UNIVERSITY OF KERALA

DRAFT

COURSE STRUCTURE AND SYLLABUS

FOR

Complementary Course in Biochemistry
For
First Degree Programme in Botany and Zoology

UNDER

CHOICE BASED CREDIT AND SEMESTER SYSTEM

Revised Syllabus-2020

[w.e.f. 2020 admissions]

SEMESTER -I

BC1131: Complementary Course-1
Course Title: Biophysical Chemistry

No. of Credits: 2 **No. of Contact Hours: 36**
Hours/week: 2 **(L, T, P, C – 2, 1, 2, 2)**

Objective of the course: To enable students to understand the basic concepts of acid, bases and colloidal systems and its importance in biological system and understanding the principle of different techniques used in the study of Biochemistry.

Course outcome: Student will be able to

- Gain knowledge about the preparation of different types of solutions and buffers
- Identify different types of bonds in biomolecules.
- Explain different biochemical separation techniques.

Course Outline

Module I **(7 hrs)**

Water, Acids, Bases and Buffers

Ions, definition of acids and bases (Bronsted, Lewis,and Arrhenius concept). Dissociation of water,concept of pH and pOH including simple numerical problems. Determination of pH using indicators and pH meter. Dissociation of strong and weak electrolytes. Henderson-Hasselbalch equation and its significance, pKa value, buffers, mechanism of buffer action and buffers in biological system. Simple numerical problems based on Henderson-Hasselbalch equation.

Core Text:

- Essentials of Physical Chemistry by Arun Bahl, and BS Bahl and GD Tuli.S. Chand & Company Ltd.ISBN-81-219-2978-4.
- Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain (2008) Publishers: S. Chand & Co Ltd ISBN: 81-219-2453-7.

Module II **(7 hrs)**

Colloids & Solutions

Distinction between true solutions, colloidal solutions and coarse solutions, properties of colloids, Tyndall effect, lyophilic and lyophobic colloids. Emulsions and emulsifying agents. Applications of colloids. Elementary ideas about surface tension and viscosity. Donnan membrane equilibrium and biological significance.

Methods of expressing concentration- normality, molality, molarity, percentage solution, mole fraction, parts per million and parts per billion. Fundamental principles of diffusion and osmosis: definition of osmotic pressure, relationship of osmotic pressure to gas laws-Vant Hoff's law, general equations for dilute solutions with simple numerical problems. Biological significance of osmosis. Influence of ionization and molecular size on osmotic pressure. Definitions of isotonic, hypotonic and hypertonic solutions.

Core Text:

- Introduction to Biophysics by Pranab Kumar Banerjee (2008) Publishers: S. Chand & Company ltd ISBN: 81-219-3016-2.
- Essentials of Physical Chemistry by Arun Bahl, and BS Bahl and GD Tuli.S. Chand & Company Ltd.ISBN-81-219-2978-4.

Module III **(6 hrs)**

Bio-organic Chemistry

Common functional groups and their significance in biomolecules –OH, -SH, -CHO, -C=O, -COOH, -NH_2.Intra and Intermolecular interactions in biological system: Hydrogen bond, Covalent bond, hydrophobic interaction, disulphide bond, Peptide bonds, glycosidic bond and Phosphodiester linkage.

Core Text:

- Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain (2008) Publishers: S. Chand & Co Ltd ISBN: 81-219-2453-7.

Module IV **(10 hrs)**

Biochemical Separation Methods

Chromatography- Basics of Ion exchange, TLC, gel filtration, paper, affinity, GLC and HPLC. Electrophoresis- Native and SDS PAGE, Isoelectric focusing, two dimensional electrophoresis, flow cytometry. Centrifugation- Principle, Svedberg constant, principle and application of density gradient and ultracentrifugation.

Core Text:

- Practical Biochemistry Principles and Techniques, Keith Wilson and John Walker, 4th edition.ISBN0-521-49849-X-9780521498494.

Module V **(6 hrs)**

Colorimetry & Radioactivity

Beer Lamberts law, Molar extinction coefficient and absorption spectra. Principle and instrumentation of Colorimetry and Spectrophotometry. Radioactive isotopes- half life, important stable isotopes used in biochemical research (^{32}P, ^{125}I, ^{131}I, ^{60}Co, ^{14}C, etc). Biological applications of radioactive isotopes.

Core Text:

- Practical Biochemistry Principles and Techniques, Keith Wilson and John Walker, 4th edition.ISBN0-521-49849-X-9780521498494.

Suggested Reading

- E.S. West**,** W.R. Todd**,** H.S. Mason and J.T. van Bruggen**, A** Text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974
- Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson, Michael M.Cox.Publisher: W. H. Freeman; Fourth Edition (April 23, 2004).Principles of Physical Chemistry (2008) by Puri BR, Sharma LR, Madan S PathaniaVishal Publishing Co, India.
- Practical Biochemistry Principles and Techniques, Keith Wilson and John Walker, 4th edition.

SEMESTER-II

BC 1231: Complementary Course-2
Course Title: Biomolecules

No. of Credits: 2 **No. of Contact Hours: 36**
Hours/week: 2 **(L, T, P, C - 2, 1, 2, 2)**

Objective of the course: To familiarize the students with the building blocks of living matter, the biomolecules, their structure, components, reactions, their derivatives, biological significance and the basic tests to identify them.

Course outcome: Student will be able to

- Classify and characterize different types of biomolecules like carbohydrates, lipids, amino acids, proteins, nucleic acids and hormones.

Course Outline

Module I **(8 hrs)**

Chemistry of Carbohydrates

Classification, isomerism, D and L configuration, epimers, anomers, mutarotation, reactions of carbohydrates (oxidation, reduction, oxidizing property, reducing property, dehydration and osazone formation). Structure and properties of monosaccharide (linear and cyclic structures of glucose, fructose, mannose and galactose), disaccharides (sucrose, lactose, maltose, isomaltose and cellobiose) and polysaccharides (cellulose, starch and glycogen). Glycosaminoglycans-types and functions (structure not required). Colour reactions of carbohydrates.

Core Text:

- Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain (2008) Publishers: S. Chand & Co Ltd ISBN: 81-219-2453-7.

Module II **(8 hrs)**

Chemistry of Lipids

Classification of lipids, biological functions of lipids, classification of fatty acids, physical and chemical properties of fatty acids, saturated and unsaturated fatty acids, essential and non essential fatty acids, important reactions of fatty acids and Acrolein test for glycerol.Definition and significance of the following: saponification number, iodine number, acid value and Reichert-Meissl number. Triglycerides - simple and mixed triglycerides (basic structural representation of both). Steroids- structure of cholesterol & ergosterol and colour reactions of cholesterol. Phospholipids: structure and function of phosphatidic acid, phosphatidyl choline, phosphatidyl ethanolamine, phosphatidyl serine, plasmalogens, and phosphatidyl inositol. Sphingolipids- functions of sphingomyelin, cerebrosides and gangliosides.

Core Text:

- Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain (2008) Publishers: S. Chand & Co Ltd ISBN: 81-219-2453-7.

Module III **(8hrs)**

Chemistry of Amino acids and Proteins

Classification, structure and important reactions of amino acids. Zwitter ion and isoelectric point. Essential and non essential amino acids. Proteins- classification, levels of structural organization of proteins: primary, secondary, tertiary and quaternary structure. Forces stabilizing the structure of

proteins. Determination of N terminal amino acid (Edmans method) and C-terminal amino acid (using $LIBH_4$) -only basic principles of methods employed. Denaturation of proteins, precipitation reactions- salt effect and heavy metal precipitation.Colour reactions of amino acids and proteins. Structure and functions of hemoglobin and functions of plasma proteins.

Core Text:

- Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain (2008) Publishers: S. Chand & Co Ltd ISBN: 81-219-2453-7.

Module IV **(8hrs)**

Chemistry of Nucleic Acids

Types of nucleic acids, nitrogenous bases, nucleosides, nucleotides, structure of adenine, guanine, cytosine, uracil and thymine. cAMP, cGMP, ATP and GTP. Types of RNA (basics only). Primary and secondary structure of DNA- Watson and Crick model, Chargaff's rule, types of DNA. Comparison between RNA and DNA.

Core Text:

- Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain (2008) Publishers: S. Chand & Co Ltd ISBN: 81-219-2453-7.

Module V **(4hrs)**

Chemistry of Hormones

General classification of hormones. Site of biosynthesis, chemical structure and function of the following hormones: Estrogens, Testosterone, Aldosterone, Cortisone, Cortisol, Corticosterone, Progesterone, T3, T4, Adrenalin, Noradrenalin, Insulin, Glucagon, TSH, ACTH, GTH, SH, MSH, Oxytocin, Vasopressin, PTH, Gastrin, Secretin (structures of peptide hormones not required). Second messengers, Mechanism of action of hormones (basics only).

Core Text:

- Text Book of Biochemistry, 5^{th} edition by DM Vasudevan and Sreekumar S, JAYPEE Publishers, New Delhi, ISBN81-8448-124-1, 9788184481242.

Suggested Readings:

- Lehninger Principles of Biochemistry, 4^{th} Edition by David L. Nelson Publisher: W. H. Freeman; Fourth Edition.
- E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen, A Text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974.
- Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc
- Principles Of Biochemistry (1995) by Geoffrey L Zubay, William W Parson, Dennis E Vance Publisher: McGraw-Hill Book Company – Koga
- Principles Of Biochemistry, 4/e (2006) by Robert Horton H , Laurence A Moran, Gray Scrimgeour K Publisher: Pearsarson
- Biochemistry (2008) by RastogiPublisher:McGraw Hill

SEMESTER-III

BC 1331: Complementary Course-3
Course Title: Enzymes and Bioenergetics

No. of Credits: 2 **No. of Contact Hours: 54**
Hours/week: 3 **(L, T, P, C – 3, 1, 2, 2)**

Objective of the course: To introduce the students with the basics of enzymology, such as classification, types of inhibition, regulation, coenzymes and an introduction to bioenergetics.

Course outcome: Student will be able to

- Classify enzymes and describe the factors affecting an enzyme catalyzed reaction
- Describe different types of enzyme inhibition.
- Elaborate on the role of vitamins in human nutrition.
- Elicit different pathways and mechanism of energy production in carbohydrate metabolism.

Course Outline

Module I **(14hrs)**

Enzymes

Classification of enzymes. Activation energy, holoenzyme, apoenzyme, prosthetic group, active site, features of active site. Enzyme units- IU, Katal, specific activity and turnover number. Elementary study on the different factors affecting enzyme catalyzed reaction- concentration of enzyme, concentration of substrate, temperature and pH. Michaelis-Menton equation-significance of km. Lineweaver-Burk plot. Enzyme specificity (different types). Types of enzyme inhibition-competitive, non-competitive and uncompetitive. Double reciprocal plots of each type of inhibition. Feedback inhibition, brief study of allosteric regulation with ATCase as example. Isoenzymes and clinical application (basics only). Marker enzymes, Zymogens and their activation.

Core Text:

- Principles of Biochemistry, by Albert Lehninger, David L Nelson, Michael M Cox, CBS Publishers & Distributors Delhi ISBN 81-239-0295-6.

Module II **(12hrs)**

Vitamins and Coenzymes

Classification and types of vitamins. Basic physiological functions of vitamin A, D, E and K and water soluble vitamins C, B1, B2, Pyridoxine, Nicotinic acid, B12 and Folic acid. (Structure not required). Coenzyme forms of the above vitamins with example of reactions.

Core Text:

- Text Book of Biochemistry, 5th edition by DM Vasudevan and Sreekumari S, JAYPEE Publishers, New Delhi.

Module III **(14 hrs)**

Bioenergetics

Redox reactions, redox potential and free energy, structure of mitochondria, mitochondrial electron transport chain, coenzymes and prosthetic groups of respiratory chain enzymes- sites of ATP production, P/O ratio, inhibitors of electron transport chain, oxidative phosphorylation-chemiosmostic

hypothesis (outlines only), uncouplers of oxidative phosphorylation. Formation of ATP- oxidative and substrate level phosphorylation. Role of high energy compounds with structures (ATP, ADP, Creatine phosphate, 1, 3-bis Phosphoglycerate and PEP).

Core Text:

- Principles of Biochemistry, by Albert Lehninger, David L Nelson, Michael M Cox, CBS Publishers & Distributors Delhi ISBN 81-239-0295-6.

Module IV (14 hrs)

Photosynthesis

Outlines of cyclic and non-cyclic photophosphorylation, photosystems I and II, Path of carbon in dark reaction-Calvin cycle, photorespiration and C_4 pathway, nitrogen cycle, nitrogen fixation-nitrogenase complex, nitrogen assimilation -role of glutamate dehydrogenase and synthetase (outline study only).

Core Text:

- Lehninger Principles of Biochemistry, 4th Edition by David L. Nelson Michael M. Cox Publisher: W. H. Freeman; Fourth Edition, ISBN-10: 0716743396.

Suggested Reading

- Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins by Nicholas C. Price, Lewis Stevens, and Lewis Stevens (2000) Publisher:Oxford University Press, USA ISBN:019850229X ISBN-13: 9780198502296, 978-0198502296
- Enzyme Mechanism by P.K. Shivraj Kumar (2007) Publisher:RBSA Publishers ISBN:8176114235 ISBN-13: 9788176114233, 978-8176114233
- Enzymes: Biochemistry, Biotechnology, Clinical Chemistry (second Edition) by Trevor Palmer, Philip Bonner (2007) Publisher:Horwood Publishing LimitedISBN:1904275273 ISBN-13:9781904275275, 978-1904275275.
- Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500.
- Plant Biochemistry by Hans-Walter Heldt Professor Em (3ed 2004) Publisher: Academic ISBN-10: 0120883910 ISBN-13: 978-0120883912
- Principles Of Biochemistry (1995) by Geoffrey L Zubay, William W Parson, Dennis E Vance Publisher: McGraw-Hill Book Company – Koga ISBN:0697142752 ISBN-13: 9780697142757, 978-0697142757

SEMESTER-IV

BC 1431: Complementary Course-4
Course Title: Intermediary Metabolism

No. of Credits: 3 **No. of Contact Hours: 54**
Hours/week: 3 **(L, T, P, C – 3, 1, 2, 3)**

Objective of the course: The course aims at providing an overview of energy production by explaining the general principles of cellular energy metabolism and schematizing the different metabolic pathways.

Course outcome: Student will be able to

- Describe digestion and absorption of carbohydrates, lipids and proteins.
- Elaborate the reactions & regulations involved in carbohydrate, lipid & amino acid metabolism.
- Explain the genetic aspects of metabolism.

Course Outline

Module I **(15hrs)**

Metabolism of Carbohydrates

Digestion and absorption of carbohydrates (outline study only). Glycolysis- reaction pathway, fate of pyruvate, regulation of glycolysis,Gluconeogenesis-reaction pathway, reciprocal regulation of gluconeogenesis and glycolysis. Cori cycle. Pentose Phosphate Pathway- reaction pathway, biological significance, regulation of pathway, Glycogen metabolism-glycogenesis, glycogenolysis, control of glycogen metabolism-allosteric and hormonal regulation. TCA Cycle (Only pathway outlines with enzymes and coenzymes involved without structure of intermediates).

Core Text:

- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.
- Text Book of Biochemistry, 5 th edition by DM Vasudevan and Sreekumar S, Jaypee Publishers, New Delhi, ISBN81-8448-124-1, 9788184481242.

Module II **(15hrs)**

Metabolism of Lipids

Digestion and absorption of lipids (outline study). Scheme oβ-oxidation, ATP yield inβ-oxidation (Stearate & Palmitate as examples) and regulation. Basics of ω- and α-oxidation. Ketone body formation. Cytoplasmic system of fatty acid biosynthesis and regulation of the pathway. Essential fatty acids. Synthesis of Triacylglycerols. Biosynthesis of cholesterol and bile acids. Physiological functions of phospholipids (Structure of intermediates of metabolic pathway not required).

Core Text:

- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.
- Text Book of Biochemistry, 5 th edition by DM Vasudevan and Sreekumar S, Jaypee Publishers, New Delhi, ISBN81-8448-124-1, 9788184481242.

Module III **(9 hrs)**

Metabolism of Amino acids and Proteins

Digestion of proteins and absorption of amino acids-role of glutathione cycle. Activation of zymogen forms of proteolytic enzymes of GI tract. Reactions involved in the metabolism of amino acids- deamination, transamination and decarboxylation- coenzymes involved in these reactions. Urea cycle.

Core Text:

- Lehninger Principles of Biochemistry, 4th Edition by David L. Nelson, Michael Cox, CBS publishers ISBN 81-239-0295-6.
- Text Book of Biochemistry, 5 th edition by DM Vasudevan and Sreekumar S, Jaypee Publishers, New Delhi, ISBN81-8448-124-1, 9788184481242.

Module IV **(15hrs)**

Genetic aspects of Metabolism

DNA structure-nucleosomes, 30nm fibers and radial loops. Prokaryotic DNA replication: DNA polymerases, replication forks, Okazaki fragments and accessory proteins. Brief study of structure and types of RNA and their functions. Prokaryotic transcription process: initiation, elongation and termination (brief study). Genetic code-properties of genetic code. Protein biosynthesis in prokaryotes-synthesis of aminoacyl tRNA, initiation-Shine Dalgarno sequence, elongation-aminoacyl tRNA binding, peptide bond formation, translocation followed by termination.

Core Text:

- Text Book of Biochemistry, 5 th edition by DM Vasudevan and Sreekumar S, Jaypee Publishers, New Delhi, ISBN81-8448-124-1, 9788184481242.

Suggested Readings:

- Lehninger Principles of Biochemistry, 4th Edition by David L. Nelson, Michael Cox, CBS publishers ISBN 81-239-0295-6.
- E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen, A Text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974
- Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500
- Principles Of Biochemistry (1995) by Geoffrey L Zubay, William W Parson, Dennis E Vance Publisher: McGraw-Hill Book Company – Koga ISBN:0697142752 ISBN-13: 9780697142757, 978-0697142757
- Principles Of Biochemistry, 4/e (2006) by Robert Horton H , Laurence A Moran, Gray Scrimgeour K Publisher: PearsarsonISBN: 0131977369, ISBN-13:9780131977365, 978-0131977365
- Biochemistry (2008) by RastogiPublisher:McGraw Hill ISBN**:**0070527954 ISBN-13**:** 9780070527959**,** 978-0070527959

Semester-I

Complementary Practical-I

Hours/week: 2No. of Contact Hours: 36

- Weighing in Chemical balance
- Preparation of solutions
  -percentage, molar & normal solutions, dilution from stock solution etc.
- Demonstration of dialysis
- Demonstration of PAGE
- Demonstration of Paper Chromatography
- Demonstration of Thin Layer Chromatography
- Colorimetry and Spectrophotometry techniques
- Verification of Beer Lambert's law
- Verification of molar extinction coefficient of any known compound

References

- Hawk's Physiological Chemistry, Bernard L. Oser (ed) TATA McGraw Hill Publishing Company LTD, New Delhi p 10- 15.
- Experimental Biochemistry: A Student Companion, BeeduSasidhar Rao & Vijay Deshpande, I.K International Pvt. LTD, New Delhi, ISBN 81-88237-41-8, p 13- 17, p 39 – 43.
- Introductory Practical biochemistry, S. K. Sawhney&Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9, p 1- 15, 195-303.

Semester-II

Complementary Practical -II

Hours/week: 2 **No. of Contact Hours: 36**

1. Isolation of starch from potato
2. Estimation of glucose by titration method
3. Estimation of Saponification value of oil
4. Test for amylase in saliva
5. Test for mucin and calcium in saliva

References

- Hawk's Physiological Chemistry, Bernard L. Oser (ed) TATA McGraw Hill Publishing Company LTD, New Delhi p 10- 15.
- Experimental Biochemistry: A Student Companion, BeeduSasidhar Rao & Vijay Deshpande, I.K International Pvt. LTD, New Delhi, ISBN 81-88237-41-8, p 13- 17, p 39 – 43.

- Introductory Practical biochemistry, S. K. Sawhney&Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9, p 1- 15, 195-303.

Semester-III

Complementary Practical-III

Hours/week: 2 **No. of Contact Hours: 36**

Experiments are to be conducted individually

Qualitative Analysis of Biomolecules

1. General Reactions of biomolecules
2. Qualitative analysis of reducing sugars
3. Qualitative analysis of starch
3. Qualitative analysis of aminoacids
4. Qualitative analysis of proteins
5. Qualitative analysis of lipids

- **Reducing sugars**:-

  Solubility, Molisch's test, Fehling's test, Barfoed's test, Benedicts test, Picric acid test,Bial's test, Seliwanoff's test and Osazone test. (Glucose, Fructose, and Xylose).
- **Starch**:-

  Molisch's s test, Iodine test, hydrolysis of starch and precipitation reactions with alcohol.
- **Aminoacids:**-

  Solubility, Ninhydrin test, Xanthoproteic test, Millon's test, Morners test, Glyoxalic acid test, Ehrlich's test, Nitroprusside test, Lead acetate test, Test for Methionine, Aldehyde test, Sakaguchi reaction and Isatin test.(Any **three** amino acids- should include an aromatic amino acid and a sulphur containing amino acid).
- **Proteins:**-

  Solubility, Xanthoproteic test, Folin's test, Biuret test, Sulphosalicylic acid test, Heat denaturation, TCA precipitation, Hellar's-nitric acid test, Metal precipitation and ,Alcohol precipitation.
- **Lipids:-**

  Fatty acids: Stearic acid /Oleic acid: Solubility, Translucent spot tests, Test for Unsaturation
  Glycerol: Solubility, Acrolein Test, Borax fusion test.
  *Cholesterol:*Solubility, Salkowski reaction, Liebermann-Burchard reaction, Zaks test.

References

- Experimental Biochemistry: A Student Companion, BeeduSasidhar Rao & Vijay Deshpande (ed), I.K International Pvt. LTD, New Delhi ISBN 81-88237-41-8.

- Introductory Practical biochemistry, S. K. Sawhney&Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9.
- Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana ISBN 81-7663-067-5.
- ES West, WR Todd, HS Mason and JT van Bruggen. A text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi.

Semester-IV

BC-1432-Complementary Practical-IV

No. of Credits: 4 **No. of Contact Hours: 36**
Hours/week: 2

***Experiments are to be conducted individually**

Quantitative Analysis of Biomolecules
(Minimum of **nine** experiments to be done)

1. Estimation of Glucose by Nelson-Somogyi method
2. Estimation of Glucose by Anthrone method.
3. Estimation of Fructose by Roe-Papadopoulos method
4. Estimation of Xylose by Orcinol Method
5. Estimation of Protein by Folin-Lowry method
6. Estimation of Protein by Biuret method
7. Estimation of Tyrosine by Folin-Denis method
8. Estimation of Cholesterol by Zak's method
9. Estimation of DNA by Diphenylamine method
10. Estimation of RNA by Orcinol method

References

- Experimental Biochemistry: A Student Companion, BeeduSasidhar Rao & Vijay Deshpande (ed), I.K International Pvt. LTD, New Delhi ISBN 81-88237-41-8.
- Introductory Practical biochemistry, S. K. Sawhney&Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9.
- Standard Methods of Biochemical Analysis, S. K. Thimmaiah (Ed), Kalyani Publishers, Ludhiana ISBN 81-7663-067-5.
- Hawks Physiological Chemistry, Bernard L.Oser (ed).TATA McGRAW Hill Publishing Company LTD, New Delhi.

Scheme of Evaluation

Theory & Practical

- Continuous Internal Assessment -20 marks
- End Semester Assessment – 80 marks
  Total -100 marks

Scheme of Evaluation for Practical

BC1432- Complementary Practical - IV

Time: 3 hoursMax. Marks: 80
Experiment: Qualitative and Quantitative Analysis of Biomolecules (Carbohydrates/ Lipids / Proteins / Amino acids)

Components

1. **Major Experiment (Quantitative Analysis) - 40 marks**

   Principle and Procedure – 5 marks (2 + 3)
   Tabular column- 2 ½ marks
   Calculation- 2 ½ marks
   Final Result – 30 marks
   Error
   0- 5 % – 30 marks
   6 – 10 % - deduct one mark each
   11- 13% - deduct 2 marks each
   13- 15% - deduct 3 marks each
   >15%- grace mark

2. **Minor Experiment (Qualitative Analysis of Biomolecules) – 25 marks**
   Identification of specific biomolecule with general, positive, negative and confirmatory tests.

3. **Record – 15 marks**
   - Qualitative analysis - Minimum of 9 (nine) qualitative experiments to be done. Deduct 1 mark each for lesser number of experiments.
   - Quantitative analysis - Minimum of 9 (nine) quantitative experiments to be done. Deduct 1 mark each for lesser number of experiments.
   - Neatness – 3 marks.

Model Question Paper
BC1131: Complementary Course-1
Biophysical Chemistry

Time: 3 hours **Maximum marks: 80**

Section-A
(Very Short Answer Type- maximum two sentences -Answer **all** questions)

1. Give any two differences between true solution and a colloid.
2. Mention the use of SDS in electrophoresis.
3. State Beer-Lambert's law.
4. Give a biological application of ^{32}P isotope
5. Define molar extinction coefficient.
6. Mention about the function of a monochromator.
7. List the two types of ion exchangers with an example.
8. How will you prepare a 1N solution of an acid?
9. State Vant Hoff's law of osmotic pressure
10. Differentiate between osmosis and diffusion

(10x1=10 marks)

Section-B
(Short Answer Questions-not to exceed one paragraph-Answer any **eight** questions**)**

11. Illustrate the formation of a peptide bond.
12. Discuss about TLC and thin layer materials.
13. Define osmotic pressure and reverse osmosis.
14. How are emulsions classified? Give examples.
15. Write note on pH scale.
16. A solution contains 8g NaOH/100ml. Calculate the molarity of the solution.
17. Illustrate Phosphodiester linkage and mention its significance.
18. Explain buffer capacity
19. Discuss about ion product of water.
20. List out the biological applications of osmosis.
21. Give an account of flow cytometry.
22. Discuss about density gradient centrifugation

(8 x 2 = 16 marks)

Section-C
(Short Essay-not to exceed 120 words- Answer any **six** questions**)**

23. Describe the working of a pH meter.
24. Derive Henderson Hasselbalch equation. List out its applications.
25. Describe the principle and instrumentation of Spectrophotometer
26. Discuss about a technique for separating DNA fragments.
27. List the differences between lyophobic and lyophilic colloid.

28. Discuss about the types of isomerism exhibited by biomolecules.
29. Comment on the molecular interactions in protein.
30. Discuss about surface tension and its biological importance.
31. A buffer solution contains 0.015M of acetic acid and 0.025M of sodium acetate. Calculate the pH of the solution. Dissociation constant (Ka) of acetic acid is 1.80×10^{-5}.

(6 x 4 = 24 marks)

Section-D

(Long Essay-Answer any **two** questions)

32. Explain process of separation of proteins based on molecular weight.
33. Explain Donnan Membrane equilibrium and its biological significance.
34. Discuss the principal and applications of different types of centrifugation techniques.
35. Give a detailed account of the biological applications of radioactive isotopes.

(15 x 2 =30 marks)

Model Question Paper
BC 1231: Complementary Course-2
Biomolecules

Time: 3 hours **Maximum marks: 80**

Section-A

(Very Short Answer Type- maximum two sentences -Answer **all** questions)

1. Write the significance of iodine number and acid number.
2. Give a test to identify glycerol.
3. Write the structure of two aromatic amino acids.
4. Define a holoenzyme and write its components.
5. Mention the role of tRNA in protein synthesis.
6. How are anomers formed?
7. State Chargaff's rule.
8. Define amphipathic nature of lipids.
9. Why are certain fatty acids considered as essential? Give two examples
10. Define Vmax

(10x1=10 marks)

Section-B

(Short Answer Questions-not to exceed one paragraph-Answer any **eight** questions**)**

11. Write a note on sphingolipids
12. Represent a glycosidic bond
13. Differentiate between reducing and non-reducing sugar
14. Give the structure of two second messengers
15. Write a note on collagen triple helix
16. Give function of two hormones involved in carbohydrate metabolism
17. Define zwitter ions. Give one example
18. Comment on glycosaminoglycans.
19. Give the principle of a general test for identifying carbohydrates.
20. List out the essential amino acids. Why are they considered essential?
21. Define saponification number and its significance
22. Distinguish between fibrous proteins and globular proteins with examples.

(8 x 2 = 16 marks)

Section-C

(Short Essay-not to exceed 120 words- Answer any **six** questions**)**

23. Discuss about precipitation reactions of proteins
24. Detail the types of DNA.
25. Give a brief account of phospholipids.
26. Illustrate the DNA double helical structure.
27. Give the structure and functions of the following: ATP and GTP
28. Discuss about the acid base properties of amino acids
29. Describe the classification of amino acids
30. Compare and contrast between cerebroside and ganglioside.
31. Explain the alpha helical and beta pleated sheet structure of proteins

(6 x 4 = 24 marks)

Section-D

(Long Essay- Answer any **two** questions)

32. Discuss the structural organization of proteins
33. Describe about the classification and functions of steroid hormones
34. Classify lipids. Explain each class with examples, structures and important functions
35. Illustrate the structure and function of different types of RNAs.

(15 x 2 =30 marks)

Model Question Paper
BC 1331: Complementary Course-3
Enzymes and Bioenergetics

Time: 3 hours **Maximum marks: 80**

Section-A

(Very Short Answer Type- maximum two sentences -Answer **all** questions)

1. Define photophosphorylation.
2. Which are the organelles involved in photorespiration.
3. Write about the deficiency disease of Vit C
4. Defineturnover number of an enzyme.
5. Define optimum temperature and optimum pH for an enzyme reaction.
6. Give the name of coenzymes involved in dehydrogenation reactions.
7. Give the function of creatine phosphate.
8. Mention the cause of hypervitaminosis.
9. Mention the role of cyanide in relation to ETC.
10. Define redox potential and free energy.

(10x1=10 marks)

Section-B

(Short Answer Questions-not to exceed one paragraph-Answer any **eight** questions**)**

11. Write a short note on the features of Km value.
12. Explain L-B plot.
13. Write about the role of a vitamin involved in DNA synthesis.
14. Write about the major enzyme involved in fixation of carbon.

15. Name two uncoupling agents of electron transport chain. How do they act?
16. Define P/O ratio. Mention its significance in respiration?
17. Give the functions and sources of vitamin E.
18. Give the structure of ATP.
19. Discuss about ATP synthase.
20. Give the coenzyme forms of Vitamin B1, B2 and B6.
21. Define specific activity of an enzyme.
22. Discuss about the various respiratory chain inhibitors.

(8 x 2 = 16 marks)

Section-C

(Short Essay-not to exceed 120 words- Answer any **six** questions**)**

23.Write about enzyme specificity
24.Give a brief account of allosteric regulation of enzymes.
25.Write a note on the significance of $\Delta G^{0'}$ value
26.List out the deficiency diseases of Vit A.
27.Differentiate substrate level phosphorylation and oxidative phosphorylation
28.Explain cyclic photophosphorylation.
29.Describe chemiosmostic hypothesis
30.Detail the factors affecting enzyme activity.
31.Explain clinical applications of isoenzymes of lactate dehydrogenase.

(6 x 4 = 24 marks)

Section-D

(Long Essay- Answer any **two** questions)

32.Explain Calvin cycle
33. Give a detailed account on mitochondrial electron transport chain.
34. Illustrate enzyme inhibitions with suitable examples.
35.Discuss in detail the biochemical functions of Vitamin D and Vitamin C.

(15 x 2 =30 marks)

Model Question Paper
BC 1431: Complementary Course-4
Intermediary Metabolism

Time: 3 hours **Maximum marks: 80**

Section-A

(Very Short Answer Type- maximum two sentences -Answer **all** questions)

1. Write down the rate limiting steps of glycolysis.
2. How is limit dextrin formed?
3. Name two essential fatty acids.
4. Write about Wobble hypothesis.
5. Where do you find codon and anticodon?
6. Name the site at which the following occurs: Gluconeogenesis, β oxidation.
7. Mention the role of Glycogenin in glycogenesis
8. Name primary and secondary bile acids.
9. Write the significance of omega oxidation.

10. Why are Okazaki fragments formed?

(10x1=10 marks)

Section-B

(Short Answer Questions-not to exceed one paragraph-Answer any **eight** questions**)**

11. List out the key enzymes of gluconeogenesis.
12. Give two functions of phospholipids.
13. Write about the role of lactate dehydrogenase in carbohydrate metabolism.
14. Explain transamination reaction. Give two examples.
15. Comment on Shine-Dalgarno sequence and anti-Shine Dalgarno sequence.
16. Write note on ribosomes.
17. Mention the action of endopeptidases with two examples.
18. Give an account of codon-anticodon recognition.
19. Define genetic code. Discuss its salient features.
20. With regard to transcription, what are the roles of the promoter, terminator & regulatory sequences?
21. How bile acids are formed?
22. Write down the structural organization of a nucleosome.

(8 x 2 = 16 marks)

Section-C

(Short Essay-not to exceed 120 words- Answer any **six** questions**)**

23. Write down the significance of deamination reaction in the breakdown of amino acids.
24. Describe Cori's cycle and its significance.
25. How is ammonia detoxified in the body?
26. Discuss about the digestion and absorption of lipids.
27. Explain the digestion and absorption of carbohydrates
28. Compare and contrast α and ω oxidations
29. Sketch the structure of tRNA and mention its role
30. Detail the role of glutathione cycle in amino acid metabolism.
31. List out the ketone bodies. How are they formed?

(6 x 4 = 24 marks)

Section-D

(Long Essay- Answer any **two** questions)

32. Why Glycolysis and gluconeogenesis are often described as"two sides of the same coin". Illustrate this statement by describing the reactions of each pathway and discussing theirregulation.
33. Describe in detail the process of prokaryotic transcription.
34. Illustrate scheme of β-oxidation and ATP yield of one mole of stearic acid.
35. Give an account of the reactions of HMP shunt pathway.

(15 x 2 =30 marks)