 Subj. B_ II

Core Course Biochemistry (General) (one out of three)

BIOCHEMISTRY OF CELL (Semester I)

PROTEINS AND ENZYMES (Semester II)

INTERMEDIARY METABOLISM (Semester III)

GENE ORGANIZATION, EXPRESSION AND REGULATION ((Semester IV)

DSE-Biochemistry (any two) (SEMESTERS V-VI)

1. **NUTRITIONAL BIOCHEMISTRY**
2. **BASIC MICROBIOLOGY**
3. **MOLECULAR BASIS OF INFECTIOUS DISEASES**
4. **MOLECULAR BASIS OF NON-INFECTIOUS HUMAN DISEASES**

SEC (any four (total) to be chosen from three subjects one/two of which may be Biochemistry) (SEMESTERS III-VI)

Biochemistry

1. **TOOLS AND TECHNIQUES IN BIOCHEMISTRY**
2. **CLINICAL BIOCHEMISTRY**
3. **PROTEIN PURIFICATION TECHNIQUES**
4. **RECOMBINANT DNA TECHNOLOGY**

Scheme of B.Sc. (General) Life Sciences with Biochemistry as one of the three (3) core subjects under CBCS

SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	Ability Enhancement Compulsory Course-I	English Communications/ Environmental Science	2
	Core Course Biochemistry I	BIOCHEMISTRY OF CELL	4
	Core Course Biochemistry I Practical	BIOCHEMISTRY OF CELL	2
	Core Course Subj A I		4
	Core Course Subj A I Practical		2
	Core course Subj B I		4
	Core Course Subj B I Practical		2
Total Credit			20
II	Ability Enhancement Compulsory Course-II	English Communications/ Environmental Science	2
	Core course Biochemistry II	PROTEINS AND ENZYMES	4
	Core Course Biochemistry -II Practical	PROTEINS AND ENZYMES	2
	Core Course Subj A II		4
	Core Course Subj A II Practical		2
	Core Course Subj B II		4
	Core Course Subj B Practical II		2
Total Credit			20
III	Core Course Biochemistry III	INTERMEDIARY METABOLISM	4
	Core Course Biochemistry III Practical	INTERMEDIARY METABOLISM	2
	Core Course Subj A III		4
	Core Course Subj A III Practical		2
	Core Course Subj B III		4
	Core Course Practical Subj B III		2

	Skill Enhancement Course-I	SEC-I	2
Total Credit			20
IV	Core Course Biochemistry IV	GENE ORGANIZATION, EXPRESSION AND REGULATION	4
	Core Course Biochemistry-IV Practical	GENE ORGANIZATION, EXPRESSION AND REGULATION	2
	Core Course Subj A IV	Subj A IV	4
	Core Course Subj A IV Practical	Subj A IV Practical	2
	Core Course Subj B IV	Subj B IV	4
	Core Course Subj B IV Practical	Subj B IV Practical	2
	Skill Enhancement Course-II	SEC-II	2
Total Credit			20
V	Discipline Specific Elective Biochemistry -I	DSE Biochemistry 1	4
	Discipline Specific Elective Biochemistry I Practical	DSE Biochemistry 1	2
	Discipline Specific Elective Subj A	DSE Subj A I	4
	Discipline Specific Elective Subj A I Practical	DSE Subj AI Practical	2
	Discipline Specific Elective Subj B I	DES Subj BI	4
	Discipline Specific Elective Subj B I Practical	DES Subj BI Practical	2
	Skill Enhancement Course -III	SEC-III	2
Total Credit			20

VI	Discipline Specific Elective Biochemistry -II	DSE Biochemistry II	4
	Discipline Specific Elective Biochemistry II Practical	DSE Biochemistry II	2
	Discipline Specific Elective Subj A II	DSE Subj A II	4
	Discipline Specific Elective Subj A II Practical	DSE Subj A II	2
	Discipline Specific Elective Subj B II	DSE Subj B II	4
	Discipline Specific Elective Subj B II Practical	DSE Subj B II	2
	Skill Enhancement Course -IV	SEC-IV	2
Total Credit			20
Grand Total Credit			120

Core Course
B.Sc. (General) BIOCHEMISTRY (CBCS STRUCTURE)
Paper-1: BIOCHEMISTRY OF CELL (THEORY)

SEMESTER - I

TOTAL HOURS: 60

CREDITS: 4

Unit 1 Biomolecules in their cellular environment No. of Hours : 6

The cellular basis of life. Cellular structures – prokaryotes and eukaryotes. Chemical principles in biomolecular structure. Major classes of biomolecules. Role of water in design of biomolecules.

Unit 2 Amino acids and peptides No. of Hours : 10

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 No. of Hours : 10

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

Unit 4 Nucleosides, nucleotides and nucleic acids No. of Hours : 10

Structures and chemistry, DNA structures and their importance, different types of RNA. Unusual DNA structures, other functions of nucleotides.

Unit 5 Lipids No. of Hours : 10

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 No. of Hours : 8

Occurrence and nutritional role. Coenzymes and their role in metabolism. Metal ion containing biomolecules - heme, porphyrins and cyanocobalamin; their biological significance.

Unit 7 Signalling molecules No. of Hours : 6

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

Paper-1: BIOCHEMISTRY OF CELL (PRACTICALS)

SEMESTER - I

TOTAL HOURS: 60

CREDITS: 2

1. General safety procedures in a laboratory. Use of auto pipettes. Making solutions and buffer preparation - acetate and tris buffers.
2. Qualitative tests for biomolecules - 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.

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SUGGESTED READINGS

6. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13; 978-1-4641-0962-1 / ISBN:10-14641-0962-1.
7. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

B.Sc. (General) BIOCHEMISTRY (CBCS STRUCTURE)

Paper-2: PROTEINS AND ENZYMES (THEORY)

SEMESTER – II

Total Hours: 60

CREDITS: 4

Unit 1 Introduction to proteins No. of Hours: 4

Polypeptides and proteins. Subunit structures, conjugated proteins, diversity of function.

Unit 2 Isolation and analysis of proteins No. of Hours : 12

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 Merrifield method.

Unit 3 Introduction to protein three-dimensional structures No. of Hours : 10

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 No. of Hours : 4

Oxygen binding curves, cooperativity models for haemoglobin.

Unit 5 Introduction to enzyme catalysis No. of Hours : 8

Features of enzyme catalysis, superior catalytic power. General mechanisms of catalysis. Nomenclature.

Unit 6 Enzyme kinetics No. of Hours : 10

Principles of reaction rates, order of reactions and equilibrium constants. Derivation of Michaelis-Menten equation. Significance of K_m and V_{max} . Catalytic efficiency parameters. Competitive and mixed inhibitions. Kinetics and diagnostic plots. Types of irreversible inhibitors.

Unit 7 Mechanisms of enzyme action and regulation No. of Hours : 6

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 No. of Hours : 6

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

Paper 2: PROTEINS AND ENZYMES (PRACTICALS)

SEMESTER – II

Total Hours: 60

CREDITS: 2

8. Protein estimation by UV absorbance and Biuret method.

9. Protein microassay by Lowry/Bradford method.

10. Ammonium sulphate fractionation of crude homogenate from germinated mung bean.

11. Setting up assay for acid phosphatase and activity measurements of the ammonium sulphate fractions (progress curve and effect of pH).

12. Determination of K_m and V_{max} of enzyme enriched fraction.

13. Inhibition of acid phosphatase activity by inorganic phosphate.

SUGGESTED READINGS

3. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13; 978-1-4641-0962-1 / ISBN:10-14641-0962-1.

4. Fundamentals of Enzymology (1999) 3rd ed., Price, N.C and Stevens, L., Oxford University Press Inc., (New York), ISBN:13: 978-0-19-806439-8.

B.Sc. (General) BIOCHEMISTRY (CBCS STRUCTURE)

Paper-3: INTERMEDIARY METABOLISM (THEORY)

SEMESTER - III

Total Hours: 60

CREDITS: 4

Unit 1 Basic concepts and design of metabolism No. of Hours : 4

The nature of metabolism. Role of oxidation and reduction and coupling of these. ATP as energy currency.

Unit 2 Glycolysis and gluconeogenesis No. of Hours : 6

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

Unit 3 The citric acid cycle No. of Hours : 6

Pyruvate dehydrogenase complex, oxidation of acetyl CoA, amphibolic role, regulation and glyoxylate pathway.

Unit 4 Oxidative phosphorylation No. of Hours : 6

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 No. of Hours : 8

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 No. of Hours : 6

Glycogenolysis, phosphorylase regulation, role of epinephrine and glucagon for glycogenolysis, glycogenesis; reciprocal regulation of glycogenesis and glycogenolysis.

Unit 7 Fatty acid synthesis and degradation No. of Hours : 6

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 No. of Hours : 6

Protein degradation to amino acids, urea cycle, feeder pathways into TCA cycle. Nitrogen fixation, synthesis of non-essential amino acids.

Unit 9 Nucleotide metabolism No. of Hours : 6

Biosynthesis - *de novo* and salvage pathways, regulation of nucleotide synthesis by feedback inhibition, degradation and excretion.

Unit 10 Integration of metabolism No. of Hours : 6

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.

Paper-3: INTERMEDIARY METABOLISM (PRACTICALS)

SEMESTER - III

Total Hours: 60

CREDITS: 2

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

1. Biochemistry (2012) 7th ed., Campbell, M.K. and Farrel, S.O. Brooks/Cole, Cengage Learning (Boston), ISBN: 13:978-1-111-42564-7.

B.Sc. (General) BIOCHEMISTRY (CBCS STRUCTURE)

Paper-4: GENE ORGANIZATION, EXPRESSION AND REGULATION (THEORY)

SEMESTER - IV

Total Hours: 60

CREDITS: 4

Unit 1 Structure of genes and chromosomes No. of Hours: 8

Definition of a gene, chromosomal organization of genes in viruses, bacteria and eukaryotes. Supercoiling of DNA.

Unit 2 Replication of genomes No. of Hours : 12

General features of DNA replication, properties of prokaryotic and eukaryotic DNA polymerases. Replication of DNA and telomeres in linear chromosomes. Replication of RNA genomes.

Unit 3 Recombination of DNA No. of Hours : 4

Homologous genetic recombination, Holliday model, proteins and enzymes mediating recombination.

Unit 4 Gene mutations and repair No. of Hours : 6

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 No. of Hours : 10

General features of gene transcription, prokaryotic and eukaryotic RNA polymerases, stages of transcription, initiation, elongation and termination. Inhibitors of transcription.

Unit 6 RNA processing No. of Hours : 4

Processing of eukaryotic mRNA, splicing of introns, alternate splicing and editing, ribosomal and tRNA processing.

Unit 7 Protein synthesis No. of Hours : 10

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 No. of Hours : 6

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.

Paper-4: GENE ORGANIZATION, EXPRESSION AND REGULATION

(PRACTICALS)

SEMESTER - IV

Total Hours: 60

CREDITS: 2

1. Quantitative determination of DNA and RNA by absorbance at 260 nm and using A_{260}/A_{280} 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

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13; 978-1-4641-0962-1 / ISBN:10-14641-0962-1.

B.Sc. (General) BIOCHEMISTRY (CBCS STRUCTURE)

Discipline Specific Electives (DSE) (Any two of the following)

DSE-1: NUTRITIONAL BIOCHEMISTRY (THEORY)

TOTAL HOURS: 60

CREDITS: 4

Unit 1 Introduction to Nutrition and Energy Metabolism

No. of Hours: 8

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

No. of Hours: 8

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

No. of Hours: 8

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

No. of Hours: 8

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

No. of Hours: 8

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

No. of Hours: 12

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, 38

Zn, Se, Manganese, Chromium, Molybdenum Distribution in the human body, Physiology, Function, deficiency, Toxicity and Sources

Unit 7 Assessment of Nutritional status

No. of Hours: 4

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 Nutraceuticals

No. of Hours: 4

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.

**DSE-1: NUTRITIONAL BIOCHEMISTRY (PRACTICALS)
SEMESTER – V/VI**

TOTAL HOURS: 60

CREDITS: 2

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

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Nutrition for health, fitness and sport (2013); Williams.M.H,Anderson,D.E, Rawson,E.S. McGraw Hill international edition. ISBN-978-0-07-131816-7.
3. Krause's Food and Nutrition Care process.(2012); Mahan, L.K Strings,S.E, Raymond,J. Elsevier's Publications. ISBN- 978-1-4377-2233-8.
4. The vitamins, Fundamental aspects in Nutrition and Health (2008); G.F. Coombs Jr. Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.
5. Principles of Nutritional Assessment (2005) Rosalind Gibson. Oxford University Press.

DSE-2: BASIC MICROBIOLOGY (THEORY)
SEMESTER – V/VI

Total Hours: 60

CREDITS: 4

Unit 1 History of Development of Microbiology

No. of Hours: 12

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

No. of Hours: 8

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

No. of Hours: 10

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

No. of Hours: 10

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

Unit 5 Algae

No. of Hours: 6

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

No. of Hours: 6

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

No. of Hours: 4

General characteristics with special reference to Amoeba

Unit 3 Scope of Microbiology

No. of Hours: 4

DSE-2 : BASIC MICROBIOLOGY (PRACTICALS)

SEMESTER – V/VI

Total Hours : 60 CREDITS: 2

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

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W M.T.Brown Publishers.
2. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company

DSE-3: MOLECULAR BASIS OF INFECTIOUS DISEASES (THEORY)
SEMESTER – V/VI

Total Hours: 60

CREDITS: 4

Unit 1 Classification of infectious agents

No. of Hours: 12

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

No. of Hours: 18

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

No. of Hours: 12

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

No. of Hours: 8

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

No. of Hours: 10

Fungal diseases, General characteristics. Medical importance of major groups, pathogenesis, treatment.

DSE-3: MOLECULAR BASIS OF INFECTIOUS DISEASES (PRACTICALS)
SEMESTER – V/VI

Total Hours: 60

CREDITS: 2

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

SUGGESTED READINGS

1. 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. 44
2. Mandell, Douglas and Bennett.S, Principles and practices of Infectious diseases, 7th edition, Volume, 2. Churchill Livingstone Elsevier.
3. Sherris Medical Microbiology: An Introduction to Infectious Diseases by Kenneth J. Ryan, C. George Ray, Publisher: McGraw-Hill
4. Medical Microbiology by Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller, Elsevier Health Sciences

DSE-4: MOLECULAR BASIS OF NON-INFECTIOUS HUMAN DISEASES (THEORY)
SEMESTER – V/VI

Total Hours: 60

CREDITS: 4

Unit 1 Nutritional disorders

No. of Hours: 10

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

No. of Hours: 12

Obesity and eating disorders like Anorexia nervosa and Bulimia. 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

No. of Hours: 20

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

No. of Hours: 8

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

Unit 5 Monogenic diseases

No. of Hours: 10

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.

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DSE-4: MOLECULAR BASIS OF NON-INFECTIOUS HUMAN DISEASES (PRACTICALS)

SEMESTER – IIV/VI

Total Hours: 60

CREDITS: 2

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

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley &

Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.

2. Introduction to Human Physiology (2013) 8th edition; Lauralee Sherwood. Brooks/Cole, Cengage Learning.

3. The World of the cell, 7th edition (2009)

4. Genetics (2012) Snustad and Simmons,

5. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

**DSE-5: RESEARCH PROJECT
SEMESTER – V/VI**

Total Hours: 180

CREDITS: 6

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 carryout 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.

**DSE-6: ADVANCED CELL BIOLOGY (THEORY)
SEMESTER – V/VI**

Total Hours: 60

CREDITS: 4

Unit 1 Plasma Membrane and Nuclear Transport

No. of Hours: 8

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

No. of Hours: 12

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

No. of Hours: 16

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

No. of Hours: 12

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

Unit 5 Advanced Methods in Cell Biology

No. of Hours: 12

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

**DSE-6: ADVANCED CELL BIOLOGY (PRACTICALS)
SEMESTER – V/VI**

Total Hours: 60 CREDITS: 2

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

1. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
2. Karp, G. 2010 Cell and Molecular Biology: Concepts and Experiments. 6 edition. John Wiley & Sons. Inc.
3. Alberts, B., Johnson,A., Lewis, J., and Enlarge, M. 2008 Molecular Biology of the Cell. 47 5th ed., Garland Science (Princeton),
4. 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),
5. 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-7: PLANT BIOCHEMISTRY (THEORY)
SEMESTER – V/VI

Total Hours: 60

CREDITS: 4

Unit 1 Introduction to Plant cell structure

No. of Hours: 4

Plasma membrane, Vacuole and tonoplast membrane, cell wall, plastids and peroxisomes.

Unit 2 Photosynthesis and Carbon assimilation

No. of Hours: 14

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

No. of Hours: 12

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

No. of Hours: 14

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

No. of Hours: 4

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

Unit 6 Secondary metabolites

No. of Hours: 8

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

No. of Hours: 4

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.

DSE-7: PLANT BIOCHEMISTRY (PRACTICALS)

SEMESTER – V/VI

Total Hours: 60

CREDITS: 2

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

1. Plant Biochemistry (2008), Caroline Bowsher, Martin steer, Alyson Tobin, Garland science ISBN 978-0-8153-4121-5
2. Biochemistry and molecular Biology of plant-Buchanan. (2005) 1 edition. Publisher: I K International. ISBN-10: 8188237116, ISBN-13: 978-8188237111.
3. Plant Biochemistry by P.M Dey and J.B. Harborne (Editors) (1997) Publisher:

DSE-8: RESEARCH METHODOLOGY
SEMESTER – V/VI

Total Hours: 20 hrs Theory and 140 hrs Practical

CREDITS: 6

Unit 1 Introduction to Research Methodology

No. of Hours: 4

Objectives and motivation in research.

Unit 2 Defining the Research Problem

No. of Hours: 4

Selecting and defining a research problem, Reviewing and conducting literature search, Developing a research plan.

Unit 3 Designing of Experiment

No. of Hours: 4

Different experimental designs – single and multifactorial design, Making measurements and sources of error in measurements, Methods of data collection and record keeping.

Unit 4 Data Processing and Statistical Analysis

No. of Hours: 8

Processing operations, tabulation, and graphical representation, Statistics in research:

Concepts of sample and population, Measure of central tendency, dispersion, asymmetry (skewness, kurtosis), Normal distribution (p-value), Statistical tests and hypothesis (Standard error, t-test, chi-square test), and regression analysis, Report writing, Writing a research paper - abstract, introduction, methodology, results and discussion.

Based on the teaching above, each student will undertake the following exercises.

1. A teacher (adviser) who would guide the student will discuss with student and identify a topic of mutual interest.
2. The student will collect the literature, collate the information and write the same in the form of a term paper with proper incorporation of references using appropriate software such as EndNote.
3. The student will identify scope of research on the topic and will frame objectives to be addressed in the project through a work plan.
4. The student will write standard operating protocols (SOPs) and identify requirement for equipment and reagents.
5. Each student will be asked to make presentation about the project including literature available, objective sought and work plan including methodologies as described above.

SUGGESTED READINGS

1. Research in Education (1992) 6th ed., Best, J.W. and Kahn, J.V., Prentice Hall of India Pvt. Ltd.
2. At the Bench: A Laboratory Navigator (2005) Barker, K., Cold Spring Harbor Laboratory Press (New York), ISBN: 978-087969708-2.
51
3. Research Methodology - Methods and Techniques (2004) 2nd ed., Kothari C.R., New Age International Publishers.
4. Research Methodology: A Step by Step Guide for Beginners (2005) 2nd ed., Kumar R., Pearson Education.
5. Biostatistics: A Foundation for Analysis in the Health Sciences (2009) 9th ed., Daniel W.W., John Wiley and Sons Inc.
6. Statistics at the Bench: A Step-by-Step Handbook for Biologists (2010) Bremer, M. and Doerge, R.W., Cold Spring Harbor Laboratory Press (New York), ISBN: 978-0-879698-57-7.

Skill Enhancement Courses (SEC)
Biochemistry
(Any one or two of the following courses may be chosen)

SEC-1: TOOLS AND TECHNIQUES IN BIOCHEMISTRY
SEMESTER – III

TOTAL HOURS: 30

CREDITS: 2

Unit 1 Biochemical reagents and solutions

No. of Hours: 18

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

No. of Hours: 6

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 **No. of Hours: 6**

SUGGESTED READINGS

1. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN:978-0-470-85602-4 / ISBN:978-0-470-85603-1.
2. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D., W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.
3. An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

SEC-2: PROTEIN PURIFICATION TECHNIQUES
SEMESTER – III

TOTAL HOURS: 30

CREDITS: 2

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

No. of Hours: 24

Exercises

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

Unit 2 Demonstration of High Performance Liquid Chromatography (HPLC)

No. of Hours: 6

SUGGESTED READINGS

1. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN:978-0-470-85602-4 / ISBN:978-0-470-85603-1.
2. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D., W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.
3. An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

SEC-3: CLINICAL BIOCHEMISTRY SEMESTER – III

TOTAL HOURS: 30

CREDITS: 2

Unit 1 Introduction No. of Hours: 4

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

No. of Hours: 4

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

No. of Hours: 4

Clinical significance of variations in blood glucose. Diabetes mellitus.

Exercises

- Estimation of blood glucose by glucose oxidase peroxidase method.

Unit 4 Lipid profile

No. of Hours: 4

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

Exercises

- Estimation of triglycerides.

Unit 5 Liver function tests

No. of Hours: 4

Exercises

- Estimation of bilirubin (direct and indirect).

Unit 6 Renal function tests and urine analysis

No. of Hours: 6

Use of urine strip / dipstick method for urine analysis.

Exercises

- Quantitative determination of serum creatinine and urea.

Unit 7 Tests for cardiovascular diseases

No. of Hours: 4

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

1. 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). ISBN:9780070076594 / ISBN:9780070076631
2. Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol. II (2010), Mukherjee, K.L., Tata Mc Graw – Hill Publishing Company Ltd. (New Delhi), ISBN: 9780070076648.
3. Medical Biochemistry (2005) 2nd ed., Baynes, J.W. and Dominiczak, M.H., Elsevier Mosby Ltd. (Philadelphia), ISBN:0-7234-3341-0.
4. Experimental Biochemistry: A Student Companion (2005) Rao, B.S. and Deshpande, V., IK International Pvt. Ltd. (New Delhi), ISBN:81-88237-41-

**SEC-4: RECOMBINANT DNA TECHNOLOGY
SEMESTER - IV**

TOTAL HOURS: 30

CREDITS: 2

Unit 1 Work flow for *in silico* cloning

No. of Hours: 2

Unit 2 Preparation of media, antibiotic solution, culturing of *E. coli*, isolation of single colonies No. of Hours : 6

Exercises

- Preparation of LB broth and agar.
- Inoculation of medium.
- Preparation of glycerol stocks of bacterial strains.
- Obtaining isolated colonies by streak plate method.
- Preparation of stock solutions.

Unit 3 Overview of plasmid vectors and methods of isolation

No. of Hours: 8

Exercises

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

Unit 4 Characterization of plasmid by gel electrophoresis

No. of Hours: 2

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

No. of Hours: 12

Polymerases chain reaction (parametric optimization, primer designing), ligation, introduction of DNA construct into host cells, selection of recombinants.

Exercises

- Amplification of DNA segment/gene of interest by PCR.
- Purification of PCR product, digestion of insert and vector by restriction enzymes for directional cloning, purification of insert and digested vector by gel extraction.
- Ligation of vector and insert.
- Preparation of competent cells of *E. coli* DH5 α and transformation with the ligation mixture.
- Functional selection of recombinants (blue/white selection and eGFP fluorescence).

SUGGESTED READINGS

1. Molecular Cloning: A laboratory Manual (2012) Vol. 1-3, 4th ed., Green M.R. and Sambrook J., Cold Spring Harbour Laboratory Press (New York). ISBN: 978-1-936113-41-5 / ISBN: 978-1-936113-42-2

