

The University of Burdwan
Syllabus for B.Sc. Honours
(1+1+1 Pattern)
in
BIOCHEMISTRY
with effect from 2007-2008 onwards

Full Marks – 2400 (Theoretical – 1800, Practical – 600)

Part – I (1st year)

Theoretical (6 Papers X 100 = 600)

BC – 101: Principles of Physical Chemistry

BC – 102: Principles of Organic Chemistry

BC – 103: Cells & Their Organization

BC – 104: Molecular Design of Life & Preliminary Concepts of Molecular Biology

BC – 105: Mathematics & Biostatistics

BC – 106: Communicative English

Practical (2 Papers X 100 = 200)

BC – 107: Physical Chemistry & Organic Chemistry

BC – 108: Methods & Application of Important Biochemical Analyses using known Bioorganic substance

Part – I (1st year)
Detailed Syllabus

Theoretical

BC – 101: (Principles of Physical Chemistry)

1. Kinetic theory of gass – ideal and real (only Vander Waals equ.)
determination of molecular wt. from vapour density, abnormal vapour density;

15L

2. (a) Definition of systems, surroundings and types of systems (isolated, closed & open). Extensive & intensive properties, concept of thermodynamic equilibrium. Concept of temperature, heat & work, reversible, irreversible and maximum work.
 (b) Laws of thermodynamics and their application. Concept of internal energy, entropy and enthalpy. Maxwell's relations, C_p - C_v relation, Joule-Thompson coefficient for Vander Waals gases; phase transition, phase rule. 15L
3. Periodic Table; chemical bonding & reactivity – ionic bonding, covalent bonding, weak chemical forces, metallic bonding, coordination compounds. 6L
4. Electrochemistry – electrolytic dissociation & conduction. Ionic equilibrium; pH, indicators, acid-base neutralization curves, buffer action, Bronsted acids; Henderson-Hasselbalch equation; preparation of buffers, buffer capacity; solubility product – principle & application; Nernst equation; electromotive force. 10L
5. Flow of electrical charge, electrical conductance, cell constant, specific resistance, specific conductance and equivalent conductance; equivalent conductance of strong and weak electrolytes, ion conductance & ionic mobility; dissociation constant, chemical kinetics (zero order, 1st order, 2nd order). 10L
6. Mass flow – general features of fluid flow (streamlined & turbulent); nature of viscous drag of streamline, viscosity coefficient and its determination, origin of viscosity of gases and liquids, surface tension of liquids origin and determination. 10L
7. Radioactivity – alpha, beta and gamma radiation; detection and measurement of dose, law of radioactivity – decay, half-life, specific activity of radio-isotopes; application of isotopes in biological experiments. 10L
8. Tutorial classes for each topic. 24L

BC- 102: (Principles of Organic Chemistry)

1. Organic molecules: General introduction organic compounds and their classification; Nomenclature of organic compounds. 2L
Tetra-covalency and Hybridization of Carbon – Sp^3 , Sp^2 , Sp , formation of C-C, C=C, C \equiv C, C-O and C=O bonds. Bond length, bond strength (bond energy and bond dissociation energy), bond angles, shapes of molecules, variation of carbon compounds involving Sp^3 , Sp^2 , Sp hybridized carbon atoms. 8L
2. Localized and delocalized bonds, inductive effect, field effect, electromeric effect, conjugation, resonance, hyperconjugation, steric assistance and steric inhibition of resonance; Tautomerism. 6L
3. Concept of Aromaticity – Aromaticity, Huckel's rule, aromatic, anti-aromatic and nonaromatic compounds. Application of Huckel's rule to benzenoid and non-benzenoid aromatic compounds. 6L
4. Qualitative idea of dipole moment and its application in aliphatic and aromatic compounds, Inter and intermolecular forces and their effects on physical and chemical properties of molecules, Weak Chemical forces – Van der Waals forces, hydrogen bond, dipolar interactions. Molecular structure and physical properties (m-p, b-p 2 solubility) 5L
5. Stereochemistry – different types of isomerisms, configuration & conformation. Representation of molecules in flying-wedge; Fischer, Sawhorse, Chirality, elements of symmetry. Optical isomerism, optical activity, specific rotation and molar rotation, enantiomerism and diastereoisomerism. D-L, R-S, threo-erythro nomenclature. Racemisation-resolution of racemic acids, bases and alcohols. Geometrical isomerism – associated with C=N & C=C bonds; cis-trans, syn-anti, E-Z systems of nomenclature. 12L
6. Conformational analysis – Dihedral angle, torsion angle, eclipsed, staggered, gauche and anti; Klyne-Prelog nomenclature-antiperiplanar, anti-clinal and syn-clinal. Energy barrier to rotation, relative stability of conformers, dipole-dipole interactions; conformational analysis of ethane, propane and n-butane with energy - profile diagrams. 6L

7. Organic reactions mechanisms – classification of organic reactions; Acid-Base reactions; Relationship between structure and acidity, Organic compounds as acid and bases; thermodynamics and kinetics of organic reactions and their control; energy profiles. Reactive intermediates – carbocations, carbanions, free radicals, Substitution reaction: S_N^1 , S_N^2 , S_N^i , reactions, Neighbouring group participation in substitution reaction. Electrophilic multiple bonds, electrophilic additions to C-C multiple bonds, Nucleophilic addition to carbonyl group. Generation, structure & stereochemistry of free radicals. Aromatic electrophilic substitution and Aromatic nucleophilic substitution. Effect of substrate structure, nucleophile, medium of reactivity and mechanism. Elimination reactions: E_1 , E_2 and E_1CB . Elimination vs substitution reaction. 25L
8. Tutorial classes for each topic. 30L

BC – 103: (Cells & Their Organization)

1. Cell types – prokaryotic and eukaryotic cells; plant and animal cells; range of cell structure in bacteria; types of cells in plant and animal systems; shape, size and number, external and internal structures, general composition of cells of different types; biochemical functions ascribed to cellular components; characteristics of dividing and permanent cells; differentiation of cells and tissues. 10L
2. Biological membranes – cellular boundary, plasma membrane; structure and functions of cell membrane. Transport mechanisms in biomembranes; energy transforming biomembranes. Uptake of materials through membranes and its regulation. 12L
3. Cell organelles – types in plant and animal cells, in prokaryotes and eukaryotes; structure and function of each organelle; Microbodies- types, functions with structures; vacuoles and their functions; cytoskeleton. 12L
4. Cell as an energetic system – application of first and second laws of thermodynamics cell an open system, dynamic equilibrium, chemical potential, water potential in water relations, chemical potential of ions; free

- energy in biochemical reactions, phosphate transfer and phosphorylation, redox systems and redox potential. 12L
5. Cell as a metabolic system – biological catalysts, metabolic compartmentation of the cell, Transport mechanisms in cells, principles of metabolic reactions and their regulation. 8L
 6. Cell as a dividing system – cell divisions, mitosis and meiosis; regulation, determination of the division plane; cells cycle and cell differentiation. 6L
 7. Cell as a polar system – definition of polarity, significance of cell polarity, induction of polarity. 4L
 8. Cell as a growing system – biophysical basis of cell growth; growth and cell wall structure in plant system; extension of growth of multicellular organs, regulation of extension growth. 6L
 9. Tutorial classes for each topic. 30L

BC- 104: (Molecular Design of Life & Preliminary Concepts of Molecular Biology)

1. Chemical unity of diverse living organisms – characteristics of living matters; Overview to three-dimensional structures of living matters; chemical unity underlying biological diversity; precursor compounds of macromolecules of living organisms. 6L
2. Energy production and consumption in metabolism – energy as a central theme in biochemistry; non-equilibrium condition of living organisms with their surroundings; molecular composition and dynamic steady state; exchange of energy and matter by living organisms with their surroundings; interconversions of different forms of energy by cells and organisms; flow of electrons as the source of energy for organisms; ATP as the universal carrier of metabolic energy linking catabolism and anabolism. Metabolic energy balance and economy. 12L
3. Biological information transfer – DNA molecules as genetic continuity; structure of DNA, its repair mechanisms and replication, Linear sequence of DNA encoding proteins and their three dimensional structures; stabilization of three-dimensional structures; Replication, transcription and translation

mechanisms in prokaryotes and eukaryotes – preliminary concepts. Junk DNA, exons and introns. 18L

4. Water and living cells – structure and properties of water; polarity of water, molecules providing H-bonds; thermal, cohesive and adhesive properties of water; water as an excellent solvent of polar molecules; water as a weakener of ionic and H-bonds; tensile strength of water; hydrophobic interactions; association of nonpolar groups with water; water transport mechanisms in biological organisms, exudation of water. 12L

Blood, lung and buffer- buffering against pH changes in biological systems; bicarbonate buffer system; fitness of aqueous environment for living organisms. Maintenance of sodium-potassium balance in blood. Diffusion, osmosis and reverse osmosis. 10L

5. General idea about primary metabolic pathway, integration and regulation of cellular metabolism – strategy of metabolism, coupling of pathways, interaction of energy charge with pathway intermediates; interaction of energy charge with ATP - generating sequences. 12L

6. Tutorial classes for each topic. 30L

BC – 105: (Mathematics & Biostatistics)

1. Differential Calculus: Functions, Limit, Continuity (Graphical Method), Differentiation: second order (Algebraic, Logarithm, Exponential functions). Successive differentiation, Expansion of function optimum, partial differentiations, Application of Euler's Theorem, L'Hospital Theorem. 20L
2. Integral Calculus: Definite and Indefinite integral (Algebraic, Logarithm and Exponential functions) Area, Differential equation. 14L
3. Statistics and Probability: Primary and secondary data, Frequency distribution, Diagrammatic representation, Population and sample, law of statistical regularity, Mean, Median, Mode, Standard deviation and their simple problems, Methods of sampling, Basic concepts of probability, Poisson distribution, Normal distribution, Chi-square distribution, Student's distribution, Test of Significance. Some mathematical ideas about Biostatistics and Bioinformatics. 36L

4. Tutorial classes for each topic. 30L

BC – 106: (Communicative English)

Objectives: [To develop the learner's language skills in English: Listening, speaking, reading and writing (LSRW) and to develop the learner's specific skills for communication in the field of Science, Technology and Computer Application].

1. Communication and communicative activities the notions of encoder and the message and the medium. 9L
2. Communicative and competence. 9L
3. Concise grammatical structures and key vocabulary for general as well as specific purpose accuracy and appropriateness in the use of English. 9L
4. English speech sounds and sound combinations. 9L
5. Elements of Spoken English. 7L
6. Topic of discourse, mode of discourse and style of discourse with special reference to scientific discourse. 7L
7. Writing note, reports, proceedings etc. 7L
8. Expanding and summarizing. 7L
9. Narrating and describing. 6L
10. Tutorial for each topic. 30L

Practicum on all these language activities and communicative tasks-
group discussion, seminar.

Practical (Examination in two days)

BC-107: (Physical & Organic Chemistry) (Examination in two days)

- I. Physical Chemistry (Full Marks = 50; Two sets of experiments = 20X2 = 40
Practical Records = 5; Viva voce = 5
 1. Preparation of Phosphate, Citrate, Acetate and Tris buffer and determination of pH using indicators and pH meter.
 2. Titration of strong acid with a strong base.
 3. Titration of a strong acid with a weak base.
 4. Titration of weak acid with a strong base.
 5. Determination of pKa.
 6. Determination of partition coefficient of a solute between two immiscible solvents (Iodine in water/organic solvents, Benzoic acid in water/Benzene).
 7. Equilibrium constant determination of reaction $KI + I_2 = KI_3$
 8. Measurement of viscosity coefficient of a liquid / solution by Viscometer
 9. Determination of solubility & solubility product.
 10. Conductometric & Potentiometric titrations – acid-base titration; redox system.
 11. Kinetics – hydrolysis of methyl/ethyl acetate.
 12. Measurement of specific rotation by Polarimeter.

- II. Organic Chemistry (Full Marks = 50; Qualitative Analysis = 40; Practical Records = 5, Viva voce = 5 Marks)
Qualitative analysis of solid organic compounds with respect to following points :
 - i. Detection of characteristic elements in organic compounds (N, Cl, Br, I & S)
 - ii. Determination of melting point of a given organic compound.
 - iii. Solubility test & solubility classification.

- iv. Detection of functional groups in an organic compound – one functional group to be detected (carboxyl, carbonyl, phenolic – OH, nitro, amino, amido, anilido & ester (hydrocarbon excluded))
- v. Preparation of one derivative of the given compound, its purification & melting point determination.

BC-108: (Methods & Application of important Biochemical Analyses of known Bio-organic compounds) (Full Marks = 100; Four sets of Expts. = 20X4 = 80 Practical records = 10; Viva voice = 10 Marks)

1. Separation of amino acids by two dimensional paper chromatography and their identification.
2. Separation of fats by thin layer chromatography.
3. Estimation of glucose by Benedict's quantitative method.
4. Colorimetric estimation of amino acids by ninhydrine reagent.
5. Estimation of protein by Biuret method and Lowry's method.
6. Determination of acid value of a fat.
7. Determination of saponification value of a fat.
8. Determination of iodine number of a fat.
9. Estimation of DNA by diphenylamine reagent.
10. Estimation of RNA by orcinol reagent.
11. Determination of K_m & V_{max} values of alkaline phosphatase.

BOOKS (RECOMMENDED)

1. Text book of Biochemistry for Medical Students – D.M. Vasudevan
2. Principles of Cell & Molecular Biology – Klein Smith and Lewis
3. Text book of Biochemistry – Thomas Devlin
4. Chromosome Techniques – Sharma & Sharma
5. Laboratory Manual in Microbiology – P. Gunasekaran
6. Text book of Medical Biochemistry – S. Chatterjee
7. Biophysics & Biophysical Chemistry by – Debojyoti Das
8. Practical Biochemistry in Clinical Medicine – R.L. Nath

9. Laboratory Manual in Biochemistry – J. Jayaraman
10. Biochemical Methods – M. Sadasivam
11. Laboratory manual of Environmental Chemistry – Sunita Hooda, Sumanjeet kaur
12. Molecular Biology of the Cell – Alberts, Bruce
13. An Introduction of Practical Biochemistry – David Plummer
14. Advanced Molecular Biology- Richard Twyenan
15. Instant Notes in Genetics – Winter and Hickey
16. Instant Notes in Molecular Biology – P.C. Turner
17. Instant Notes in Biochemistry – Hames, Hooper, Hughton
18. Biochemistry & Molecular Biology by Ethit & Ethit
19. Cell Biology and Laboratory Handbook – Julio Celis
20. Essential Cell Biology – Alberts
21. Oxford Dictionary of Biochemistry & Molecular Biology – A.D. Smith (Ed.)
22. Principles in Biochemistry – A.L. Lehninger, D.L. Helson & M.M. Cox.
23. The cell-a Molecular approach – Geoffrey Cooper
24. Biochemistry – J.M. Ber, J.L. Tymoczko & L. Stryer (2002) (4TH Edn.)
25. Cell & Molecular Biology – Gerald Karp
26. Biochemistry – Voet & Voet
27. Principles and Techniques of Practical Biochemistry – Keith Wilson & Walker.
28. Experiment in Microbiology (Plant, Pathology, Tissue Culture & Mushroom Cultivation) – K.R. Aneja
29. Clinical Biochemistry – G. Guru
30. Manual in Practical Biochemistry – K.P. Sinha
31. Cell & Molecular Biology – E.D. P. De Robertis & E. M.F. De Robertis
32. Molecular Biology by D. Freielder
33. Recombinant DNA by Watson
34. Essential Immunology – Roitt Ivan
35. Immunology – Nandini Shetty
36. Advanced in cell & Chromosome Research – Sharma and Sharma
37. Microbiology & Immunology – M.K. Majumdar

38. Fundamental Principles of Bacteriology - A.J. Salle
39. Biochemistry – David E. Metzler
40. Medical Biochemistry – Dandekar
41. Recombinant DNA & Biotechnology Mass Krenzer
42. Environmental Biology – Verma & Agarwal
43. Plant Tissue Culture – A.K. De
44. Instant notes in Chemistry for Biologists – Fisher
45. Molecular Cell Biology- Ber Lodish
46. Instant Notes in Microbiology – J. Nicklin, K. Graeme – Cork, T. Paget & R. Kellington
47. Short Protocols in Molecular Biology – F.M. Ausubel, Roger Brent, R.F. Kingston, David D. Moore, J.G. Seidman, J.A. Smith and Kevin Struhl
48. Immunology – Donald M. Wein & John Stewart
49. Text Book of Biochemistry – A. Mazur and B. Harrow
50. Stereochemistry at a Glance – J. Eames & J.M. Peach.
51. Organic Chemistry (Vol. I) – I. L. Finar
52. Organic Chemistry (Vol. II) – I.L. Finar
53. Stereochemistry of Organic Compounds – D. Nasipun
54. Organic Chemistry – (7th Edn) – G. Solomons and C. Tsyhic
55. Organic Chemistry – (6th Edn.) – R.T. Lincison and R.N. Boyd.
56. Stereochemistry – P.S. Kalsi
57. Advanced Organic Chemistry (Reactions, Mechanism and Structure) _ Jones March
58. Stereochemistry of Organic Compounds – E.L. Eliet & S.H. Wilm
59. Thermodynamics – P.C. Rakshit
60. Elementary Physical Chemistry – S.R. Palit
61. Physical Chemistry – P.C. Rakshit
62. Inorganic Chemistry – R.L. Dutta
63. Inorganic Chemistry – R. Sarkar
64. Voselis Text Book of Practical Organic Chemistry (4th Edn.)
65. Advanced Practical Organic Chemistry – O.P. Agarwal
66. Introduction of Protein Chemistry –S.N. Fox and J.F. Fosted

67. Carbohydrate Chemistry – J. Tenneds
68. Carbohydrate Chemistry – E.A. Davidson
69. An Introduction to the Chemistry of Carbohydrates –R.D. Guthrie and Hanymus
70. Organic Reaction Mechanism – Peter Syres.
71. Optics & Lasers in Biomedicine Culture by T.G. Fotakis
72. College Physics Vol I & IV by Sinha & Das Sharma
73. Basic Concepts in Biochemistry by A.C. Deb (2000)
74. Cell Biology by S.CV. Rastogi (2002)
75. Methods in of ant Molecular Biology – A Laboratory Course Manual by P. Maliga, D.F. Klissig, A.R. Cashmore & J.E. Varner (1995)
76. Experimental Biochemistry by T.M. Clark, Jr. (Freeman & Co.)
77. Molecular Cell Biology by D. Baltimore
78. Molecular & Cell Biology: Theory & Problems by Stansfield, Colome & Camo.
79. Methods in Biotechnology by H.P. Schmander (ed.)
80. Basic concepts in Biochemistry – A Students survival guide by H.F. Gilbert
81. Biotechnology (1) including Biochemistry, Mathematics & Computer Science
82. Statistical Methods for Analysis of Biomedical data by Woolson
83. Laboratory Techniques in Biochemistry & Molecular Biology by work & work.
84. Stathistical Methods in Bioinformatics – An introduction by Warren Ewans & Grant
85. Biophysical Chemistry by Upadhyay, Upadhyay & Nath.

THREE-YEAR INTEGRATED COURSES IN BIOCHEMISTRY (H)

Syllabus of B.Sc. (H) Part-II

(2nd Year)

BC – 201 (Biosynthesis of macromolecular precursors & Macromolecules)

1. Definition of biomolecules and macromolecules with examples. Name of precursors of major macromolecules (starch / glycogen, lipids, proteins and nucleic acids). A brief account of the key processes of the initial generation of carbohydrates, lipids, proteins and nucleic acids. 10L
2. Carbohydrates and lipids as the major source of precursors as well as energy for the biosynthesis of macromolecules. RNA molecules as catalysts in early 'RNA world'. RNA-directed polypeptide synthesis linking the RNA and protein world. DNA as a stable storage form for genetic information. Proteins playing both structural and catalytic roles. 10L
3. Biosynthesis of glucose, the precursor for polysaccharides. Biosynthesis of starch and glycogen. 10L
4. Biosynthesis of amino acids, the precursor of proteins. Biosynthesis of proteins up to quaternary structures. 10L
5. Biosynthesis of long-chain fatty acids and glycerol, the precursors of simple fat. Biosynthesis of fat/lipids. 10L
6. Biosynthesis of pentose sugars, pyrimidine and purine bases, the precursors of nucleic acids. Biosynthesis of DNA and RNA. 10L
7. Integration of metabolisms – high interconnections of metabolism. Metabolic regulation, major control sites of metabolic pathways. Metabolic fates of the products of glucose breakdown. 10L
8. Tutorial classes for each topic. 30L

BC – 202 (Biochemistry of Carbohydrates and Lipids)

1. Introduction to Carbohydrates: Definitions of carbohydrates, mono-di-oligo and polysaccharides; definition of sugars with examples. 4L
2. Monosaccharides: Nomenclature and structures of aldoses and ketoses; Isomerism in monosaccharides – optical activity, dextro and levorotation; Use of prefixes D(+), D(-), L(+) and L(-) in enantiomers with examples. Cyclic structures of monosaccharides – pyrans and furans; anomers and mutarotation in monosaccharides. 12L
3. Compounds derived from monosaccharides – L-ascorbic acid, polyols (polyalcohols), amine sugars and their role in biological organisms. 4L
4. Chemical properties of monosaccharides – esters, alkylation, oxidation, actions of conc. acids, phenylhydrazine. 4L
5. Oligo and polysaccharides: Reducing and non-reducing disaccharides, trisaccharides and tetrasaccharides. Homopolysaccharides – starch, glycogen, cellulose, dextrans, chitin, arabans, xylans, fructosans and pectins. Heteropolysaccharides – glucosides, galactosides, nucleosides and glycans. 12L
6. Introduction to Lipids: Definitions; fats and oils; classes of lipids – long and linear hydrocarbons, branched chain; linear or cyclic structures that are only partially reduced. Glycolipids, sphingolipids and waxes. 10L
7. Fatty acids: saturated fatty acids; unsaturated fatty acids (MUFA & PUFA); hydroxylated fatty acids, branched fatty acids, prostaglandin, leukotrienes, lipid peroxides. 12L
8. Glycerolipids: Glycerides, glycerophospholipids – diacyl phosphatides, alkenylphosphatides, alkylphosphatides; glycosyl diacylglycerides, cerides, polyisoprenic lipids; phospholipids and sulpholipids 12L
9. Tutorial classes for each topic 30L

THREE YEAR INTEGRATED COURSE IN BIOCHEMISTRY (H)

syllabus of B.Sc. (H) Part-II

(2nd Year)

BC – 203 (Biochemistry of Amino acids, Proteins and Nucleic acids)

1. Proteins and their biological functions, functions of amino acids, physicochemical properties of amino acids. 4L
2. Isomerism, classifications and properties of amino acids; properties of proteins and the classification. 5L
3. Metabolic fates of amino acids, transamination, transdeamination, oxidative deamination, non-oxidative deaminations. 5L
4. Peptides – structure and properties; primary structure of protein, secondary, tertiary and quaternary structures. 6L
5. Purification of proteins, protein denaturation and folding, oxygen binding protein; protein targeting and degradation. 5L
6. Protein synthesis, ribosome and t RNA function; antibiotic inhibitors of protein synthesis; synthesis of amino acids. 6L
7. DNA stores genetic information; base composition. Nucleotides, nucleosides and bases. Structure and chemical properties of bases. Nucleotides and nucleosides, their synthesis and major roles. 6L
8. Primary structure of nucleic acids, polarity; chemical and enzymatic hydrolysis of nucleic acids. Secondary structure of DNA; Watson-Crick structure – its elucidation and characteristics; A-DNA, B-DNA and Z-DNA. 6L
9. Strategy of sequence analysis of nucleic acids, Purification of nucleic acids, denaturation and renaturation of nucleic acids. 6L
10. DNA replication in prokaryotes and eukaryotes Antibiotic inhibitors of replication. 5L
11. Different types of RNA; primary and secondary structures, ribosome and ribosomal RNA. 5L
12. Elements of transcription, DNA- dependent RNA polymerization; mechanism of transcription; Control of RNA synthesis, Antibiotic inhibitors of transcription, post transcriptional processing. 6L
13. Tutorial classes for each topic 30L

BC – 204 (Cell Biology and Enzymology)

1. Molecular constituents of cells: Cellular chemistry, Properties and behavior of water. Salt, ions gases: Acids, Bases pH and Buffering, chemical bonds. The Cellular Macromolecules: An overview of the structures and functions of proteins, Polysaccharides and Lipids; Cellular roles of the nucleic acids. 7L
2. Structure and functions of the major cell organelles; Plasma membrane, Endoplasmic reticulum, Golgi bodies, Lysosomes, Mitochondria and Plastids. The interphase nucleus, chromatin nucleosomes and chromosomes. 7L
3. The Cell Cycle and Cell Division: Regulation of cell cycle. Significance of mitosis and meiosis. DNA metabolism in Meiosis. 6L
4. Cell Differentiation: General characteristics of cell differentiation; Localization of cytoplasmic; Determination in Egg, Molecular mechanism of cell differentiation. 6L
5. Cloning and Transgenesis: Cell cloning, Tissue culture-plant and Animal cloning: animal Tissue culture – Transgenesis – Principles of transgenesis, Examples of Transgenesis in Plants and animals. 7L
6. Cell signaling: Protein trafficking: Signal transduction 6L
7. Classification of Enzymes; Kinetics; Coenzymes; Structure and function; Inhibition of enzymes. 10L
8. Allosteric control of Enzyme activity, Enzyme specificity; Mechanism of Catalysis. 6L
9. Clinical Application of Enzymes 5L
10. Regulation of enzyme activity. 5L
11. Restriction enzymes and their application. 5L
12. Tutorial classes for each topic 30L

BC – 205 (Intermediary metabolism and Metabolic pathways)

1. Introduction to Intermediary metabolism: Definitions, metabolism (catabolism and anabolism); intermediary metabolism in biological organism – chemical transformations occurring in cells & organisms; metabolic pathways interconverting precursors, metabolites and products (excluding macromolecules). Interconversions of carbohydrates, lipids and proteins including amino acids. 8L
2. Carbohydrates metabolism: Glycolysis, Citric acid cycle (Krebs cycle), Pentose phosphate pathway, Electron transport chain and oxidative phosphorylation; Gluconeogenesis; Fermentation (alcohol and lactic acid); Pasteur effect; Glyoxylate cycle; Entner-Douduroff pathway; Respiratory metabolism coupled to other pathways. 15L
3. Protein metabolism: Biosynthesis of proteins – activation of amino acids and formation of aminoacyl t RNAs; transfer of amino acids from aminoacyl t RNAs to polypeptides. Protein catabolism – proteolytic enzymes; protein turn-over; Ubiquitin-mediated destruction of proteins. Amino acids degradation, metabolic fates of amino groups; metabolism of ammonia and nitrogen containing monomers; fates of carbon skeletons of amino acids. Nitrogen excretion and urea cycle. 15L
4. Lipid metabolism: Lipid biosynthesis (lipogenesis) – biosynthesis of fatty acids (saturated and unsaturated) and glycerol; formation of triglycerides. Lipid breakdown – action of lipases; β -oxidation of fatty acids and its energetics; fate of glycerol, oxidation of odd-carbon straight-chain saturated and straight-chain unsaturated fatty acids; α - and ω -oxidation of fatty acids. 15L
5. Nucleic acid metabolism: Biosynthesis of purines and pyrimidines; formation of nucleosides and nucleotides; biosynthesis of nucleic acids – DNA and RNA polymerases. Degradation of nucleic acids – nucleases actions. 9L
6. Regulation of cellular metabolism: Integration of carbohydrate, lipid, protein and nucleic acid metabolism. Control of metabolic activities – regulation of synthesis of enzymes, effects of substrate conc; regulation of enzyme activity by activation or inhibition; covalent modification of proteins; effect of hormones. 8L
7. Tutorial classes for each topic 30L

BC – 206 (Nutrition and Clinical Biochemistry)

1. Assessment nutritional status in human :
 - a. Clinical assessment, Dietary assessment, Anthropometric measurements, laboratory based assessment of individual nutrients (assessment of energy expenditure, protein, vitamins and minerals). 12L
 - b. Role of carbohydrate, lipid and protein, vitamins and minerals (bulk and trace elements) in maintaining nutritional balance, nutritional disease (protein energy malnutrition, vitamin deficiency diseases) obesity. 12L
2. Inborn errors of metabolism:
 - a. General Consideration
 - b. Galactosemia
 - c. Intrinsic disorders of red cell, hemoglobin (such as G6PD deficiency, thalassaemia, hemoglobinopathy E,C,D, disorder of porphyrins metabolism
 - d. Gout and genetic defects in urate metabolism 16L
3. Diagnostic Biochemistry and organ function tests:

General consideration:

 - a. Digestion and absorption, physiological function of liver, kidney, heart, thyroid. Enzymes and isoenzymes and their application in various disorders.
 - b. Biochemical diagnosis and assessment of disease of liver kidney, thyroid, mal absorption syndromes and their biochemical evaluation.
 - c. Disturbances in acid-base balance
 - d. Lipoproteins and its disorders
 - e. Glucose tolerance test and its disorders, especially Diabetes mellitus. 20L
4. Clinical Biochemistry Method:
 - a. Units of measurements, S.I. Unit
 - b. Principles of colorimetry and Spectrophotometry:
Glucose, Urea, Creatinine, Uric acid, Cholesterol, Triglycerides, serum bilirubin, serum alkaline phosphatase, Serum ALT and AST.
 - c. Radioisotopes and their use in Biochemistry
 - d. Basic Statistics: (Mean, SD, CU, normal distribution) – Normal or Reference range 10L
5. Tutorial classes for each topic 30L

BC- 207 (Extraction & Assay of some representative Enzymes & Clinical Biochemistry)

1. Urine analysis (Qualitative for Sugar, Protein, Bile pigments, ketone bodies, Perphobolinogen, Faecal occult blood test.
2. Verification of Lamber-beer's law utilizing methyl orange solution.
3. Estimation of blood sugar by Colorimetric method.
4. Estimation of urea by diacetyl monoxime method.
5. Estimation of Cholesterol and Triglyceride by GOD / POP method.
6. Estimation of serum ALT and AST by Colorimetric method.
7. Estimation of Serum Alkaline Phosphatase by Colorimetric method
8. To perform Renal Function test by Creatinine clearance test.
9. Estimation of serum bilirubin by Colorimetric method.
10. Estimation of Free-acidity and total acidity by titrimetric method.

List of Books:

| Sl. No. | Title of Book | Name(s) of Author | Publishers |
|----------------|---|---|------------------------------------|
| 1. | Clinical Chemistry in Diagnosis & Treatment | E.J. Zilva, R.R. Panval, P.P. Mayne | Edward Arnold P.G. Publishers Ltd. |
| 2. | Microanalysis in Medical Biochemistry | I.D.P. Wootton | Churchil Livingstone |
| 3. | Lecture Notes on Clinical Chemistry | White, HG, Percy, R, Smith, I.W. | Blackwell Scientific |

Practical

BC – 208 (Isolation & Estimation of Principal Biomolecules from Living Materials)

1. Extraction and estimation of total reducing sugars from biological materials by colorimetric method (Anthrone method). (use glucose as standard).
2. Chromatographic (paper or TLC) separation of sugars (glucose, fructose and ribose) using ethylacetate; pyridine; water as solvent system.
3. Extraction and estimation of total amino acids from biological materials by colorimetric method (Ninhydrin method). (Use glycine as standard).
4. Chromatographic separation (paper or TLC) of free amino acids (alanine, aspartic acid and tryptophan) in extract of biological samples (Use one dimensional chromatography with the solvent system butanol; acetic acid; water or phenol; water)
5. Extraction and estimation of protein from biological samples by the method of Lowry (Folin-phenol reagent). (Use BSA as standard).
6. Colorimetric estimation of total nitrogen by Nessler's reagent and rough estimation of protein from it. (Multiply total nitrogen by the factor 6.25).
7. Extraction and estimation of lipids from biological samples by Sudan-III or Sudan black reagent (For extraction use chloroform: methanol (3:1)
8. Determination of glycerol from ether-extracted, aqueous, saponified lipid by colorimetric method (α -naphthol method)
9. Extraction and estimation of DNA from biological sample by colorimetric method (Use Diphenylamine reagent).
10. Extraction and estimation of RNA biological sample by colorimetric method (use Orcinol reagent).
11. Estimation of ascorbic acid (vit. C) in plant sample. (Use Dinitrophenyl hydrazine reagent).
12. Determination of cholesterol in biological sample (Use Liebermann-Burchard reagent)

DRAFT SYLLABUS

THE UNIVERSITY OF BURDWAN

3-Year Integrated Course of B.Sc. (H) in Biochemistry

PART-III (3RD Year)

THEORETICAL: (6 papers each carrying 100 marks)

Paper: BC – 301 (Genetic Information & Recombinant DNA Technology)

1. DNA and RNA: The molecular vehicles of hereditary information – general introduction. Flow of genetic information – mol. Mechanism. 7L
2. Flow of genetic information in reverse direction – retroviruses, genome replication, reverse transcriptase. 7L
3. Cell to cell communication through cell signaling fundamental concept and definitions. 7L
4. Recombinant DNA technology: Tools and techniques (Type-I, II, III restriction enzymes, restriction digests; RFLP) 10L
5. Generation of recombinant DNA by molecular cloning – the basis of genetic engineering. Hosts and vectors (Definition & examples of plasmids, cosmids, YAC, Phages, BAC, HAC). 12L
6. Organization of cloned gene; cDNA mapping. Construction of DNA libraries and cDNA libraries, screening. Expression of cloned gene; nucleic acid hybridization and FISH; DNA sequencing; enzymatic amplification of DNA by PCR. 12L
7. Gene transfer in plants and animals; transfection; transgenic plants and animals 6L
8. Mutation induction in cloned DNA and its application 5L
9. Tutorial classes for each topic 30L

Paper: BC – 302 (Biophysical Chemistry and Bioenergetics)

1. Biological systems compared to physical systems. Different physical parameters of bio molecules (density refractive index, viscosity, surface tension, electrical conductance and resistance affecting the properties of cell) 10L
2. Colloidal systems: classification of colloids; properties of colloids; suspension and emulsion; dialysis, ultra filtration and absorption –application of biology 8L
3. Photochemical reactions (chlorophyll, phytochrome & other biological pigments involved in such reactions). Light sensitization & light driven electron flow. 7L
4. Membranes, micelles, bilayers, liposomes, permeable, semipermeable and impermeable biological membranes; Donnan equilibrium; membrane transport, membrane potential, action potential. Polarization & depolarization of membrane. 10L
5. Properties of light, bright field and dark field microscopy. Beer-Lambert's law; UV absorption; Physical principles behind chromatography (liquid and gaseous); Electrophoresis; Centrifugation; Light microscopy, Electron microscopy; Phase contrast microscopy; UV microscopy; Fluorescence microscopy; Colorimetry and Spectro Phtometry; Fulorometry; Flame photometry, IR spectroscopy. 15L
6. The concept of free energy; change in free energy; determination of ΔG ; energy-rich compounds; factors contributing to the stability of scuh compounds, Oxidation - reduction reaction, Free energy changes for ATP hydrolysis. 5L
7. Bioenergetics obeys thermodynamic laws; Cells require sources of free energy; standard free energy; equilibrium constant of a reaction; phosphorylation and dephosphorylation as energy transfer systems. Oxidative and photophosphorylation follow Mitchell's Chemiosmotic hypothesis. 15L
8. Tutorial classes for each topic 30L

Paper: BC – 303 (Molecular Biology & Immunology)

1. DNA – the master molecule of life; physical and chemical structure and properties. 15L
Replication in prokaryotes and eukaryotes – comparison and chemical nature; RNA classes and their role in maintaining cellular functions. RNA as a hereditary material. Protein – the biological executors of hereditary instructions. Protein Structure: Primary, Secondary, Tertiary and Quaternary structure
2. DNA damage and repair – UV- induced lesions; formation of TT-dimers and their significance. Repair by (a) enzymatic photoactivation and (b) Excision repair process. 5L
3. Central dogma in molecular biology – Prokaryotic gene regulation; structural genes, controlling sites; operons; lac operon system. 20L
Transcription in eukaryotes – RNA polymerases controlling transcription initiation, elongation and termination.
mRNA Processing: spacer DNA , introns, exons, RNA splicing, primary transcript to the formation of mature m-RNA.
Translation : genetic code, nature and feature of genetic code, Protein synthesis – aspects and mechanism; codon-anticodon interaction; polypeptide chain initiation elongation and termination; prokaryotic versus eukaryotic system.
4. General features of Immunity – antigens and immunogens; B cell and Humoral response; T cell and cell-mediated response. 5L
5. Immunoglobulins – basic structure of immunoglobulin molecules. Immunoglobulin classes; biological functions; immunoglobulin super family. 5L
6. Cytokines – general characteristics of cytokines and their functions. 6L
7. Complement system – Complement components; reaction sequence of complement components leading to cell lysis (classical pathway, alternative pathway and lactic pathway) 4L
8. Antigen-antibody interaction – molecular basis of antigen-antibody interaction. 10L
Precipitation reaction, agglutination methods; immunoassays (ELISA and RIA; immunofluorescence; Western blotting.
9. Tutorial classes for each topic 30L

Paper: BC – 304 (Plant and Human Physiology)

Group – A (Plant Physiology)

(50 marks)

1. Cell organcells (mitochondria, chloroplasts, peroxisomes, glyoxisomes, ribosomes) and their physiological functions – a general discussion. 5L
2. Water uptake and transport. A brief idea of Transpiration. 4L
3. Essential nutrients of plants, functions, their deficiencies and disorders. 4L
4. Solute transport – passive and active transport; phloem loading and unloading; mechanism – pressure flow model. 6L
5. Photosynthesis – light reactions, photosystems I & II; oxygen evolving complex (OEC); Calvin cycle (C-3 cycle) – carboxylation phase, reductive phase and regeneration phase. C-2 cycle – oxygenation function of RUBISCO, photorespiration; integration of C-2 cycle with C-3 cycle. A brief account of bacterial photosynthesis, C-4, CAM and C-1 photosynthesis. 10L
6. Growth and Development – A brief account of five classes of phytohormones and their role in growth and development (dormancy, flowering & senescence). 6L
7. Tutorial classes. 15L

Group B (Human Physiology)

(50 marks)

1. Nervous system – Nervous system as coordinator, Integrative function of nervous system. Division of Nervous system – Central Nervous system, peripheral Nervous system (spinal and autonomic).
Excretable tissue – Nerve and muscle. Development of Action Potential and propagation of nerve impulse. Junctional transmission – synaptic, ganglionic and neuro muscular. Peripheral neurotransmitter system; Chemical transmission.
Division of Brain – Spinal cord, subcortical (medulla, pons, hypothalamus, thalamus, cerebellum, basal ganglia); cerebral cortex (somato-sensor/cortex, motor cortex, association area).
Sensory division of the Nervous system – sensory receptors, classification.
Motor function – the corticospinal tract; maintenance of equilibrium. Special sensory receptor – special senses, vision- photoreceptor mechanism in rods and cones, Hearing – perception of sound frequency and intensity (loudness). Chemical senses – smell and signal transduction mechanism.
Autonomic Nervous system – sympathetic and parasympathetic divisions. Chemical division - cholinergic and noradrenergic. 15L
Higher function of Brain – Cognitive function, Neuro chemistry (Accepted hypothesis)
2. Circulation (Cardiovascular System) - Heart as a pump; origin of heart beat; electrical activity of heart; relationship with cardiac cycle. 4L
3. Respiration – Pulmonary function; gas exchange between lungs and tissues. Regulation of Respiration. 4L
4. Gastrointestinal System – Secretory functions of the Alimentary tract. Digestion and absorption in gastrointestinal tract. 4L
5. Kidney – Renal function and Reproduction. Urine formation by the kidneys; Glomerular filtration and tubular processing; Renal blood flow and their control. Regulation of extra cellular fluid osmolarity.
Regulation of Acid – base balance.
Reproduction – The Gonads – male and female hormones. Mechanism of fertilization and Implantation. Pregnancy. 5L
6. Pituitary gland – Control by hypothalamus.
Concept of Neuroendocrinology. 3L
7. Tutorial classes. 15L

Paper: BC – 305 (Hormonal Regulation of Metabolic Processes in Plants and Animals)

Group A (Plants)

(50 marks)

1. Action of hormones as chemical messengers. Coordination of cell to cell interactions by hormones. 2L
2. Auxins – biochemistry of mode of action of IAA; biochemistry of auxin effects on cell wall hydrolyzing enzymes and cell wall loosening; proton extrusion and acid growth hypothesis. Calcium and intracellular pH as possible signaling intermediates, mechanisms. A brief account of auxin regulation of apical dominance, lateral root development, adventitious root development, abscission and lateral bud development. Effect on RUBISCO, PEP case, Malate dehydrogenase; RNA & DNA polymerases. 6L
3. Gibberellins – Biochemistry of mode of action; biochemistry of gibberellin effects on seed germination; development of shoot, inflorescence and fruit set. Interactions of gibberellin receptor with G-proteins on plasma membrane, cell wall extensibility and internode elongation, c-GMP, Ca⁺⁺ and protein kinases as possible signaling intermediates. 6L
4. Cytokinins – biochemistry of mode of action of cytokinins; biochemistry of regulation of growth and cell division in shoot and roots, cell expansion on leaves and cotyledons by cytokinins; regulation of cell cycle, lateral bud growth, nutrient movement and chloroplast development. Effect on the expression of regulator genes. Histidine phosphotransferase in the cytokinin signaling system. Activation of transcription factors by cytokinin – induced phosphorylation. 6L
5. Abscisic acid – Biochemistry of mode of action of ABA, Regulation of stem elongation, dormancy, seed germination and stomatal closure. ABA effect on membrane permeability cytosolic Ca⁺⁺ & pH and membrane depolarization. Regulation on phosphates and protein kinase and gene expression by ABA. Effects on RNA & DNA polymerases. 6L
6. Ethylene – Biochemistry of ethylene action; receptor-ethylene binding; regulation of response pathway. Regulatory role of ethylene on fruit ripening and its molecular mechanism. Involvement of serine/threonine protein kinase in ethylene signaling. 6L
7. Hormone action – molecular mechanism; second messengers (c-AMP, Ca⁺⁺, IP₃), Signal transduction pathway and response. 3L
8. Tutorial classes 15L

Paper: BC – 305 (Hormonal Regulation of Metabolic Processes in Plants and Animals)

Group B (Animals)

(50 marks)

1. An overview of metabolic pathways. Integration of anabolic and catabolic pathways. 2L
2. Mechanism of hormone action – second messengers (IP₃, eicosanoids, Ca-calmodulin, c-AMP). 4L
3. Pancreatic hormones – structure, physiological roles and mechanism of action of Insulin and Glucagon. 7L
4. Thyroid hormone – Thyroxine, structure and permissive action of Thyroxine. 2L
5. Adrenal hormones – sympathoadrenal functions on carbohydrate, fat and protein metabolism. Glucocorticoids structure; physiological roles on intermediary metabolism and permissive actions; mechanism of action. 8L
6. Growth hormone and somatomedin. 3L
7. Sex steroid hormones – Estrogens & Androgens, role in protein and lipoprotein synthesis 3L
8. Endocrinopathies – diabetes mellitus (type I & II), Obesity, Addison's disease (secondary), Cushing's syndrome, Cretinism, Myxedema. 6L
9. Tutorial classes. 15L

Paper: BC – 306 (Gene Expressions & Regulation)

1. Basic principle – m RNA – the language of genes. Condon-amino acid relationship. mRNA formation and processing. Hn RNA, ribozymes (RNA splicing, editing or amplification). Experimental evidence for – COOH end elongation of polypeptide chain. Chaperones in folding protein sorting and trafficking using signal proteins. Zinc fingers, leucine zippers, helix-loop-helix. 20L
2. Gene Expression and Bacteria and Bacteriophages – Features of regulation. Operon – detailed discussion on lac operon, its use in molecular biology and biotechnology. The trp operon. 10L
3. Gene regulation in Eukaryotes – (a) Ecdysone stimulation of gene expression in Drosophila (b) Gene action in the giant chromosomes of Drosophila and the lampbrush chromosomes of amphibian oocytes (c) Brief discussion in dosage compensation of Drosophila (d) Genetic activity of the genes on the x-chromosomes in mammals – Lyon's hypothesis. Facultative and constitutive heterochromatin (Inactivation theories excluded). 18L
4. Manipulation of gene expression – (a) Insertional inactivation in prokaryotes and eukaryotes, (b) Chromosomal integration of exogenous gene (c) Reporter gene in gene therapy and transgenesis (d) Antisense oligonucleotide (d) Concept of RNAi, SiRNA for silencing genes (f) Expression of transgenes. 16L
5. Gene Activity in relation to Health and welfare : (a) Expression of recombinant pharmaceutical genes for human growth hormone insulin factor VIII and tPA. (b) Regulation of expression of genes in vectors for gene therapy (SCID) and vaccine (Hepatitis B) production 6L
6. Tutorial classes 30L

PRACTICAL

(2 papers each carrying 100 marks)

BC- 307 (CELL BIOLOGY, BIOSTATISTICS AND BIOCOMPUTATION)

Cell Biology:

1. Cell fractionation & study of cell organelles under light microscope.
2. Effect of colchicines and gammadaxane on mitosis in *Allium cepa*/*Allium sativum*.
3. Study of meiosis in *Allium cepa* and *Rhoeodiscolor*.
4. Isolation of mitochondria and identification by vital staining.
5. Study of meiosis in Grasshopper testis.
6. Blood film preparation and identification of different types of cells.
7. Blood group analysis and Rh factor determination.
8. Preparation of permanent slides and identification of different stages.
9. Determination of Nucleolus frequency in *Allium SP* by hematoxylin staining.

Biostatics:

1. Solving of the following statistical problems through MS-Excel
2. Mean, Median and Mode.
3. Chi-square test.
4. Standard deviation, Correlation coefficient and Covariance.
5. Normal Distribution and Poisson Distribution.
6. Probability Analysis.
7. 't' test

Bio-computation:

1. Counting short word (nucleotide, dinucleotide, trinucleotide) frequencies of a DNA sequence through website. (concerned site – www.genomatix.de/cgi-bin/tools/tools.pl.)
2. Viewing the 3D structure of a particular protein from PDB.(site [www.rcsb.org / pdb](http://www.rcsb.org/pdb)) .
3. Comparing the amino acid sequence of a protein with the sequences present in protein databases by using BLAST P and demonstration of the significance of different scores in BLAST output.
4. (site – www.expasy.org/sprot/ ----- for downloading protein sequences, www.ncbi.nlm.nih.gov/BLAST ---- for comparison of protein sequences).

BC- 308 (Project Report & Dissertation)

1. Project Report : 25 marks
2. Dissertation : 75 marks

N.B: Project Report should be based on visit to any reputed Biochemistry Laboratory.

Dissertation should be based on review work on some relevant aspect of Biochemistry or Experimental work (Dissertation – 50 marks + Seminar lecture on dissertation – 25 marks). Seminar lecture – internal assessment.

Recommended Books

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| 1. | Molecular Biology – D. Freifelder |
| 2. | Advances in Molecular Genetics – Twymann |
| 3. | Molecular Biology – G. Karp |
| 4. | Biochemistry – Devlin (5 th edn.) |
| 5. | Biochemistry of Physiology – T.C. Moore |
| 6. | Plant Physiology – L. Taiz & E. Zeiger |
| 7. | Aspects of Physiology & Biochemistry – S.S. Purohit (4 volumes) |
| 8. | Introduction of Plant Physiology – W.G. Hopkins |
| 9. | Endocrinology (2000) – M.E. Hadley (5 th edn.) |
| 10. | Comparative Vertebrate Endocrinology (1998) – P.J. Bentley (3 rd edn.) |
| 11. | General Endocrinology (1996) – C.D. Turner and W.B. Saunders. |
| 12. | The Insects – Structure & Function (2000)- R.F. Chapman (4 th Edn.) |
| 13. | Basic and Clinical Endocrinology (1983) – F.S. Greenspan & P.H. Forsham |
| 14. | Williams Text Book of Endocrinology (2002) – Larsen et al (10 th edn.) |
| 15. | Physical Chemistry –S.R. Palit |
| 16. | Biochemistry - Cohn & Stumpf. |
| 17. | Textbook of Medical Physiology – A.C. Guyton & J.E. Hall (10 th Edn.) |
| 18. | Review of Medical Physiology – W.F. Ganong (17 th edn.) |