Annex (3)

Hemvati Nandan Bahuguna Garhwal University
(A Central University)

Department Of Biochemistry
NEP-Based Program Framework For
UG (Interdisciplinary Course: Biochemistry)

SEMESTER	PAPER	CODE	THEORY (CREDIT)	PRACTICAL (CREDIT)
I	MOLECULES OF LIFE	(SOLS/BIOCHEM/ ID -1)	2	2
II	CELL BIOLOGY	(SOLS/BIOCHEM/ ID -2)	2	2
III	CONCEPTS OF MOLECULAR BIOLOGY	(SOLS/BIOCHEM/ ID -3)	2	2
IV	ENZYMOLOGY	(SOLS/BIOCHEM/ ID -4)	2	2
VII	IMMUNOLOGY	(SOLS/BIOCHEM/ ID -5)	2	2
VIII	BIOTECHNOLOGY	(SOLS/BIOCHEM/ ID -6)	2	2

MOLECULES OF LIFE

UNIT I :

Cellular and chemical foundations of life, Water: unique properties, Water as a biological solvent, weak interactions in aqueous systems, ionization of water, buffering action in biological system, water as a reactant and fitness of the aqueous environment. Henderson - Hasselbalch equation.

UNIT II:

Carbohydrates: Structure, occurrence and biological importance of monosaccharides, disaccharides, oligosaccharides and polysaccharides (Cellulose, glycogen and starch, chitin, agar).

Fatty acids: Classification, structure and functions. Essential fatty acids. Triacylglycerols, saponification, halogenation, Acetyl number, Rancidity of fats.

UNIT III

Amino acids: Structure and classification of amino acids, physical and chemical properties.
Protein structure: Classification of proteins, primary, secondary and tertiary structure of proteins

UNIT IV:

Nucleotides - structure and properties of bases, pentoses, nucleosides; Nucleic acid structure – Watson-Crick model of DNA, forms of DNA; Structure of major species of RNA - mRNA, tRNA and rRNA

LAB COURSE–I

1. Safety measures in laboratories.
2. Preparation of normal and molar solutions.
3. Calibration of glass wares - pipettes, burettes and volumetric flasks (demonstration)
4. Preparation of buffers, phosphate and acetate buffers.
5. Qualitative tests for carbohydrates.
6. Qualitative test for lipids.
7. Qualitative test for amino acids, proteins.
8. Qualitative test for nucleic acids.
9. Separation of amino acids/ sugars/ bases by thin layer chromatography/paper chromatography.
10. Any other practical as per the facility in the department

SUGGESTED READINGS:

1. Lehninger's Principles of Biochemistry (2nd Ed 2000) D.L Nelson and M.M. Cox, Macmillan Worth Pub. Inc. NY.
2. Biochemistry (4th edn. 1992) by Lubert Stryer WH Freeman & Co., NY.
3. Biochemistry; Voet , D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.

CELL BIOLOGY

UNIT I

Morphology of cell, prokaryotic and eukaryotic cell structure, differences in plant and animal cell, structure and composition of plant and bacterial cell wall. Detailed structure and function of cell organelles i.e. nucleus, mitochondria and chloroplast, ribosomes, endoplasmic reticulum, golgi apparatus, peroxisomes, lysosomes and cytoskeleton.

UNIT II

The Cell Cycle. Overview and control. Cyclins, CDKs and Checkpoints.

UNIT III

Apoptosis and Necrosis, Development and causes of Cancer; Oncogenes, Tumor Viruses;

UNIT IV

Membrane lipids. Physical properties of lipids, Concept of fluidity and factors causing variations in fluidity. Micelles, liposomes, Lipid rafts. Membrane asymmetry.

Membrane transport: Channels, transporters and pumps (Na^+ K^+). Active and passive transport.

LAB COURSE–II

1. Study of mitosis and meiosis
2. Fractionation of Cell organelles
3. Extraction of Proteins from biological materials
4. Estimation of Proteins by Lowry's method
5. Protein separation methods: Precipitation, Chromatographic, Electrophoretic
6. Extraction and estimation of RNA
7. Extraction and estimation of DNA
8. Any other practical as per the facility in the department

SUGGESTED READINGS:

1. Molecular Biology of the Cells (3rd edn 1994) by Alberts et al., Garland Publications Inc. NY and London
2. Cell biology (1993) by E.S. Sedava, Jones and Barlett Publishers Boston, London.

3. Cell and Molecular Biology (8th ed. 2001) by E.D.P. de Robertis & E.M.F. de Robertis (Jr) Lippincott Williams & willkins, Philadelphia.
4. Principles of Cell Biology (1988) by Klein Smith and M. Kish, Harper-Cellins PUb. Inc. New Delhi.

CONCEPTS OF MOLECULAR BIOLOGY

UNIT I

Basic Concepts of genome and its organisation: Nucleic acid as the genetic material (Griffith's experiment, Avery, MacLeod and McCarty's experiment, Hershey-Chase experiment), Central Dogma of Molecular Biology, DNA, denaturation and renaturation of DNA, melting temperature (Tm), hyperchromic effect.

UNIT II

Replication of DNA in prokaryotes: Features of DNA Replication, Proof of semiconservative nature of DNA replication, Features of bidirectional DNA replication.
Transcription: Transcription in prokaryotes with *E. Coli* as model system: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains.

UNIT III

Translation: Genetic code, properties of genetic code, Wobble hypothesis, Components of Protein synthesis machinery: Messenger RNA, tRNA structure and function, Charging of tRNA, aminoacyl tRNA synthetases, ribosome structure and assembly, Mechanism of protein synthesis in prokaryotes: initiation, elongation and termination.

UNIT IV

Gene regulation: Principles of gene regulation, negative and positive regulation, concept of operons, Regulation of gene expression in bacteria: lac operon concept.

LAB COURSE III:

1. Determination of absorption spectra of DNA and protein using a UV-Visible spectrophotometer.
2. Estimation of DNA by diphenylamine reaction.
3. Estimation of RNA by orcinol method.
4. Using turbidometry (light scattering) to estimate microbial growth.
5. Measure the OD ratio at 260 and 280 nm for supplied DNA and protein samples.
6. Estimate purity of DNA sample.
7. Agarose gel electrophoresis of DNA Sample.
8. Any other practical as per the facility in the department

SUGGESTED READINGS :

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R, Molecular Biology of the Gene, 7th edition, Cold Spring Harbour Laboratory Press, Pearson Publication.
2. Biochemistry, by Donald Voet and Judith Voet.
3. Genes xii Benjamin Lewin, Oxford Univ Press. London.
4. Biochemistry, by Lubert Stryer WH Freeman & Co., NY

ENZYMOLOGY

UNIT I

Introduction to enzyme catalysis: Features of enzyme catalysis, General mechanisms of catalysis, Nomenclature, IUB enzyme classification.

UNIT II

Enzyme kinetics: Concept of ES complex, active site, specificity, Michaelis-Menten equation. Significance of Km and Vmax. Enzyme activity, international units, specific activity, turnover number, Factors affecting enzyme activity, Allosteric enzymes.

UNIT III

Mechanisms of enzyme action and regulation: Mechanism of action of chymotrypsin. Enzyme inhibition: Competitive, noncompetitive and uncompetitive inhibition. Inhibitors of enzymes - antibiotics. Regulation of enzyme activity and its importance – aspartate transcarbamoylase.

UNIT IV

Enzymes in medicine and industry: Commercial application of enzymes in food, pharmaceutical and other industries, immobilized enzymes, Biosensors - glucose oxidase.

LAB COURSE IV

1. To Study Effect of amylase activity on Starch.
2. Determination of α-amylase of saliva.
3. Effect of substrate concentration on enzyme activity.
4. Effect of Salt concentration on enzyme activity.
5. Effect of pH, temperature, Time on enzyme activity.
6. Effect of different metal ions on enzyme activity,
7. Immobilization of enzyme in sodium alginate matrix
8. Any other practical as per the facility in the department

SUGGESTED READINGS:

1. Enzymes by M. Dixon, E.C. Webb, CJR Thorne and K.F. Tipton, Longmans, London.
2. Fundamentals of Enzymology, by Price, N. C. and Stevens, L. 3rd Edn. Oxford University Press, London.

3. Immobilized enzymes by inhiro Chibata, Halsted Press Book.
4. Enzyme structure and function by S. Blackburn , Marcel Dekker, Inc., NY

IMMUNOLOGY

UNIT I

Basic concepts of immune system, components of immune system, Organs and cells involved in immune response. Types of immunity: innate and acquired, active and passive, humoral and cell mediated. Antigen and their types, Antibody structure and their types.

UNIT II

Antigen-Antibody interaction, precipitation and agglutination reactions, Complement system: components, classical and alternate pathways, MHC molecules, Antigen processing and presentation.

UNIT III

Cytokines: structure and function, Hypersensitivity: types I–IV, Immune tolerance, Autoimmunity

UNIT IV

Immunodeficiency diseases: primary and secondary, Tumour immunology, Transplantation immunology, Vaccines and their types

LAB COURSE V

1. Identification of blood groups
2. Separation of serum and plasma from blood
3. Total leukocyte count and differential count
4. Colorimetric assay to observe enzymatic reactions in ELISA
5. Demonstration of agglutination reaction
6. ELISA – demonstration
7. Observation of immune cells (lymphocytes, monocytes) under the microscope
8. Any other practical as per the facility in the department

Suggested Readings:

1. **Goldsby, R.A., Kindt, T.J., Osborne, B.A., & Kuby, J.** *Kuby Immunology*, 6th Edition, W.H. Freeman and Company, New York, 2006.ISBN: 9780716785903
2. **Roitt, I.M., Brostoff, J., & Male, D.** *Immunology*, 8th Edition, Mosby/Elsevier, London, 2001. ISBN: 9780323033247

3. **Roitt, I.M. & Delves, P.J.** *Roitt's Essential Immunology*, 13th Edition, Wiley-Blackwell, Oxford, 2017. ISBN: 9781118415772
4. **Rao, C.V.** *Immunology: A Textbook*, 1st Edition, Alpha Science International Ltd., 2005. ISBN: 9781842652593

BIOTECHNOLOGY

UNIT I

Biotechnology: An overview, Genetic engineering and gene cloning, Tools of genetic engineering: restriction enzymes, ligases, DNA polymerases, Vectors: plasmids, cosmids, phagemids, BACs, YACs

UNIT II

Recombinant DNA technology, Isolation and purification of DNA, Gel electrophoresis, Southern, Northern and Western blotting, PCR and its applications

UNIT III

Construction of genomic and cDNA libraries, Screening of recombinants, Expression vectors, Expression systems: prokaryotic and eukaryotic, Gene transfer methods: electroporation, microinjection, lipofection, Agrobacterium-mediated transformation

UNIT IV

Applications of biotechnology in medicine: insulin, vaccines, gene therapy; in agriculture: GM crops, Bt toxin, biofertilizers. Biosafety and ethical issues

LAB COURSE VI

1. Use of some laboratory equipment: Autoclave, Hot air oven, Incubator, Laminar Air flow
2. Preparation and sterilization of culture media
3. Isolation of microorganism from water and soil samples
4. Isolation of genomic DNA from bacteria or plant
5. Agarose gel electrophoresis of DNA
6. Quantification and purity check of DNA using spectrophotometry (A260/A280 ratio)
7. PCR amplification
8. Plasmid isolation from bacterial cultures using the alkaline lysis method
9. Any other practical as per the facility in the department

SUGGESTED READINGS:

1. **Old, R.W. & Primrose, S.B.** *Principles of Gene Manipulation and Genomics*, 7th Edition, Wiley-Blackwell, Oxford, 2006. ISBN: 9781405135443
2. **Singh, B.D.** *Biotechnology: Expanding Horizons*, 5th Edition, Kalyani Publishers, New Delhi, 2020. ISBN: 9789327236396
3. **Glick, B.R., Pasternak, J.J., & Patten, C.L.** *Molecular Biotechnology: Principles and Applications of Recombinant DNA*, 4th Edition, ASM Press, Washington, D.C., 2010. ISBN: 9781555814984
4. **Satyanarayana, U.** *Biotechnology*, 1st Edition, Books and Allied (P) Ltd., Kolkata, 2008. ISBN: 9788173816376

EXIT COURSE BIOCHEMISTRY

SKILL ENHANCEMENT/VOCATIONAL COURSE

UG CERTIFICATE/UG DIPLOMA PROGRAM

UG Certificate Program: For those who wish to exit the UG program after completing the 1 st year (Two Semesters with 40 credits)

UG Diploma Program: For those who wish to exit the UG program after completing the 2nd year (Four Semesters with 80 credits)

Note: The students will have to attend this one-month exit program for a certificate/diploma during the summer vacation

(4 credits)

Paper: Practical Biochemistry: From Basics To Benchwork (BCMEX-PB-2025)

Course Outcomes

By the end of the course, students will be able to:

1. Understand and apply basic laboratory safety and documentation practices.
2. Perform and analyze common biochemical assays using colorimetric methods.
3. Operate essential lab instruments and follow Good Laboratory Practices (GLP).

Unit I: Introduction to Biochemistry Lab Practices

- Lab rules, safety symbols, handling chemicals & biological specimens.
- Types of glassware, pipettes (volumetric & micropipettes), centrifuge tubes, balances.
- Types of water (distilled, deionized, Milli-Q) and their lab applications.
- Maintenance of lab records: lab notebooks, result sheets, and observation templates.

Unit II: Solution Preparation and Buffer Systems

- Concept of molarity, normality, ppm, % solutions.
- Dilution calculations, stock solution preparation.
- pH and buffer systems: Henderson-Hasselbalch equation.
- Buffer preparation and adjustment (e.g., phosphate buffer, Tris-HCl).

Unit III: Qualitative and Quantitative Biochemical Techniques

- Colorimetric estimation of biomolecules:
  - Carbohydrates (e.g., glucose using Benedict's.)
  - Proteins (e.g., Bradford/Lowry method)
  - Lipids (e.g., sulfo-phospho-vanillin method)
- Beer-Lambert's Law and construction of standard curves.

Unit IV: Instrumentation & Good Laboratory Practices (GLP)

- Spectrophotometer, pH meter, Centrifuge: Principles & use.
- Basic chromatography demo (e.g., paper or TLC).
- Accuracy vs precision, Types of experimental errors.
- Standard operating procedures (SOPs) and maintenance of equipment

SUGGESTED READINGS

Wilson, K., & Walker, J. (2018). *Principles and Techniques of Biochemistry and Molecular Biology* (8th ed.). Cambridge University Press.

Sawhney, S. K., & Singh, R. (2009). *Introductory Practical Biochemistry* (2nd ed.). Narosa Publishing House.

Plummer, D. T. (1987). *An Introduction to Practical Biochemistry* (3rd ed.). McGraw-Hill Book Company.

Department of Biochemistry
School of Life Sciences

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