UNIVERSITY OF KERALA

DRAFT

COURSE STRUCTURE AND SYLLABUS

For

FIRST DEGREE PROGRAMME IN BIOCHEMISTRY

Under

CHOICE BASED CREDIT & SEMESTER SYSTEM

Revised Syllabus-2020

(w. e. f 2020 admissions)

OBJECTIVES OF THE PROGRAMME

- To impart knowledge of Science as the basic objective of education.
- To develop scientific attitude is the major objective to make the students open minded, critical, curious.
- To develop skill in practical work, experiments and laboratory material and equipments along with the collection and interpretation of scientific data to contribute the science.
- To understand scientific terms, concepts, facts, phenomenon and their relationships.
- To provide practical experience to the students as a part of course to develop scientific ability to work in the field of research and other fields of their own interest and to make them fit for society.
- To create the interest of the society in the subject and scientific hobbies, exhibitions and other similar activities.
- To enrich the students with the latest development in the field of biochemistry, biotechnology and other related field of research and development.
- To keep the scientific temper which the students acquire from school level and to develop research culture.
- To encourage students to describe and analyze scientific data.

Syllabus for First Degree Programme in Biochemistry under CBCS System

Semester	Course Title	L	T	P	C	TC
First semester	**EN 1111**-Lang. Course I (English I)	5	-	-	4	17
	1111 - Language Course II (Addl. Lang. I)	4	-	-	3	
	1121 - Foundation Course I	4	-	-	2	
	BC 1141: Perspectives, Methodology & Biomolecules-I (Core-I)	**2**	**1**	**-**	**4**	
	BC 1141: Practical for BC 1141	**-**	**-**	**2**	**-**	
	1131 - First complementary course- 1	2	-	2	2	
	1131 - Second complementary course- 1	2	-	2	2	
Second semester	**EN 1211-** Lang. Course III(English II)	5	-	-	4	17
	1212 - Lang. Course IV(English III)	4	-	-	3	
	1211 - Lang. Course V (Addl. Lang. II)	4	-	-	3	
	BC 1221:Foundation Course II : Biomolecules-II & Bioinformatics	**2**	**1**	**-**	**3**	
	BC 1221: Practical for BC1221	**-**	**-**	**2**	**-**	
	1231 - First complementary course- II	2	-	2	2	
	1231 - Second complementary course- II	2	-	2	2	
Third semester	**EN 1311 -** Lang. Course VI (English IV)	5	-	-	4	17
	1311 -Lang. Course VII (Addl. Lang. III)	5	-	-	4	
	BC 1341:Cellular Biochemistry (Core-II)	**3**	**1**	**-**	**3**	
	BC 1341: Practical for BC1341	**-**	**-**	**2**	**-**	
	1331 - First complementary course- III	3	-	2	3	
	1331 - Second complementary course- III	3	-	2	3	
Fourth semester	**EN 1411 -** Lang. Course VIII (English V)	5	-	-	4	27
	1411 -Lang. Course IX (Addl. Lang. IV)	5	-	-	4	
	BC 1441: Techniques in Biochemistry (Core-III)	**3**	**1**	**-**	**3**	
	BC 1442: Qualitative Analysis of Biomolecules- Practical (Core-IV)	**-**	**-**	**2**	**2**	
	1431 - First complementary course- IV	3	-	-	3	
	1432 - First complementary practical-IV	-	-	2	4	
	1431 - Second complementary course- IV	3	-	-	3	
	1432 - Second complementary practical-IV	-	-	2	4	
Fifth semester	**BC 1541: Physiology & Immunology (Core-V)**	**4**	**1**	**-**	**4**	20
	BC 1542: Bioenergetics & Carbohydrate Metabolism-I (Core-VI)	**3**	**1**	**-**	**3**	
	BC 1543: Food Science (Core-VII)	**3**	**1**	**-**	**3**	
	BC 1544: Classical & Molecular Genetics (Core-VIII)	**4**	**1**	**-**	**4**	
	BC 1545: Quantitative Analysis of Biomolecules-Practical (Core-IX)	**-**	**-**	**6**	**4**	
	Choice Based Open Course *	3	-	-	2	
	Project Work	-	1	2	-	
Sixth semester	**BC 1641: Clinical Biochemistry (Core-X)**	**4**	**1**	**-**	**4**	22
	BC 1642: Metabolism –II (Core- XI)	**4**	**1**	**-**	**4**	
	BC 1643: Clinical Biochemistry & Enzymology- Practical (Core-XII)	**-**	**-**	**6**	**4**	
	BC 1644: Food Analysis- Practical (Core-XIII)	**-**	**-**	**5**	**4**	
	Elective Course**	**3**	**1**	**-**	**2**	
	BC 1646: Project Work	**-**	**-**	**3**	**4**	

Total credits: 120

L-Lecture, T- Tutorial, P- Practical, C- Credit, TC-Total Credit
(Tutorial hours are outside the regular working hours)

***Choice based Open Course offered to students of other Departments (5th Semester)**

1. BC 15 51.1: Clinical Diagnosis of Common Diseases 2 credits.
2. BC 1551.2 : Life style Diseases 2 credits

**** Elective Course offered to students of Biochemistry Department (6th Semester)**

1. BC 1661.1: Analytical Biochemistry 2 credits
2. BC 1661.2 : Immunology & Immunological Technique 2 credits

Total number of courses

Core course– 13 (9 – theory, 4 –practicals)
Foundation course (core related)-1
Foundation course -1
Open course-1
Elective course -1
English -5
Additional Language – 4
Complementary courses -10

Credits

Core Courses-Theory- 32 credits
Core Practicals – 16 credits
Foundation course (core related) - 3 credits
Open course- 2 credits
Elective course- 2 credits
Project work - 4 credits
English -19 credits
Additional language-14 credits
Complementary courses -28 credits

Total credits for the Programme = 120

Scheme of Evaluation

Theory & Practical

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

Total -100 marks

Scheme of Evaluation for Practicals

BC1442: Core Course-IV - Practical

Course Title: ***Qualitative Analysis of Biomolecules***
Time: 3 hours Max. Marks: 80
Experiment: Qualitative analysis of bio molecules (Carbohydrates/ Lipids / Proteins / Amino acids)

Components

1. **Qualitative Analysis (45 marks)**
   Preliminary experiment to identify the type of bio molecule (15 marks).
   Identification of specific biomolecule with general, positive, negative & confirmatory tests (30 marks).
2. **Record (25 marks)**

Scheme of analysis	-	4 marks
A minimum of 15 samples should be analyzed qualitatively (Lesser number of samples – deduct 1 mark for each)	-	10 marks
Other Experiments – 5 Nos. (Lesser number of experiments – deduct ½ mark for each)	-	5 marks
Neatness and legibility (Maximum 5 marks to be given)	-	6 marks

3. **Viva (10 marks) -**Questions based on S-4 practicals only

BC 1545: Core Course-IX - Practical

Course Title: ***Quantitative Analysis of Biomolecules***
Time: 3 hours Max. Marks: 80
Experiment: Quantitative analysis of biomolecules (Carbohydrates/ Lipids / Proteins / Amino acids)

Components

1. **Quantitative Analysis (50 marks)**
   Principle and procedure writing (7 marks)
   Tabular column (7 marks)
   Graph (7 marks)
   Calculation (7 marks)
   Final result (22 marks)
   Error Up to 5% - Full marks

6-12%	-	Minus one mark each
13-15%	-	Minus two marks each
> 15%	-	Grace Mark (9)

2. **Record (20 marks)**
   Minimum 12 number of experiments to be done - 15 Marks
   (Lesser experiments – Deduct one mark each)
   Neatness & Legibility - 5 Marks
3. **Viva (10 marks)**
   (Based on practical experiments)

BC 1643: Core Course-XII- Practical

Course Title: ***Clinical Biochemistry and Enzymology***
Time: 3hours Max. Marks: 80
Experiment: Quantitative estimation of biomolecules in blood/serum, Hematology/Urine analysis.*

Components

1. **Quantitative Analysis (40 marks)**
   Principle and procedure writing - 5
   Tabular column - 5
   Graph - 5
   Calculation - 5
   Final result - 20
   (Error up to 5 % - full marks, 5 -11% - minus 1 mark each, > 11% - Grace Mark: 8)
2. **Hematology Experiments* (10 marks)**
   Principle & procedure writing - 5
   Experiment result - 5 (Error up to 5% - full marks, 5-10% - minus ½)
3. **Urine Analysis* (10 marks)**
4. **Record (20 Marks)**
   Minimum number of experiments required: Quantitative analysis – 8 nos. , Hematology – 4 nos., Clinical enzymology – 2 nos., Urine analysis- 5 nos. **16 marks**, Neatness & legibility – **4 marks**)
5. **Viva (Based on practical experiments only - Max. Marks - 10)**

*[*For practical exam the student should be given either urine analysis or hematology and not both.]*

BC 1644: Core Course-XIII- Practical

Course Title: ***Food Analysis***
Time: 3hours Max marks: 80
Experiment: Quantitative analysis of biomolecule and detection of adulterants in the given food sample

Components

1. **Quantitative Analysis (30 marks)**
   Principle and procedure writing - 4
   Tabular column - 4
   Graph - 4
   Calculation - 4
   Final result - 14
   (Error up to 5 % - full marks, 5 -11% - minus 1 mark each, > 11% - Grace Mark: 8)

2. **Qualitative analysis of adulterants in the given food sample (20 marks)**
3. **Record (20 marks)**

(Minimum number of experiments required: Quantitative analysis of food – 6 nos., detection of adulterant - 8 nos. – 16 marks, Neatness & legibility – 4 marks.

4. Viva (Based on practical experiments only – 10 marks)

BC 1646: Project Work

Max. Marks: 100 (Institute visit***** & Project – 80 marks; Viva -20 marks)
Institutional visit/Study tour: 30 marks (10 – 15 Pages)
Project: 50 marks (20 – 30 Pages)

Components	Marks	Requirements
Institutional Visit/Study Tour	**30**	1. Visit-15 marks 2. Visit Report-15 marks
Project	**50**	
a) Dissertation	25	1. Objective & scope of study 2. Methodology-appropriateness & accuracy 3. Results & Discussion 4. Summary/Conclusion & References
b) Research/Lab Work	25	1. Originality of approach 2. Relevance of topic 3. Presentation of results (Tables/Graphs/ Figures) 4. Significance of finding
Viva-Voce	**20**	1. Understanding of project objective 2. Background knowledge of project 3. Correct & Clear answers 4. Knowledge of basics in Biochemistry 5. Awareness about the visited institutes.

PROJECT

Components required: - (a) Institutional visit (compulsory)* + report
(b) Project work (lab work)
(c) Report of the project work done
(d) Viva voce of the work

* For the institutional visit and study tour, a maximum of **7-10** days can be availed.

Suggested topics for the conduct of the project

The project work can be done either in the college or in any other institutes / lab. The following type of project works or any other can be given as per the laboratory facilities available.

1. Food analysis – Carbohydrate content
   Protein content
   Lipid content
   Analysis of Vitamin C (In fruits – comparison)
   Ca^{2+} content (milk, potato, cabbage etc.)
   Fe^{2+} content (bitter gourd, moringa etc.)

2. Electrophoretic analysis – any source

Separation and characterization of proteins (molecular weight determination)
3. Marker enzymes of any disease (analysis) – comparison with normal
4. Isolation of secondary metabolites of medicinal plants.
5. Water analysis etc.

SEMESTER-I

BC1141: Core Course- I
Course Title – Perspectives, Methodology and Biomolecules-I

No. of Credits: 4 **No. of Contact Hours: 36**
Hours/week: 2 **(L, T, P, C – 2, 1, 2, 4)**

Objectives of the course: To familiarize the students about the fundamental characteristics of science as a human enterprise and enable them to understand how science works and to impart a general introduction to Biochemistry.

Course outcome: Student will be able to

- Elicit the concepts of science
- Describe the evolution and scope of biochemistry as a science discipline.
- List out the different experimental approaches to study biochemical processes.
- Prepare solutions of different concentration and pH.
- Classify and characterize carbohydrates and lipids.

Course Outline

Module I **(3 hrs)**

Methods and Tools in Science (Brief study)

Types of knowledge: Practical, Theoretical and Scientific. Definition of science, pseudoscience and scientific attitude. Science disciplines (pure and applied). Scientific method- posing a question, formulating hypothesis and testing. Types of hypothesis (adhoc and auxilliary). Reasoning- deductive and inductive. Hypothetico-deductive model. Definition of corroboration and falsification. Difference between theory, hypothesis and law. Definition of repeatability, replication, sensitivity of instruments, accuracy and precision.

Good laboratory practices. Laboratory safety and management of hazards in the laboratory (Chemical, Electrical and Fire). Examples of great experiments in science to illustrate how various tools were applied to answer a question [Miller- Urey experiment, Priestley's experiment on photosynthesis & Meselson-Stahl experiment- outline only].

Core Text:

- Lehninger Principles of Biochemistry, 4th edition by David L Nelson. Publisher: WH Freeman ISBN-10:0716743396.
- Tietz Text book of Clinical chemistry and Molecular Diagnostics. Carl A. Burtis, Edward R. Ashwood, David E. Bruns (Eds), Elsevier (Saunders) 2006.

Module II **(3 hrs)**

Emergence & Scope of Biochemistry (Brief study)

Basic aspects of biochemistry as the molecular logic of living organisms, characteristics of living matter, scope and applications of biochemistry.

Historical resume (brief mention about the works of Wohler, Berzelius, Miescher, Emil Fischer, Buchner, Harden and Young, Michaelis & Menton, Sumner, Krebs & Henseleit, Meyerhof, Frederick Sanger, Erwin Chargaff, Watson & Crick, GN Ramachandran and HG Khorana)

Core Text:

- Principles of Biochemistry, by Albert Lehninger, David L Nelson, Michael M Cox, CBS Publishers & Distributors Delhi ISBN 81-239-0295-6.
- Biochemistry. 2nd edition. Lehninger, Kalyani Publishers.

Module III **(4 hrs)**

Methods in Biochemistry

Terms in biochemistry- anabolism, catabolism and metabolism. Approaches to study biochemical processes- whole animal, isolated perfused organ, tissue slice, whole cells, homogenate, isolated cell organelles, sub-fractionation of organelles, purified metabolites and enzymes, chemical labeling, radiolabeling studies-tracer techniques and isolated genes. Classical experiments illustrating the application of various approaches to prove DNA as genetic material (Griffith's Experiment, Identification of the 'Transforming Principle' by Avery, McCarty & MacLeod and Hershey Chase Blender experiment-outlines only).

Core Text:

- Lehninger Principles of Biochemistry, 4th edition by David L Nelson. Publisher: WH Freeman ISBN-10:0716743396.
- Biochemistry. 2nd edition. Donald Voet and Judith G Voet. John Wiley & Sons International, ISBN-0-471-58651-X

Module IV **(4 hrs)**

Physical Aspects of Biochemistry

Bronsted theory of acids and bases, concepts of pH, pOH, and calculations based on pH and pOH. Dissociation of weak acids, Ka and pKa value. Buffers: buffer action, buffers in biological system, Henderson-Hasselbalch equation – derivation, significance and problems based on the equation.

Method of expressing concentration of solutions: Normality, molarity, molality, percentage solutions, mole fractions, parts per million and parts per billion (simple numerical problems related to them). Types of solutions (isotonic, hypotonic and hypertonic). Biological significance of diffusion & osmosis. Vant Hoff's law of osmotic pressure, simple numerical problems related to osmotic pressure.

Colloids, biological significance of colloids, fundamentals of Donnan-membrane equilibrium-biological applications. Emulsions and emulsifying agents.

Core Text:

- Introduction to Biophysics by Pranab Kumar Banerjee (2008) Publishers: S. Chand & Company Ltd ISBN: 81-219-3016-2 page no-21, 32, and 74.
- Essentials of Physical Chemistry by Arun Bahl, and BS Bahl and GD Tuli.S. Chand & Company Ltd.ISBN-81-219-2978-4.

Introduction to Biomolecules

Module V **(12 hrs)**

Carbohydrates

Classification: ketoses and aldoses (C3 to C6) series exemplified by one for each group (structure only), Monosaccharides: structure, ring formation, anomeric forms, mutarotation, Haworth projection formula, configuration, stereoisomers and optical isomers. Chemical reactions of carbohydrates (with reference to glucose): reaction with alcohol (glycosides), reaction with acetic anhydride (esterification), reaction with methyl iodide (etherification), oxidation with acids (mild and strong), oxidation with metal hydroxides (Fehling's, Benedicts & Barfoeds tests), reduction reactions (with sodium amalgam, strong mineral acids & dilute alkali), reaction with hydrogen cyanide, alanine, reaction of different carbohydrates with phenyl

hydrazine (ozazone formation), reaction with hydroxyl amine and fermentation reaction. Derived monosaccharides, sugar acids, sugar alcohols, amino sugars and deoxy sugars. Dissacharides-maltose, lactose, sucrose, isomaltose, cellobiose (Haworth structure, occurrence and function).Polysaccharides: Classification as homo and heteroploysaccharides, Homopolysaccharides: storage polysaccharides (starch and glycogen- structure, reaction, properties), structural polysaccharides (cellulose and chitin-structure, properties), Heteroploysaccharides: glycoproteins and proteoglycans (Brief study).

Core Text:

- Lehninger Principles of Biochemistry, 4th edition by David L Nelson. Publisher: WH Freeman (April 23, 2004) ISBN-10:0716743396

Module VI **(10 hrs)**

Lipids

Classification and functions of lipids, fatty acids-classification, nomenclature, structure and properties of unsaturated fatty acids. Essential fatty acids, reactions of fatty acids, simple lipids [neutral fat (triglyceride) and wax]: physical properties, chemical properties. Definitions and significance of saponification number, acid number, iodine number and Reichert-Meissel number. Rancidity of fat, reactions of glycerol, biological significance of fats. Complex lipids: glycerophospholipids, shingophospholipids, glycolipid, lipoproteins and proteolipids (structure, properties and function), Derived lipids – general structure and functions of prostaglandins, thromboxanes, leukotrienes, steroids and sterols (cholesterol, ergosterol and sitosterol).

Core Text:

- Lehninger Principles of Biochemistry, 4th edition by David L Nelson. Publisher: WH Freeman (April 23, 2004) ISBN-10:0716743396.

Suggested Readings:

- 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 [with CD rom] (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500.
- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.
- Principles of Biochemistry, by Albert Lehninger, David L Nelson, Michael M Cox, CBS Publishers & Distributors Delhi ISBN 81-239-0295-6.

BC 1141: Practical for BC 1141

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

Objective: To resolve quantitative problems concerning the preparation of solutions, buffers, reagents and analysis of biomolecules etc.

1. **Introduction to Laboratory and Lab Equipment**

- Awareness of good laboratory practices.
- Laboratory safety and management of hazards in the laboratory.
- Use of balances-common, analytical and electronic balances.
- Preparation of solutions: Percentage, molar, normal, dilution of stock solutions, standard solution
- Standardization of pH meter & determination of pH of solution using pH meter.
- Preparation of Buffer. (application of Henderson-Hasselbalch equation)

2. **General reactions of Carbohydrates and Lipids**

- Carbohydrates- Molisch's test, Anthrone test, Fehling's test, Benedict's test, Picric acid test, Barfoed's test, Bial's test, Seliwanoff's test, Foulger's test, Phloroglucinol test, Mucic acid test, Iodine test, Hydrolysis of Sucrose and Starch, Ozazone test.
- Lipids- solubility, translucent spot tests, test for saturation/unsaturation, Salkowski test, Liebermann-Buchard test and Zaks test.

References

- 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.
- ES West, WR Todd, HS Mason and JT van Bruggen. A text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974.
- Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Despande(ed). I.K International Pvt. LTD, NewDelhi. ISBN 81-88237-41-8.

Model Question Paper
BC 1141: Core Course -I
Course Title: Perspectives, Methodology and Biomolecules -I

Time**: 3 hours** Max. Marks**: 80**

Section A

Answer **all** questions. Short answer type. **Each** question carries **1** mark.

1. Write down Henderson- Hasselbalch equation for an acidic buffer.
2. Define saponification number.
3. List out the components of sodium acetate buffer.
4. Mention the outcome of Griffith's experiment.
5. Illustrate the structure of α-D- glucopyranose.
6. Mention the contribution made by GN Ramachandran.
7. Differentiate between anabolism and catabolism.
8. Name the sugars which give the same ozazone.
9. NSAIDs are used to reduce inflammation. Give reasons.
10. Define sensitivity.

(10×1=10 Marks)

Section-B

Answer **any 8** questions. Paragraph type. **Each** question carries **2** marks

11. Calculate the pH and pOH of 0.01M solution of NaOH at 25℃.
12. Explain mutarotation.
13. Define molality and molarity.
14. How will a cell respond when a cell is placed in a) hypertonic b) isotonic solution?
15. Define acid value and mention its significance.
16. How will you prepare 250ml of 0.5N NaOH solution?
17. Give the structure of lactose and sucrose.

18. Distinguish between diffusion and osmosis.
19. Phospholipids are biologically important. Give reasons.
20. Differentiate between theory and hypothesis.
21. Explain different types of knowledge.
22. List the essential fatty acids. Why are they essential?

(8×2=16 Marks)

Section-C

Answer **any 6** questions. Short essay type. **Each** question carries **4** marks

23. Write a short essay on lipoproteins.
24. Explain Hypothetico-deductive model.
25. List out and explain the types of hypothesis.
26. Explain Donnan-membrane equilibrium and its biological significance.
27. Describe the chemistry and functions of cholesterol.
28. Distinguish between starch and glycogen.
29. Write a short note on functions of prostaglandins.
30. Discuss any four chemical reactions of monosaccharides.
31. State vant Hoff's law of osmotic pressure. Calculate the osmotic pressure of a 10% solution of glucose at 18 ℃.

(6×4=24 Marks)

Section-D

Answer **any 2** questions. Long essay type. E**ach** question carries **15** marks

32. Elaborate on the various experimental approaches to study biochemical process.
33. Give a detailed account of the classification and biological functions of lipids.
34. Describe the structure and properties of structural homopolysaccharides.
35. Derive Henderson-Hasselbalch equation and mention its significance. Calculate the pH of a buffer solution containing 0.20M sodium acetate and 0.15M acetic acid. Ka for acetic acid is 1.8×10^{-5}.

(2×15=30 Marks)

SEMESTER-II

BC 1221: Foundation Course-II
Course Title: Biomolecules-II and Bioinformatics

Credits: 3 **No. of Contact Hours: 36**
Hours/Week: 2 **(L, T, P, C - 2, 1, 2, 3)**

Objective of the course: To provide a basic idea about the application of biological data bases and general informatics.

Course outcome: Student will be able to

- Elaborate the composition of proteins and their function.
- Detail the importance of genetic information carrier molecules in life.
- Recognize the scope and application of Bioinformatics.
- Perform statistical investigations related to biochemical problems.
- Identify application of information technology in biology.

Course Outline

Biomolecules in Bio Informatics

Module I **(12 hrs)**

Amino acids and Proteins

Amino acids- classification, structure and important reactions. Zwitter ion, isoelectric point. Essential and non-essential amino acids. Names of non-protein amino acids (β-alanine, ornithine, citrulline, homocysteine and homoserine) and rare amino acids in proteins (hydroxy proline, hydroxy lysine, desmosine and isodesmosine). Peptides (glutathione-structure and function), aspartame, gramicidin). Proteins- classification. Structure of proteins – primary, secondary, (with names of super secondary structures), tertiary and quaternary structure. Forces stabilizing the structure of proteins, determination of primary structure- N-terminal, C-terminal residues (One method each), action of trypsin, chymotrypsin and CNBr on peptides. Precipitation reactions of proteins - salt effect (salting-in and salting-out), heavy metal precipitation, precipitation by anionic or alkaloidal reagents. Colour reactions of amino acids and proteins and denaturation of proteins. Brief study of plasma proteins and their functions.

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 **(10 hrs)**

Nucleic Acids

Nature of genetic material, structure of purines and pyrimidines, nucleosides, nucleotides. Structure of nucleic acids: Watson-Crick DNA double helix, introduction to circular DNA, supercoiling, denaturation of nucleic acids, hyper chromic effect, Tm-values, repetitive and single copy DNA, cot values, cot curve (significance), helix to random coil transition (brief aspects only). Types of DNA and RNA (mRNA, rRNA, tRNA (secondary structure and unusual bases), siRNA, miRNA).

Core Text:

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

Module III **(4 hrs)**

Applications of Information Technology in Biology

Omics (genomics, epigenomics, lipidomics, proteomics, glycomics, transcriptomics, metabolomics, foodomics, pharmacogenomics -definition only). Artificial intelligence and robotics in biology and medicine (brief mention).

Core Text:

- Alexis and Mathews Leon, Fundamentals of Information and Technology. Alexis Leon. Vikas Publishing. ISBN 08125907890.

Module IV **(6 hrs)**

Bioinformatics

Scope and applications of bioinformatics, introduction to biological databases- classification based on type of data stored- primary, secondary and composite databases, nucleic acid databases (EMBL, GenBank, DDBJ), protein databases (Swiss-Prot, PDB, PIR). Classification based on composition of data types- sequence databases, genome databases, micro-array databases, metabolite databases, structure databases, chemical databases, bibliographic databases. Biomolecular and model organism databases. Sequence analysis tools- ORF Finder, BLAST, FASTA. Basics of sequence alignment-global and local alignments- BLOSUM.

Data Information and Knowledge

Knowledge management - Internet as knowledge repository - academic search engines (Google Scholar, Microsoft Academic, CORE, Semantic Scholar (brief approach), educational software- INFLIBNET, NICNET, BRNET. Basic concepts of IPR, copy right, patents and plagiarism. Fundamentals of cyber law (brief out line only).

Core Text:

Core Text:

- Bioinformatics: A Beginner's Guide. By Jean-Michel Claverie and Cedric Notredame; Wiley Publishing, Inc.2003.
- Bioinformatics- Principles and Applications, Zhumur Ghosh and Bibekanand Mallick, Oxford university press. ISBN-13:0-19-569230-6.
- Alexis and Mathews Leon, Fundamentals of Information and Technology. Alexis Leon. Vikas Publishing. ISBN 08125907890

Module V **(4 hrs)**

Basics of Biostatistics

Significance of statistical methods in biological investigations, probability theory (addition and multiplication theory). Stages of statistical investigation- types of data collection (primary and secondary), methods of data collection- census and sampling, sampling techniques- random (simple, stratified, systematic) and non-random (purposive, quota, convenience), presentation of data- tabular, diagrammatic (line, bar, pie diagram), graphical (line graph, histogram, frequency polygon, frequency curve, Ogive curve), analysis of data- measures of central tendency (arithmetic mean), measure of dispersion (standard deviation), testing of significance- student's t-test (paired and unpaired).

Core Text:

- An Introduction to Biostatistics: A Manual for Students in Health Sciences by P. Sundar Rao, J. Richard publishers: Prentice-Hall Pvt. Ltd. ISBN 81-203-1008-X.

Suggested Readings:

- 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.
- Bioinformatics: A Practical approach. K.Mani and N.Vijayaraj, Aparna Publication, 2004.
- Introduction to Bioinformatics T.K. Atwood and D.J. Parry – Smith Publisher Pearson Education Pvt. Ltd ISBN 81-7808-507. 2002.

BC 1221: Practical for BC 1221

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

Objective: To gain a basic knowledge about bioinformatics and qualitative analysis of biomolecules like amino acids and proteins.

1. **Bioinformatics:**
   - Internet basics
   - Introduction to NCBI Web sites
   - Introduction to Data bases

2. **General Reactions of Amino acids & Proteins**

   Amino acids
   Tests- Solubility, Ninhydrin test, Biuret test, Folins test, Xanthoproteic test, Millon's test, Morners test, Hopkin-Cole test (Glyoxalic acid test), Ehrlich's test, Sodium nitroprusside test, Pauly's test, Aldehyde test, Basic Lead acetate test, Test for Methionine and Isatin test.

   Proteins
   Tests- Solubility, Xanthoproteic test, Biuret test, Folin's test, Picric acid test, Heat denaturation, TCA precipitation, Metal precipitation, Alcohol precipitation and Hellar's- nitric acid test.

References

- Hawks Physiological Chemistry, Bernard L.Oser. TATA McGraw Hill Publishing Company LTD, New Delhi.
- ES West, WR Todd, HS Mason and JT van Bruggen. A text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974.
- Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Despande I.K International Pvt. LTD, NewDelhi. ISBN 81-88237-41-8.
- Standard Methods of Biochemical Analysis, S. K. Thimmaiah, Kalyani Publishers, Ludhiana ISBN 81-7663-067-5.

Model Question Paper
BC 1221: Foundation Course-II (Core related)
Course Title: Biomolecules-II and Bioinformatics

Time: **3 hours** Max. Marks: **80**

Section- A

Answer **all** questions. Short answer type. **Each** question carries **1** mark.

1. Name a tripeptide and the component amino acids in it.
2. Define data.
3. Mention the importance of copyright.
4. Define zwitter ion. Represent the zwitterion form of alanine.
5. Differentiate between a nucleotide and a nucleoside.
6. Name the super secondary structures of protein.
7. Define Cot value.
8. Differentiate between siRNA and mi RNA.
9. Name any two nucleic acid database.
10. Expand BRNET and DDBJ.

(10×1=10 Marks)

Section-B

Answer **any 8** questions. Paragraph type. **Each** question carries **2** marks

11. Illustrate the formation of a tripeptide.
12. Give the structure of GTP.
13. Write any two colour reactions of proteins.
14. Mention the significance of Tm value.
15. Name four unusual bases.
16. Mention the significance of IPR.
17. Write short note on DNA supercoiling.
18. Define transcriptomics and metabolomics.
19. Write short note on Swiss-Prot.
20. State Chargaff's rule of base equivalence.
21. List out the essential amino acids.
22. Give the structural details of tRNA.

(8×2=16 Marks)

Section-C

Answer any **6** questions. Short essay, **each** question carries **4** marks

23. Write short note on academic search engines.
24. Give an account of the different types of RNA.
25. Write short note on nucleic acid databases.
26. Explain Edmans method of N-terminal amino acid determination.
27. Write short note on plasma proteins.
28. Write a short essay on educational softwares.
29. Give an account of the different precipitation reactions of proteins.
30. Explain the forces stabilizing protein structure.
31. Give a brief account of the significance of statistical methods in biological investigations.

(6×4=24 Marks)

Section-D

Answer **any 2** questions- long essay, **each** question carries **15** marks

32. Explain the different modes of representation of statistical data.
33. Explain the features of Watson - Crick Model of DNA.
34. Give a detailed account of the different types of biological databases.

35. Discuss on the different levels of structural organization of proteins.

(2×15=30 Marks)

SEMESTER-III

BC1341: Core Course-II
Course Title: Cellular Biochemistry

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

Objective of the course: To prepare the students for understanding biological systems at cellular level by imparting necessary knowledge that underpins various concepts in Cell Biology and to describe the structural characteristics, functional properties and regulation of enzymes.

Course outcome: Student will be able to

- List out cell organelles and describe their structure and function.
- Elaborate the different types of transport systems across cell membrane.
- Explain types of cell division
- Outline the characteristics of cancer cells and mechanisms involved in cancer biology.
- Detail on the mechanism of interaction between cell and its environment.
- Classify enzymes; describe types of enzyme inhibition and regulation.

Course Outline

Module I **(8 hrs)**

Fundamentals of Cells

Discovery of cell and Cell Theory, comparison between plant, animal and bacterial calls, prokaryotic and eukaryotic cell, subcellular fractionation and marker enzymes, Structure and functions of nucleus, mitochondria, ribosomes, endoplasmic reticulum, Golgi complex, lysosomes, microbodies (glyoxysomes, peroxisomes), vacuoles, cytoskeleton, chloroplast and cell wall.

Core Text:

- Cell and Molecular Biology by Gerald Karp, 5th Edition, John Wiley & Son, Inc. New York ISBN 978 0470-16961-2.
- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.

Module II **(9 hrs)**

Plasma Membrane

Models of membrane structure (Charles Overton, Langmuir, Gorter and Grendel, Danielli and Davson, Robertson, Singer and Nicolson). Common features, functions and composition of membrane, membrane fluidity and factors affecting fluidity. Transport across membranes: exocytosis, endocytosis, simple diffusion, facilitated diffusion (brief outline of GLUT-1, 2, 3, 4 &5), ion channels, active transport (primary active transport- P-type [Na^+K^+ATPase], V-type, F-type pumps), secondary active transport (symport, uniport and antiport).

Core Text:

- Cell and Molecular Biology-Gerald Karp, John Wiley & Son, Inc. New York ISBN 978 0470-16961-2, 5th Edition.
- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.

Module III **(9 hrs)**

Cell Division

Major cell cycle events**,** different phases of cell division- mitosis and meiosis, apoptosis and necrosis-difference, brief outline of apoptosis (factors: internal and external), apoptotic pathways (receptor mediated, mitochondria-mediated), caspases, basic properties of cancer cells. Oncogene and tumor suppressor genes, role of p53 (brief outline only), tumor markers- Alpha-fetoprotein (AFP), Acid phosphatase, Alkaline phosphatase, Carcinoembryonic antigen (CEA), Prostate-specific antigen (PSA) - Clinical significance only.

Core Text:

- Cell and Molecular Biology by Gerald Karp, John Wiley & Son, Inc. New York ISBN 978 0470-16961-2, 5th Edition.
- Principles of Genetics by D. Peter Snustad and Michael J Simmons, John Wiley & Son, Inc., ISBN 0-471-44180-5, 3rd Edition.

Module IV **(9 hrs)**

Interaction between Cells and their Environment

Brief study of the functions of ECM, molecular components of ECM: fibrous proteins (collagen, elastin, fibronectin and laminin) and proteoglycans (Heparan sulfate, Chondroitin sulfate, Keratan sulfate, Dermatan sulfate, Hyaluronic acid) – brief study of basic features and functions only.

Brief outline of the interaction of cells with ECM- integrins. Cell-cell interaction- cell adhesion proteins (selectin, integrin, IgSF, cadherin- brief study only). Townes and Holtfreter experiment to demonstrate cell-cell interaction (basics only). Cell-cell adherence junctions: adherence junction, desmosomes, tight junction, gap junction, (Basic structural organization and function only).

Core Text:

- Cellular and Molecular Biology by Gerald Karp, 5 th Edition, John Wiley & Son, Inc. New York ISBN 978 0470-16961-2.

Module V **(9hrs)**

Enzymes

Classification of enzymes, nomenclature of enzymes: EC numbering with an example, systematic naming of six different classes of enzyme with an example. Holoenzyme, apoenzyme, prosthetic group, metalloenzymes, enzyme specificity (different types), characteristic features of active site, activation energy, binding energy, mechanism of enzyme-substrate binding (Fischer hypothesis-lock and key model, Koshland hypothesis - induced fit theory), enzyme units-definition of IU, Katal, turnover number and specific activity. Ribozymes, abzymes, coenzymes and their functions (one reaction involving TPP, FMN, FAD, NAD, NADP, PLP, Biotin, methylcobalamin and lipoic acid).

Core Text:

- Enzymes: Biochemistry, Biotechnology, Clinical Chemistry, 2 nd edition by Trevor Palmer, Philip Bonner **(**2007) Publisher: Harwood Publishing Limited ISBN-13: 9781904275275.
- Principles of Biochemistry, by Albert Lehninger, David L Nelson, Michael M Cox, CBS Publishers & Distributors Delhi ISBN 81-239-0295-6.

Module VI **(10 hrs)**

Enzyme Kinetics

Basics of the mechanism of enzyme catalysis (general acid-base catalysis, covalent catalysis, proximity and orientation effect and metal ion catalysis), order of reaction, factors affecting velocity of enzyme catalyzed reaction- enzyme concentration, substrate concentration (derivation of Michaelis- Menten equation), temperature, pH, inhibitors and activators. Vmax, significance of Km. Derivation of Lineweaver- Burk equation and LB-plot (for single enzyme catalyzed reaction).
Enzyme inhibition- Irreversible and reversible (competitive, noncompetitive and uncompetitive inhibition with an example each). Enzyme regulation- Covalent modification (Glycogen phosphorylase as example), allosteric regulation (with ATCase as example), models of kinetic behavior of allosteric enzymes (concerted model and sequential model), zymogens (trypsinogen, chymotrypsinogen and pepsinogen), isozymes (LDH, Creatine kinase, Alkaline phosphatase and their clinical significance).

Core Text:

- Principles of Biochemistry, by Albert Lehninger, David L Nelson, Michael M Cox, CBS Publishers & Distributors Delhi ISBN 81-239-0295-6.
- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.

BC 1341: Practical for BC 1341

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

Objective: To enable students to qualitatively analyze biomolecules like carbohydrates and lipids and to analyze the progress curve of enzymes.

1. **Qualitative analysis of Carbohydrates**

   Carbohydrates (glucose, fructose, galactose, xylose, sucrose, maltose, lactose, starch & dextrin).

   Tests- Molisch's test, Anthrone test, Reduction tests (Fehling's test, Benedict's test, Picric acid test, Barfoed's test, Modified Barfoed's test), Seliwanoff's test, Foulger's test, Phloroglucinol test, Mucic acid test, Bial's test, Iodine test, Hydrolysis of Sucrose & Starch and Osazone test.

2. **Qualitative analysis of Lipids**

   Fatty acids (Stearic acid, Oleic acid)
   Tests- Solubility, Translucent spot tests and Test for unsaturation

   Glycerol
   Tests- Solubility, Acrolein test and Borax-fusion test.

   Triglycerides
   Tests-Solubility, Saponification test and translucent spot test

   Cholesterol
   Tests- Solubility, Salkowski test, Zak's test and Liebermann-Burchard test.

3. **Enzyme Assays**

   - Progress curve of Urease
   - Progress curve of Trypsin

References

- Experimental Biochemistry: A Student Companion, Beedu Sasidhar 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. TATA McGraw Hill Publishing Company LTD, New Delhi.
- ES West, WR Todd, HS Mason and JT van Bruggen. A text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974.

Model Question Paper
BC 1341: Core Course-II
Course Title: Cellular Biochemistry

Time: **3 hours** Max. Marks: **80**

Section A

Answer **all** questions in **one** word or in **two** sentences. **Each** question carries **1** mark.

1. Who proposed cell theory?
2. Mention the basis of gaseous exchange in cells.
3. Define cell division.
4. List out the different cell-adhesion junctions.
5. Proteolytic enzymes are maintained in zymogen form. Give reason.
6. Name the marker enzyme of a) mitochondria b) Golgi body
7. Define K_m value.
8. Mention the clinical significance of Carcinoembryonic antigen.
9. Write down Michaelis- Menten equation and mention the terms.
10. List out any four molecular components of ECM.

(10×1=10 Marks)

Section-B

Answer **any 8** questions **not** to exceed **one** paragraph, **each** question carries **2** marks

11. Discuss about Danielli and Davson membrane model.
12. Give any 2 difference between prokaryotes and eukaryotes.
13. Differentiate between SER and RER.
14. Explain induced fit theory.
15. Write a note on different types of ion channels.
16. How do Colchicine and Taxol act?
17. Differentiate between benign and malignant tumor.
18. Define enzyme turnover number and Katal.
19. Give two functions of plasma membrane.
20. Differentiate between apoenzyme and holoenzyme with a suitable example.
21. Name one enzymatic reaction in which PLP acts as coenzyme.
22. Write about the structural organization of gap junctions.

(8×2=16 Marks)

Section-C

Answer **any 6** questions- short essay, **each** question carries **4** marks

23. Diagrammatically represent mitochondria and chloroplast and mention their functions.
24. Write a note on cell adhesion molecules.
25. Discuss about general acid-base catalysis and covalent catalysis.
26. Write a note on subcellular fractionation.
27. Discuss the effect of temperature on enzyme catalyzed reaction.
28. Explain the role of p53 in the regulation of cell cycle.
29. Write about the clinical significance of any two isoenzymes.
30. Illustrate the Lineweaver-Burk plot for competitive and non-competitive inhibition.
31. Demonstrate cell-cell interaction by Townes and Holtfreter experiment.

(6×4=24 Marks)

Section-D

Answer **any 2** questions- long essay, **each** question carries **15** marks

32. Describe the various modes of transport across the membrane.
33. Explain with diagram the phases of mitosis.
34. Derive Michaelis- Menten equation. Explain the significance of V_{max} and K_m.
35. Give a detailed account of the structure and comparison of a prokaryotic and eukaryotic cell with diagram.

(2×15=30 Marks)

SEMESTER-IV

BC 1441: Core Course- III
Course Title: Techniques in Biochemistry

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

Objective of the course: To familiarize the students with the principle, functioning and applications of techniques commonly used for the characterization, separation and identification of biological compounds. The course aims to introduce the students to the basics of research methodology which will be useful for their future scientific endeavors.

Course outcome: Student will be able to

- Explain the principle, working and application of different microscopic, photometric chromatographic, electrophoretic, centrifugation and radioactive techniques.
- Select most suitable technique for the isolation and purification of biomolecules based on different criteria.

Course Outline

Module I **(12 hrs)**

Microscopy, Photometry and Fluorimetry

Principle, instrumentation & applications of simple microscope, compound microscope, phase contrast microscope, electron microscope (SEM & TEM) and basics of sample preparation for electron microscopy.

Beer- Lambert's law, absorption and transmission of light, absorption spectra**,** instrumentation & applications of colorimeter, spectrophotometer, fluorimeter and flame photometer.

Core Text:

- Principles and Techniques of Practical Biochemistry by Keith M. Wilson, John M. Walker, 4th edition. Cambridge University Press, ISBN 052149849-X.

Module II **(6hrs)**

Homogenization and Purification Methods

Methods of tissue homogenization: motor and pestle, sonicator, blender, dyno mill, high pressure homogenizer, osmotic shock, detergents, chemicals, freeze-thaw cycle and enzymes. Salting- in & salting out, organic solvent extraction, dialysis, reverse dialysis, ultra filtration and lyophilization.

Core Text:

- Principles and Techniques of Practical Biochemistry by Keith M. Wilson, John M. Walker, 4th edition. Cambridge University Press, ISBN 052149849-X.
- Techniques in Biochemistry by Devasena T and G Rajagopal, Ahuja Book Publishers & Distributor, ISBN-13: 9789380316086.

Module III **(12 hrs)**

Chromatography

General principle of chromatography, partition coefficient, R_f value, modes of chromatography-plane chromatography and column chromatography. Principle, procedure and applications of paper chromatography, thin layer chromatography, adsorption chromatography, ion exchange chromatography, gel filtration chromatography, affinity chromatography, gas liquid chromatography and high performance liquid chromatography.

Core Text:

- Principles and Techniques of Practical Biochemistry by Keith M. Wilson, John M. Walker, 4th edition. Cambridge University Press, ISBN 052149849-X.
- Biophysical Chemistry Principles & Techniques Handbook (2003) by Avinash Upadhyay, Kakoli Upadhyay, Nirmalendu Nath Publisher: Himalaya Publishing House ISBN:8178665883.

Module IV **(6 hrs)**

Electrophoresis

Principle, procedure and applications of electrophoresis (paper electrophoresis, gel electrophoresis - PAGE, SDS- PAGE & agarose electrophoresis) and isoelectric focusing.

Core Text:

- Principles and Techniques of Practical Biochemistry by Keith M. Wilson, John M. Walker, 4th edition. Cambridge University Press, ISBN 052149849-X.
- Modern Experimental Biochemistry by Rodney F. Boyer, 3rd edition

Module V **(10 hrs)**

Centrifugation

Basic principle of centrifugation, sedimentation coefficient, Svedberg constant, RPM, RCF, Rotors (swinging bucket and fixed angle), different types of centrifuges (low speed, high speed and ultracentrifuge) and their uses, different types of centrifugation: differential centrifugation and density gradient centrifugation (rate zonal and isopycnic centrifugation).

Core Text:

- Principles and Techniques of Practical Biochemistry by Keith M. Wilson, John M. Walker, 4th edition. Cambridge University Press, ISBN 052149849-X.
- Modern Experimental Biochemistry by Rodney F. Boyer, 3rd edition

Module VI **(8 hrs)**

Radioactivity, Isotopes and its Application in Biology:

Basic concepts of radioisotopes, types of radioisotopes used in biochemistry, unit of radioactivity (Becquerel, Curie, Rutherford), disintegration constant, half-life, techniques used in radioactivity (solid and liquid scintillation counter and Geiger Muller counter), biological applications of radioisotopes, autoradiography, biological hazards of radiation, safety measures in handling radioisotopes (brief study).

Core Text:

- Principles and Techniques of Practical Biochemistry by Keith M. Wilson, John M. Walker, 4th edition. Cambridge University Press, ISBN 052149849-X.

Suggested Reading:

- Biologist's Guide to Principles and Techniques of Practical Biochemistry by BryanL.Williams, Keith Wilson Hodder Education, ISBN 071312461X (0-7131-2461-X).
- The Tools of Biochemistry by Cooper, T. G. 1977. Publisher: John Wiley & Sons.

- Biophysical Chemistry Principles & Techniques Handbook (2003) by AvinashUpadhyay, KakoliUpadhyay, Nirmalendu Nath Publisher: Himalaya Publishing House ISBN:8178665883 ISBN-13:9788178665887, 978-8178665887.
- Physical Biochemistry by David Freifelder Publisher: W.H.Freeman& Co Ltd (September 1976) ISBN-10: 0716705591 ISBN-13: 978-0716705598.
- Research Methodology for Biological Sciences (2006) by Gurumani N Publisher: MJP Publishers ISBN: 8180940160 ISBN-13: 9788180940163, 978-8180940163.
- Instrumental Methods of Chemical Analysis (2006) by M.S. Yadav Publisher: Campus Books International ISBN: 8187815620 ISBN-13: 9788187815624, 978-8187815624.

Model Question Paper
BC 1441: Core Course-III
Course Title: Techniques in Biochemistry

Time: **3 hours** Max. Marks: **80**

Section A

Answer **all** questions in **one** word or in **two** sentences. **Each** question carries **1** mark.

1. State Beer-Lambert's law.
2. Name the compounds tested in flame photometer.
3. Identify the stationary and mobile phase in paper chromatography.
4. Name the technique used for long term storage of biological samples.
5. Expand TEMED and APS.
6. Name the any two carrier gas used in gas chromatography.
7. Mention the role of monochromators in spectrophotometry.
8. Name any one counter used to measure radioactivity
9. Mention the significance of critical point drying.
10. Name two fixatives used in electron microscopy.

(10×1=10 Marks)

Section-B

Answer **any 8** questions **not** to exceed **one** paragraph, **each** question carries **2** marks

11. Mention the role of polyampholytes in isoelectric focusing.
12. Define sedimentation co-efficient.
13. Write a note on absorption spectra.
14. Name a cation and an anion exchange resin.
15. List out the components required to cast a gel for SDS gel electrophoresis.
16. Differentiate between fluorescence and phosphorescence.
17. List out the applications of ultracentrifugation.
18. Write the basic principle of a flame photometer.
19. List out any four biological applications of radioisotopes.
20. Name the ligands used for the isolation of avidin & glycoprotein by affinity chromatography.
21. Define half-life of radioactive isotopes with two examples
22. Write the principle of chromatographic techniques.

(8×2=16 Marks)

Section-C

Answer any **6** questions- short essay, **each** question carries **4** marks

23. Write a short essay on applications of fluorimetry.
24. Outline the principle of paper chromatography. Explain its applications.
25. Briefly explain sample preparation in TEM.
26. Explain the methods used in tissue homogenization.
27. Write short note on affinity chromatography.
28. Explain the principle and working of a phase contrast microscope.
29. Write short notes on ultrafiltration and lyophilization.
30. Differentiate scintillation counter from GM Counter.
31. Explain the principle, instrumentation and working of flame photometer.

(6×4=24 Marks)

Section-D

Answer **any 2** questions- long essay, **each** question carries **15** marks

32. Discuss in detail about the principle, procedure and applications of SDS-PAGE.
33. Explain the applications of radioactive isotopes in the field of biology.
34. Elaborate HPLC and its applications.
35. Discuss the principle, instrumentation and working of Scanning Electron Microscope.

(2×15=30 Marks)

SEMESTER-IV

BC 1442: Core course- IV- Practical
Course Title: Qualitative Analysis of Biomolecules

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

Objective of the course: The course aims at providing the skill for identifying a particular biomolecule through systematic analysis.
Course outcome: Student will be able to

- Qualitatively analyse the type of biomolecule.
- Identify the subclass of each biomolecule by schematic analysis

1. Qualitative Analysis of Amino acids and Proteins

Amino acids- (Tyrosine, Tryptophan, Histidine, Arginine, Cysteine, Cystine, Proline and Methionine) (single components only need to be given).***Tests***- Solubility test, Ninhydrin test, Modified Ninhydrin test, Xanthoproteic test, Biuret test, Folin's test, Millon's test, Morners test, Hopkin-Cole or Glyoxalic acid test, Ehrlich's test, Sodium nitroprusside test, Basic Lead acetate test, Test for Methionine, Aldehyde test, Sakaguchi test and Isatin test

Proteins-Ovalbumin and Casein. ***Tests***- Solubility test, Biuret test, Xanthoproteic test, Folin's test, Picric acid test, , Heat denaturation, TCA precipitation, Metal precipitation, Alcohol precipitation and Hellar's- nitric acid test.

2. Chromatographic Techniques

- Demonstration of different types of paper chromatography.
- Separation and identification of amino acid mixture by Paper chromatography
- Thin Layer Chromatography
- Extraction and quantification of total lipids.
- Separation of lipids by TLC.

3. Electrophoresis Technique (Demonstration)

- Demonstration of Native PAGE
- Demonstration of Agarose gel electrophoresis

References

- Hawks Physiological Chemistry, Bernard L.Oser (ed).TATA McGRAW Hill Publishing Company LTD, New Delhi.
- ES West, WR Todd, HS Mason and JT van Bruggen. A text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974.
- 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.

SEMESTER-V

BC 1541: Core Course -V
Course Title: Physiology & Immunology

No. of Credits: 4 **No. of Contact Hours: 72**
Hours/week: 4 **(L, T, P, C – 4, 1, 0, 4)**

Objective of the course: This course aims at providing an idea regarding the physiological functions of the biological system and to discuss the basics of immunology and immunological techniques.

Course outcome: Student will be able to

- Explain hemopoiesis and biochemical basis of blood group classification.
- Elaborate on the transport of gases, acid base and water balance in the body.
- Remember structure of muscle, neuron and bone.
- Classify hormones and explain the functions of hormones.
- Describe various aspects in basic immunology
- Identify the applications of various techniques involved in immunology.

Course Outline

Module I **(15 hrs)**

Blood

Hemopoiesis: Erythropoiesis, leucopoiesis and thrombopoiesis, blood forming organs, blood cells (Functions of RBC, WBC and platelets, Hemoglobin – structure and functions, ESR, Difference between plasma and serum. Hemostasis: blood coagulation: intrinsic and extrinsic coagulation, anticoagulants, bleeding time and coagulation time. Basis of blood group classification. Erythroblastosis foetalis.

Core Text:

- Textbook of Medical Physiology, by Arthur C Guyton, John E Hall Prism Saundersth9Edition ISBN: 81-7286-034-X.
- Principles of Anatomy and Physiology by Gerard J. Tortora and Bryan Derrickson, 13 th Edition.

Module II **(15 hrs)**

Transport of Gases

Exchange of gases in alveoli and tissues, transport of oxygen in blood, O_2 dissociation curve - Effect of PO_2 ,PCO_2, H^+ concentration (Bohr effect), temperature and 2,3 BPG. Transport of CO_2 in blood-chloride shift, carbonic anhydrase reaction. Acid base balance: Acid base disturbances (respiratory acidosis and alkalosis, metabolic acidosis and alkalosis) and compensation mechanism, body water balance (Renin –Angiotensin system)

Core Text:

- Arthur Vander, James Sherman, and Dorothy Luciano Vander et al.: Human Physiology: The Mechanism of Body Function, Eighth Edition © The McGraw-Hill Companies.
- Essentials of Physiology by Lauralee Sherwood,4th edition

Module III **(10 hrs)**

Muscle, Neuron and Bone

Structure of muscle. Muscle proteins, energy sources for muscle contraction and sliding filament theory. Biochemical events during muscle contraction. Rigor mortis. Structure of neuron, glial cells, graded potential and action potential, ionic basis of action potential, threshold and all or none response, refractory period, excitatory and inhibitory chemical synapses, neurotransmitters and neuromodulators. Bone: composition, role of Ca, P and Vitamin D in bone formation.

Core Text:

- Arthur Vander, James Sherman, and Dorothy Luciano Vander et al.: Human Physiology: The Mechanism of Body Function, Eighth Edition © The McGraw-Hill Companies.
- Human Physiology an integrated approach by Dee Ungulaub Silverthorn

Module IV **(8 hrs)**

Hormones

Classification of hormones based on chemical nature and mechanism of action. General mechanism of action of steroid hormones and mechanism of hormones that act via cyclic AMP as second messenger. Functions of hormones secreted by thyroid, pituitary, adrenal and pancreas. Chemical structure of the following hormones: Thyroxine, Cortisone, Cortisol, Epinephrine, Norepinephrine, Aldosterone, Testosterone and Estradiol.

Core Text

- Arthur Vander, James Sherman, and Dorothy Luciano Vander et al. Human Physiology: The Mechanism of Body Function, Eighth Edition , The McGraw-Hill Companies.
- Granner, Robert K. Murray Darryl K., and Peter A. Mayes Victor W. Rodwell. Harper's Illustrated Biochemistry (Harper's Biochemistry).McGraw-Hill Medical, 2006.
- Human Physiology an integrated approach by Dee Ungulaub Silverthorn

Module V **(14 hrs)**

Basics of Immunology

Basics of immunology, basic concepts of immunity, types of immunity-innate immunity, acquired immunity mechanical protection and chemical protection, phagocytosis, inflammation. Adaptive immunity-humoral and cell mediated immunity. Immune response: primary and secondary immune response. Organs and cells of adaptive immune system, antigen, hapten, epitope and paratope. Immunoglobulins- structure, classification and functions. Clonal selection of lymphocytes, antibody-formation of antibody.

Disease related to immune function – Hypersensitivity, autoimmune disorders(Hashimoto's Thyroiditis, Insulin Dependent Diabetes Mellitus, Myasthenia Gravis, Rheumatoid Arthritis) immunodeficiency disorders (X linked Agammaglobulinemia, Digeorge syndrome, SCID and AIDS) (Brief outline only) Vaccination and immunization (Brief outline only)

Core Text:

- Kuby Immunology by Thomas J. Kindt (2006). W H Freeman & Co ISBN: 0716785900, ISBN-13: 9780716785903, 978-0716785903.
- Delves, Peter J., Seamus J. Martin, Dennis R. Burton, and Ivan M. Roitt.Roitt's essential immunology. Vol. 20. John Wiley & Sons, 2011.

Module VI **(10 hrs)**

Techniques in Immunology

Antigen - antibody interactions: precipitation reactions, agglutination reaction. Immunological techniques: principle and applications of ELISA, RIA, Immunodiffusion and Immunofluorescence. Production of monoclonal antibodies (Hybridoma technology) – application in diagnosis and therapy.

Core Text:

- Kuby Immunology by Thomas J. Kindt (2006) Publisher: W H Freeman & Co ISBN: 0716785900, ISBN-13: 9780716785903, 978-0716785903

Suggested Readings:

- Human Physiology (2001) by Bipin Kumar Publisher: Campus Books International ISBN: 8187815604 ISBN-13: 9788187815600.
- Human Physiology (2001) by KC Sawant Publisher: Dominant Publishers & Distributors ISBN: 8178880202 ISBN-13: 9788178880204, 978-8178880204
- Human Physiology (2001) by Andrew Davies, Asa Gh Blakeley, Cecil Kidd Publisher: Churchill Livingstone ISBN:0443046549, ISBN-13: 9780443046544, 978-0443046544
- Principles Of Biochemistry, 6e (1959) by Abraham White, Philip Handler Publisher: Tata McGraw-hill Publishing Company Limited ISBN:0070590494 ISBN-13: 9780070590496, 978-0070590496
- Immunology: An Introduction by Ian R Tizard (2006) Publisher: Cengage Learning (Thompson) ISBN: 8131500039, ISBN-13: 9788131500033, 978-8131500033
- Immunology and Immunotechnology by Chakravarty (2006) Publisher: Oxford University Press N Delhi ISBN: 0195676882, ISBN-13: 9780195676884, 978-0195676884
- Elements of Immunology (2009) by Khan Publisher: Dorling Kindersley (India) Pvt Ltd ISBN: 8131711587 ISBN-13: 9788131711583, 978-8131711583
- Immunology by K.R. Joshi (2007) Publisher: Agrobios (India) ISBN: 8177541749, ISBN-13: 9788177541748, 978-8177541748
- Immunology by Roitt Publisher: Mosby ISBN: 0702025496 ISBN-13: 9780702025495, 978-0702025495

Model Question Paper
BC1541: Core Course-V
Course Title: Physiology and Immunology

Time: **3 hours** Max. Marks: **80**

Section A

Answer **all** questions in **a word** or **two** sentences. **Each** question carries **one** mark.

1. Define an anticoagulant. Give an example.
2. Differentiate plasma and serum.
3. Define Bohr Effect.
4. Give the reaction mediated by carbonic anhydrase.
5. Define action potential.
6. Mention the site of synthesis of Human Chorionic Gonadotropin.
7. Name the hormones of posterior pituitary.
8. Give any one example of enzyme involved in ELISA.
9. The predominant antibody in colostrum is -------.
10. A small molecule acting as an epitope but incapable of eliciting an immune response is called -----.

(10x1= 10 Marks)

Section-B

Answer any **eight** questions not to exceed a paragraph. **Each** question carries **2** marks

11. Define the term vaccine. Give two examples.
12. Compare humoral and cell mediated immunity.
13. Define bleeding time.
14. Give an account on clinical significance of ESR.
15. Explain rigor mortis.
16. State the functions of thyroid hormones.
17. Describe precipitation reaction.
18. Write note on synapse.
19. Give examples of any two peptide hormones.
20. State clonal selection hypothesis.
21. Name the components of HAT medium.
22. Define respiratory acidosis.

(8x2 = 16 Marks)

Section-C

Answer any **6** questions- short essay, **each** question carries **4** marks.

23. Describe erythropoiesis.
24. Write short note on inflammation.
25. Explain the role of calcium and phosphorous in bone formation.
26. Explain the principle and applications of ELISA technique.
27. With the help of a neat diagram explain the structure of neuron.
28. Write note on oxygen dissociation curve and factors affecting it.
29. Describe secondary lymphoid organs.
30. Give the structure of epinephrine and Aldosterone.
31. Explain sliding filament theory.

(6x4= 24 Marks)

Section-D

Answer any **two** questions. Long essay, **each** question carries **15** marks.

32. Explain in detail about blood coagulation.
33. Write an essay on transport of CO_2 in blood.
34. Write about the structure, classification and functions of Immunoglobulins.
35. Explain the production and applications of monoclonal antibody.

(2x15= 30 Marks)

SEMESTER-V

BC 1542 : Core Course VI
Course Title: Bioenergetics and Carbohydrate Metabolism

No. of Credits: 3 **No. of Contact Hours: 54**
Hours/week: 3 **(L, T, P, C – 3, 1, 0, 3)**

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

Course outcome: Student will be able to

- Describe the bioenergetics of metabolic pathways.
- Elaborate the reactions and regulation involved in the metabolism of carbohydrates.
- List out the inborn errors of carbohydrate metabolism.
- Enumerate the link between ETC and energy production in plant and animal cells.
- Elicit the mechanism of energy production in carbohydrate metabolism.

Course Outline

Module I **(8 hrs)**

Bioenergetics

First and second law of thermodynamics, concept of free energy- standard free energy change and actual free energy change. Relation between change in free energy (ΔG), enthalpy (ΔH) and entropy (ΔS). ΔG and spontaneity of reactions, high and low energy compounds, classification of energy rich compounds, structure of ATP, reason for negative value of ΔG of hydrolysis of ATP, ATP/ADP cycle, coupling of exergonic and endergonic reactions, ATP synthesis (substrate level and oxidative phosphorylation). Biological oxidation-reduction reactions; enzymes and co-enzymes involved, redox potential (Eo), relation between standard reduction potential and free energy change.

Core Text:

- Principles of Biochemistry, by Albert Lehninger, David L Nelson, Michael M Cox, CBS Publishers & Distributors Delhi ISBN 81-239-0295-6.
- Textbook of Biochemistry by Thomas M Devlin, John Wiley & Son, Inc. New York ISBN 13 978-0-471-67808-3/2 6th Edition.

Module II **(6 hrs)**

Metabolism of Mono- and Disaccharide

Digestion and absorption of carbohydrates. Site, reactions (structure required), energetics, regulation and significance of: Glycolysis (aerobic and anaerobic breakdown, Pasteur effect, Crabtree effect, Rapaport-Leubering cycle), galactose & fructose metabolism, formation of acetyl CoA, pyruvate dehydrogenase complex, TCA cycle (amphibolic nature, anaplerotic reactions), HMP shunt, gluconeogenesis (reciprocal regulation of glycolysis and gluconeogenesis) and glyoxalate cycle. Sorbitol pathway (brief outline and clinical significance. Cori cycle, Glucose-alanine cycle.

Inborn errors in carbohydrate metabolism-galactosemia, essential fructosuria, fructose intolerance, sequestering of phosphate, Wernicke-Korsakoff syndrome, hemolytic anemia and lactose intolerance.

Core Text:

- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.

Module III **(14 hrs)**

Glycogen Metabolism

Structure of glycogen. Site, reactions (structure required), energetics and regulation (allosteric and c-AMP dependent) of glycogenesis and glycogenolysis. Glycogen storage diseases: Von Gierke's, Pompe's, Cori's or Forbe's, Andersen's, McArdle's, Hers', Tarui's, Type IX and Fanconi- Bickel syndrome).

Core Text:

- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.

Module IV **(8 hrs)**

Electron Transport Chain

Structure of mitochondria, components and sequence of electron carriers (Complex I, II, III, IV), brief outline of events during electron transport, (Q-cycle, Cytochrome oxidase mechanism-brief concept), LHON and inhibitors of electron transport chain.

Core Text:

- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.

Module V **(8 hrs)**

Oxidative Phosphorylation

Complex V, structure of ATP synthase (brief outline), Chemiosmotic hypothesis of mitochondrial oxidative phosphorylation (basic concept), Boyer's binding change mechanism (brief outline), P/O ratio, inhibitors and uncouplers, ATP-ADP translocase, transport of reducing potentials into mitochondria (malate-aspartate shuttle, glycerol-3-phosphate shuttle), net ATP yield from complete oxidation of glucose.

Core Text:

- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.
- Principles of Biochemistry, by Albert Lehninger, David L Nelson, Michael M Cox, CBS Publishers & Distributors Delhi ISBN 81-239-0295-6.

Module VI **(10 hrs)**

Photosynthesis

Structure of chloroplast, structure of chlorophyll, Photosynthetic machinery- photosynthetic unit, photochemical reaction centre, light reaction (Z-scheme), cyclic and noncyclic photophoshorylation, herbicides (site of action of diuron and atrazine only), fixation of CO_2 (RUBISCO), dark reaction (Calvin cycle), and formation of carbohydrate (Sucrose and starch), photorespiration, C4 plants (Kranz anatomy, Hatch-Slack pathway).

Core Text:

- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.
- Principles of Biochemistry, by Albert Lehninger, David L Nelson, Michael M Cox, CBS Publishers & Distributors Delhi ISBN 81-239-0295-6..
- Textbook of Biochemistry with Clinical correlations – Edited by Thomas M Devlin, Wiley-Liss Publications, ISBN 10 0-471-67808-2

Suggested Readings:

- 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.
- Principles Of Biochemistry, 4/e (2006) by Robert Horton H , Laurence A Moran, Gray Scrimgeour K Publisher: Pearsarson ISBN: 0131977369, ISBN-13:9780131977365, 978-0131977365
- Biochemistry 6th Edition (2007) by Jeremy M.Berg John L.Tymoczko Lubert Stryer Publisher: B.I.Publications Pvt. Ltd ISBN:071676766X ISBN-13: 9780716767664, 978-716767664
- Biochemistry (2008) by Rastogi Publisher: McGraw Hill ISBN**:**0070527954 ISBN-13**:** 9780070527959**,** 978-0070527959

Model Question Paper
BC 1542: Core Course- VI
Course Title: Bioenergetics and Carbohydrate Metabolism

Time: **3 hours** Max. Marks: **80**

Section-A

Answer **all** questions in **one** word or in **two** sentences. **Each** question carries **1** mark.

1. Why is hexokinase not the rate limiting enzyme of glycolysis?
2. Name the defective enzyme in Von Gierke's disease.
3. State the relation between free energy, enthalpy and entropy
4. How does diuron act as herbicide?
5. Name two inhibitors of cytochrome oxidase?
6. Why ATP is called energy currency?
7. Calculate the net ATP yield when glucose-6-phosphate is converted to pyruvate.
8. Give the clinical significance of glucose-6-phosphate dehydrogenase enzyme.
9. State the role of photochemical reaction centre in photosynthesis.
10. Give the structure of ATP.

(10×1=10 marks)

Section-B

Answer **any 8** questions **not** to exceed **one** paragraph, **each** question carries **2** marks

11. How are citric acid cycle intermediates that are used for biosynthesis replenished?
12. Give a brief description of structural aspect of Complex V of ETC.
13. Differentiate between Pasteur effect and Crabtree effect.
14. State the reason for the high group transfer potential of PEP.
15. Give the reason for negative ΔG of hydrolysis of ATP.
16. There is no net oxidation-reduction in the conversion of glucose into ethanol. Why?
17. Give the clinical significance of Sorbitol pathway.
18. Give a brief description of Rapaport- Leubering cycle.
19. Why is C_3 and C_4 pathways named so?
20. Give the reactions involved in conversion of pyruvate to ethanol during anaerobic respiration.
21. How is substrate level phosphorylation different from oxidative phosphorylation?
22. Draw a neatly labeled diagram of mitochondria and mark the region where ETC is located.

(8×2=16 marks)

Section-C

Answer any **6** questions- short essay, **each** question carries **4** marks

23. Formation of acetyl CoA from pyruvate involves a multienzyme complex. Explain.
24. How is high energy compounds classified? Give examples.
25. How do tropical plants concentrate CO2?
26. Discuss the regulation of glycogen metabolism by cAMP.
27. How is ETC coupled to ATP synthesis?
28. Describe the pathway that enables plants and bacteria to grow on acetate.
29. Explain the coupling of exergonic and endergonic reaction with examples.
30. How are cytosolic NADH formed during glycolysis oxidized by respiratory chain?
31. How does galactose enter glycolysis?

(6×4=24 marks)

Section-D

Answer **any 2** questions- long essay, **each** question carries **15** marks

32. Discuss in detail pentose phosphate pathway and its significance.
33. Write an essay on mitochondrial electron transport chain.
34. Elaborate on the flow of electrons from H_2O to $NADP^+$ in photosynthesis and ATP production.
35. Explain gluconeogenesis and its reciprocal regulation with glycolysis.

(2×15=30 marks)

SEMESTER-V

BC 1543: Core Course-VII
Course Title: Food Science

No. of Credits: 3 **No. of Contact Hours: 54**
Hours/week: 3 **L, T, P, C – 3, 1, 0, 3)**

Objective of the course: This course aims at providing a thorough understanding of different aspects of human nutrition, types of food preservation, adulteration, microbiological aspects of food, role of functional foods and nutraceuticals and food safety and quality management systems.

Course outcome: Student will be able to

- Elaborate on the importance of human nutrition.
- Describe the chemical composition of different types of food.
- Explain the various food preservation techniques employed.
- Identify the common adulterants in food.
- Gain knowledge about the role of microorganisms in food and nutrition
- Explain the importance of food safety and management systems.

Course Outline

Module I **(10 hrs)**

Nutrition

Calorific value of food, determination of calorific value –Bomb calorimeter, Basal metabolic rate, factors affecting BMR, BMI range and obesity, Specific Dynamic Action of food (SDA). Nutritional significance of carbohydrates, proteins and fat. Essential fatty acids, omega-3 fatty acids, EPA and DHA. Essential amino acids, limiting amino acids and significance of dietary fibre. Definitions of balanced diet, bland diet and Recommended Daily Allowance (RDA). Definitions of terms related to protein evaluation: protein efficiency ratio (PER), digestibility coefficient, biological value, net protein utilization, net protein ratio and chemical score. Nitrogen balance-positive and negative nitrogen balance. Protein-calorie malnutrition- kwashiorkor and marasmus. Functions of minerals- Ca, P, Mg, Na, K, Cl, Iodine, Cu, Zn, Mn and Fe. Vitamins-Fat and water soluble vitamins- Functions and deficiency diseases.

Core Text:

- Advanced Text Book on Food and Nutrition, Vol I and II, Dr. M Swaminathan.2 nd edition. The Bangalore Printing and Publishing Co Ltd.

Module II **(8 hrs)**

Foods

Outline of chemical composition of: cereals, pulses, tubers, milk, egg, fish, meat, fruits, alcoholic beverages, soft drinks, coffee, tea, coconut, molasses, jaggery, honey, spices, edible oils and fats. Brief mention about the different antinutritional factors in food- phytic acid, lectins, tannins, saponins, amylase inhibitors and protease inhibitors. Food borne-diseases: Lathyrism, Favism, Ergotism and Epidemic dropsy.

Analysis of moisture content-evaporation method, distillation method (Dean and Stark method), chemical reaction method (Karl-Fischer titration and gas production method), physical method (basics of Hydrometry) and spectroscopic method (basic principle of microwave and IR only). Determination of total solid ash, total carbohydrates and fat.

Core Text:

- Foods-Facts and Principles-N Shakuntala Manay and M Shadaksharaswamy. New Age International Publishers, ISBN-81-224-1325-0.
- Food Science- Chemistry and Experimental Foods. Dr. M Swaminathan, The Bangalore Printing and Publishing Co. Ltd.

Module III **(10 hrs)**

Food Preservation and Adulteration

Preservation of foods: Low temperature (chilling and freezing), high temperature (boiling, pasteurization, autoclaving, canning-steps involved in canning), dehydration, high osmotic pressure, chemical preservatives, cold sterilization and anaerobic conditions. Food additives: Permitted colors, permitted food preservatives, emulsifying agents, flavoring agents, artificial sweeteners (saccharine).

Food adulteration: FSSA definition of an adulterant. Common adulterants in milk, coffee powder, mustard seeds, curry powders, butter, honey, rice, wheat, black pepper and vegetable oils. Health hazards due to adulteration. Elementary study on qualitative detection of adulteration in milk, edible oils and detection of saccharine.

Core Text:

- Food Science- Chemistry and Experimental Foods. Dr. M Swaminathan, The Bangalore Printing and Publishing Co. Ltd.
- Food Science-Experiments and Applications. Mohini Sethi and Eram S Rao. CBS Publishers and Distributors. ISBN-81-239-0747-8.

Module IV **(10 hrs)**

Food Microbiology

Brief outline of the factors affecting food spoilage-composition, acidity and moisture content. Brief study on types of food poisoning-staphylococcal poisoning, botulism, salmonellosis, mycotoxins and algal poisoning (causative organisms only).

Role of fermentation in production of alcohol, wine and malt beverage-beer (beer-raw materials used, steps involved -malting, mashing and finishing).

Types of microorganisms in milk: based on biochemical activity (Homofermentative and heterofermentative) and temperature response (psychrophilic, mesophilic, thermophilic and thermoduric organisms), heat treatment of milk- sterilization and pasteurization (LTH and HTST). Tests to assess quality of milk-reductase test and resazurin test. Outline study on the production of cheese, bread and fermented milk products (curd, kefir and yogurt).

Core Text:

- A Textbook of Microbiology by RC Dubey and DK Maheswari. S Chand and Company Ltd.ISBN-8121926203.
- General Microbiology-Vol-II, CB Powar and HK Daginawala. Himalaya Publishing House.

Module V **(8 hrs)**

Functional Foods and Neutraceuticals

Food fortification- types of fortification (Biofortification, microbial biofortification, industrial/commercial, home fortification). Common vehicles for food fortification (common salt, whole wheat flour, rice, vegetable oils, milk and dairy products). Criteria, advantages and disadvantages of food fortification. Basic concepts in neutraceuticals with examples (probiotics, prebiotics, dietary fibers, antioxidants, phytoestrogens, carotenoids, curcuminoids and lycopene).

Core Text:

- Food and Nutrition-2 nd edition. Harbans Lal, CBS Publishers and Distributors Pvt. Ltd

Module IV **(8 hrs)**

Food Safety and Quality Management

Food safety: definition and basic concepts of toxicity and hazard (physical, chemical and biological) in food. Food quality and safety management systems: Good Manufacturing Practices (GMP), Good Handling Practices (GHP), Hazard Analysis Critical Control Points (HACCP). Product certification/grading – BIS and AGMARK (basic approach only). Food standards: Codex Alimentarius, ISO and Codex India. Brief study of the following: FSSAI, PFA 1954, FSSA 2006, FPO and essential commodities act.

Core Text:

- Food Safety and Standards Authority of India. Ministry of Health and Family Welfare, Government of India
- Food Science. 2nd edition, SR Mudambi, SM Rao and MV Rajagopal (2006). New Age International Pvt.Ltd. ISBN-81-224-1779-5

Suggested Readings

- Industrial Microbioloy, L. E. Casida J R ISBN: 0- 85226- 101- 2.
- Microbiology by Lansing M. Prescott, 5th edition ISBN: 0- 07-282905-2.
- Microbiology by PD Sharma, Rastogi Publications.
- Food processing and preservation: B. Sivasankar; ISBN: 81- 203- 2086- 7.
- Food Science and Technology, Bhupendra Singh Khatkar; ISBN: 81- 7035- 422- 6.
- Industrial Microbiology A H Patel; SBN: 033908422.
- Microbiology, Michael J Pelczar, E C S Chan, Noel R Krieg ISBN: 0- 07- 049234-4.
- Microbiology: AN introduction' Tortora, Funke and Case.9th edition, Pearson Publications.
- Food Science, B. Sreelakshmi, 3rd edition, New Age International Pvt. Ltd, ISBN- 8122420222.
- Aurand, L.W. and Woods, A.E. 1973. Food Chemistry. AVI, Westport.
- Birch GG, Cameron AG and Spencer, M. 1986. Food Science, 3 rd edition. Pergamon Press, New York.
- Fennema, OR. Ed. 1976. Principles of Food Science: Part-I Food Chemistry. Marcel Dekker, NewYork.

.Model Question Paper
BC 1532: Core Course-VII
Course Title: Food Science

Time: **3 hours** Max. Marks: **80**

Section A

Answer **all** questions in **one** word or in **two** sentences. **Each** question carries **1** mark.

1. Define Specific Dynamic Action of Food.
2. How is BMI and obesity related?
3. List four functions of Calcium.
4. Name two permitted food colours.

5. Define an adulterant.
6. List two food borne disease and the microorganism involved.
7. Mention two disadvantages of food fortification.
8. Name two artificial sweeteners.
9. Mention the conditions in which there is negative nitrogen balance.
10. Write the calorific value of carbohydrate, fat and lipid.

(10×1=10 Marks)

Section-B

Answer **any 8** questions **not** to exceed **one** paragraph, **each** question carries **2** marks.

11. List out the diseases caused by deficiency of Vitamin A.
12. Write about the significance of nutraceuticals in health.
13. Explain the biochemical basis of scurvy.
14. Define RQ and write the RQ values of carbohydrate and fat.
15. List out the nutritional aspects of phospholipids.
16. Name the essential fatty acids. Why are they essential?
17. Define Biological value of a protein.
18. List out any four functions of phosphorus.
19. Differentiate LTH and HTST employed in pasteurization.
20. Explain cold sterilization.
21. Mention the significance of ISO and Codex India.
22. Write about the common vehicles used for food fortification.

(8×2=16 Marks)

Section-C

Answer any **6** questions- short essay, **each** question carries **4** marks.

23. How is calorific value of food determined by Bomb Calorimeter?
24. Explain the different factors affecting Basal Metabolic Rate.
25. Write about the significance of HACCP.
26. Explain the biological functions of any two trace element.
27. Write about the criteria and advantages of food fortification.
28. How are microorganisms in milk classified on the basis of temperature response?
29. Explain the detection of saccharine in a food sample
30. Describe reductase test used to assess the quality of milk.
31. Explain FSSA, 2006.

(6×4=24 Marks)

Section-D

Answer **any 2** questions- Long essay, **each** question carries **15** marks.

32. Discuss the different methods employed for the analysis of moisture content in food.
33. Write an essay on different food preservation methods.
34. Discuss in detail the steps involved in Beer production.
35. Give a detailed account of physiological functions and deficiency diseases associated with Vit. D.

(2×15=30 Marks)

SEMESTER-V

BC 1544: Core Course-VIII
Course Title: Classical and Molecular Genetics

No. of Credits: 4 **No. of Contact Hours: 72**

Hours/week: 4 **(L, T, P, C – 4, 1, 0, 4)**

Objective of the course: To create awareness about the molecular details of the biological system and to describe the events encompassing the central dogma of molecular biology

Course outcome: Student will be able to

- Give an account of Mendelian and non- Mendelian genetics.
- Predict the type of inheritance of a trait/disease using pedigree analysis.
- Explain the organization of chromatin and events during gene expression.
- Illustrate the consequences of different types of mutations and DNA-repair systems
- Depict the concepts of gene regulation in prokaryotic cells
- Describe the methods involved in rDNA technology.
- Provide insight into the molecular and cell-based methods used in the field of biology
- Understand several modern molecular methods to elucidate molecular and genetic questions

Course Outline

Module I **(15 hrs)**

Role of Genetics in Biology

Model genetic organisms (brief outline with examples). Basic principles of heredity- Mendel's laws, monohybrid, dihybrid and test cross (pea plant). Gene interaction- Allelic gene interaction (complete dominance, co-dominance and incomplete dominance- brief outline with example) and non-allelic gene interaction (Extensions of Mendelian principles- epistasis- duplicate recessive, recessive, dominant, dominant inhibitory and duplicate dominant epistasis-brief outline with example). Penetrance, expressivity, genetic anticipation and genomic imprinting (definition with examples). Sex linked characteristics (eye colour of drosophila). Maternal inheritance (kappa particles in paramecium, male sterility in maize) and maternal effect (shell coiling in snail). Pedigree analysis and applications - autosomal dominance, autosomal recessive, X-linked recessive (brief outline).

Core Text:

- Principles of Genetics by D. Peter Snustad and Michael J Simmons, John Wiley & Son, Inc., ISBN 0-471-44180-5, 3rd Edition.

Module II **(10 hrs)**

Bacterial and Viral Genetic Systems

Transformation, transduction and conjugation. Transposons and multiple drug resistance (brief outline). Chromosome variation- aneuploidy, polyploidy, duplication, deletion, inversion and translocation (Brief outline).

Core Text:

- Principles of Genetics by D. Peter Snustad and Michael J Simmons, John Wiley & Son, Inc., ISBN 0-471-44180-5, 3rd Edition.

Module III **(20 hrs)**

Gene Expression

Genome organization (prokaryotes and eukaryotes), chromatin, centromere, and telomere. Central Dogma. DNA replication in prokaryotes, enzymes involved in replication, replication inhibitors (any 3 examples). Transcription in prokaryotes, enzymes involved in transcription, transcription inhibitors (any 3 examples). Eukaryotic transcription and post transcriptional modification (brief outline only). Genetic codon (characteristics of codon), Wobble hypothesis (brief concept). Translation in prokaryotes, translation inhibitors (any 3 examples).

Core Text:

- Principles of Genetics by D. Peter Snustad and Michael J Simmons, John Wiley & Son, Inc., ISBN 0-471-44180-5, 3rd Edition.
- Biochemistry by Lubert Stryer, W.H Freeman and Company, New York ISBN 0-7167-2009-4, 4 th Edition.

Module IV **(9 hrs)**

Mutation and Repair in Prokaryotes

Various types of mutation- spontaneous and induced mutation, point mutation- substitution (transition, transversion), insertion, deletion, missense, nonsense, frame-shift mutation, mutagens- different types. Ames test. Repair in prokaryotes - direct, excision, mismatch, recombination and SOS.

Core Text:

- Principles of Genetics by D. Peter Snustad and Michael J Simmons, John Wiley & Son, Inc., ISBN 0-471-44180-5, 3rd Edition.
- Biochemistry by Lubert Stryer, W.H Freeman and Company, New York ISBN 0-7167-2009-4, 4 th Edition.

Module V **(10 hrs)**

Gene Regulation in Prokaryotes

Jacob and Monod's operon concept, structural gene, regulator gene. Inducible operon (lac operon as an example) and repressible operon (tryptophan operon as an example, attenuation).

Core Text:

- Principles of Genetics by D. Peter Snustad and Michael J Simmons, John Wiley & Son, Inc., ISBN 0-471-44180-5, 3rd Edition.
- Biochemistry by Lubert Stryer, W.H Freeman and Company, New York ISBN 0-7167-2009-4, 4 th Edition.

Module VI **(8 hrs)**

Recombinant DNA Technology

Steps involved in recombinant DNA technology, vectors (plasmids, phage, cosmids, YAC), use of restriction enzymes. Genomic and cDNA library. PCR, *in situ* hybridization, RFLP, DNA fingerprinting, applications of rDNA technology.

Core Text:

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

Suggested Readings:

- .Molecular Biotechnology: Principles and applications of recombinant DNA: Bernard R. Glick and jack J. Pasternak.
- Genes IX by Benjamin Lewin (2008) Publisher: J&B ISBN:0763752223 ISBN-13: 9780763752224, 978-0763752224.
- Molecular Biology Of The Gene 5/e (s) by James D Watson, Tania A Baker, Stephen P Bell (2008) Publisher: Dorling Kindersley (India) Pvt Ltd ISBN-13: 9788177581812, 978-8177581812.
- Cell and Molecular Biology, 3e (2003) by Karp Publisher: ISBN: 0471268909 ISBN-13: 9780471268901, 978-0471268901.
- Molecular Cell Biology (2002) by H.S. Bhamrah Publisher: Anmol Publications ISBN: 8126111429 ISBN-13: 9788126111428, 978-8126111428.

Model Question Paper
BC 1544: Core Course-VIII

Course Title: Classical and Molecular Genetics

Time: **3hrs** Max. Marks: **80**

Section A

Answer all the questions in **a** word or in **one** or **two** sentences. **Each** question carries **one** mark.

1. How is H_1 histone significant in genome organization?
2. Define Central Dogma.
3. List out the stop codons.
4. Define a chimeric DNA.
5. Why are vectors important in rDNA technology?
6. Name any two organism used for genetic studies.
7. Name any two transcription inhibitors.
8. Why is UAG a stop codon?
9. Name the type of mutation caused by insertion or deletion of a nucleotide.
10. Illustrate different tRNA binding sites in a ribosome and indicate their function.

(10 ×1= 10 marks)

Section B

Answer **any eight** questions. **Each** question carries **two** marks.

11. Give two examples of ribozymes.
12. Is dominance a case of gene interaction? Justify.
13. Why lac operon is called an inducible operon?
14. Define an operon.
15. How is co dominance different from incomplete dominance?
16. Give two applications of DNA finger printing.
17. How did Mendel arrive at Law of independent assortment?
18. Is genetic code universal? Justify your answer.
19. Differentiate between penetrance and expressivity.
20. Brief on *in situ* hybridization.
21. Illustrate transduction with a figure.
22. Write a short note on Wobble Hypothesis.

(8 ×2= 16 marks)

Section C

Answer **any six** questions. **Each** question carries **four** marks.

23. Explain the reason for codon degeneracy.
24. A child inherited an autosomal dominant trait from parents lacking the trait. True or false- Justify.
25. Name the enzymes involved in DNA replication in prokaryotes.
26. Give a brief account of multiple drug resistance.
27. Briefly describe the structure and function of tRNA.
28. How is lactose hydrolysis regulated at gene level in prokaryotes?
29. How are Okazaki fragments significant in DNA replication?
30. Briefly explain the amplification of a piece of DNA.
31. List out the post transcriptional modifications in eukaryotes.

(6 ×4= 24 marks)

Section D

Answer **any two** of the following. **Each** question carries **fifteen** marks.

32. Explain the steps involved in development of recombinant DNA.

33. How is maternal effect distinct from maternal inheritance? Explain with examples.
34. Describe the various DNA repair systems in prokaryotes.
35. Explain the processes involved in synthesis of proteins from RNA in prokaryotes.

(2 ×15= 30 marks)

Semester-V

BC 1545: Core Course – IX -Practical
Course Title: Quantitative Analysis of Biomolecules

No. of Credits: 4 **No. of Contact Hours: 108**
Hours/week: 6

Objective of the course: To develop skill in quantitative analysis of different biomolecules in a given test sample.

Course outcome: Student will be able to quantitatively analyze different biomolecules in a given test sample.

1. **Quantitative Analysis of carbohydrates**

- Estimation of glucose by Nelson-Somogyi method
- Estimation of reducing sugar by Anthrone method.
- Estimation of reducing sugar Phenol-sulphuric acid.
- Estimation of pentose by Orcinol method.
- Estimation of ketose by Roe-Papadopoulos method.
- Estimation of reducing sugar by O-toluidine method.

2. **Quantitative Analysis of Lipids**

- Estimation of Cholesterol by Zak's method.
- Determination of Acid Value.
- Determination of Saponification value.

3. **Quantitative Analysis of Amino acids and Proteins**

- Estimation of Tyrosine by Folin-Lowry method.
- Estimation of Protein by Biuret method.
- Estimation of Protein by Folin-Lowry method.
- Estimation of Protein by Bradford's method.

4. **Quantitative Analysis of Nucleic Acids**

- Estimation of DNA by Diphenylamine method.
- Estimation of RNA by Orcinol method

References

- Experimental Biochemistry: A Student Companion, Beedu Sasidhar 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.

SEMESTER-VI

BC 1641: Core Course-X
Course Title: Clinical Biochemistry

No. of Credits: 4 **No. of Contact Hours: 72**
Hours/week: 4 **(L, T, P, C- 4, 1, 0, 4)**

Objective of the course: To introduce the students to the clinical applications of biochemistry and to provide them basic information about microbiology and pharmacology.

Course outcome: Student will be able to

- List out the methods of clinical laboratory management and laboratory safety.
- Describe the principle & procedure for studying clinical parameters used for diagnosis.
- Detail the basic concepts of microbiology and pharmacology

Course outline

Module I **(14 hrs)**

Laboratory Safety and Management

Management of biological hazards in laboratory. Management of errors in laboratory- Pre analytical (wrong patient identification, wrong test ordering and conduction, improper specimen collection, separation, aliquoting). Analytical (calibration errors, failure of diagnostic systems and instruments, analytical interference- test accuracy, precision, sensitivity, specificity), laboratory quality control (internal control, external control). Post analytical errors (errors in verifying lab results, result reporting, test interpretation, communication to clinicians) (basic aspects only).

Specimen collection and preservation: Collection of blood - phlebotomy - from vein, artery and capillary. Different types of vacutainers (basic concepts). Preparation of serum and plasma. Anticoagulants with examples. Collection of 24 hour urine sample, collection of CSF, preservation of blood, CSF and urine.

Automation in clinical laboratory: Basic concepts of sample identification by bar coding, automation in analysis (cite any two types) automation in measurement method-reflectance, luminescence, turbidometric, nephlometric, ion selective method (definition only).

Core Text:

- Tietz Text book of Clinical chemistry and Molecular Diagnostics. Carl A. Burtis, Edward R. Ashwood, David E. Bruns (Eds), Elsevier (Saunders) 2006.

Module II **(14 hrs)**

Analysis of Blood

Principle of estimation of Glucose (oxidase method). Normal value with respect to FBS, PPBS, RBS. GTT- preparation of patient, conduction of test, interpretation of results with special reference to normal and impaired glucose tolerance.

Diabetes mellitus (brief account of classification - type 1, type 2, gestational and characteristics (polyuria, polydypsia, polyphagia- definition only). Brief account of management (name of any two drugs, exercise diet - name of any two management methods only).
Lipid profile: Principles of estimation of cholesterol, triglycerides, LDL and HDL. Atherosclerosis- Brief account of characteristics, diagnosis (ECG, echocardiography, TMT , coronary angiography, intravascular ultrasound, magnetic resonance imaging– mention only), brief description of management (any two hypolipidemic drugs, angioplasty, stent, bypass surgery- mention only). Cardiac markers – CK-MB, AST (SGOT) and LDH.
Serum electrolytes- Principles of estimation of Na^+, K^+ and Cl^- - normal values.

Core Text:

- Text Book of Medical Laboratory Technology, Praful B Godkar, Darshan P. Godkar. Bhalani Publishing House, Mumbai. (2003).

Module III **(14 hrs)**

Organ Function Tests

Liver function tests- Principle of estimation, normal value and clinical significance of serum bilirubin-total and conjugated bilirubin - van den Bergh reaction (test for excretory function), Galactose tolerance test (test based on carbohydrate metabolism), marker enzymes of liver injury (AST, ALT and ALP), total protein, albumin, globulin, albumin/globulin ratio (test for synthetic function), Hippuric acid synthesis test (test based on detoxification function) and Bromosulphthalein test (BSP) retention test (test to assess excretory function).
Jaundice- brief account of symptoms and management (diet, alcohol abstinence, any two drugs, liver transplantation- very brief mention only).
Renal function tests- Principle of estimation of urea, creatinine, clearance tests (urea and creatinine), BUN- normal value and clinical significance. GFR (definition), nephritis- brief account of symptoms and management (hemodialysis and peritoneal dialysis).
Thyroid function test-Assay of T3, T4, TSH, normal value and clinical significance. (Brief mention about hyper and hypothyroidism).

Core Text:

- Basic Medical Biochemistry: A Clinical Approach by Dawn B., PH.D. Marks, Allan D. Marks Colleen M. Smith (1996) Publisher: Lippincott Williams & Wilkins; illustrated edition ISBN-10: 068305595X ISBN-13: 978-0683055955.

Module IV **(10 hrs)**

Analysis of Urine and CSF

Urine: Clinical significance of physical characteristics (colour, volume, pH, specific gravity) and chemical characteristics (normal and abnormal constituents).
CSF- Normal composition, routine analysis (protein, glucose, chloride and culture for detection of microbes) and clinical significance.

Core Text:

- Tietz Text book of Clinical chemistry and Molecular Diagnostics. Carl A. Burtis, Edward R. Ashwood, David E. Bruns (6^{TH} Eds), Elsevier (Saunders) 2006 ISBN: 8131213749, ISBN-13: 9788131212742, 978-8131213742.

Module V **(10 hrs)**

Microbiology

Classification of microorganisms (brief concept of major classification with examples), sterilization - physical and chemical (four types each), types of media- based on composition (any four) and physical nature- solid, semisolid, liquid), culturing of bacteria (any four methods), isolation of pure culture (any two methods), staining techniques (positive staining, negative staining, impregnation staining method , gram staining and acid fast staining).

Identification of bacteria (Staining, morphology of bacterial colony, culture characteristics, metabolism (indole production, methyl red /Voges Prokauer test, lactose fermentation test, citrate utilization test, TSI test, catalase test, oxidase test, urease test- brief description only), antibiotic resistance/sensitivity (with any two examples only).

Core Text:

- Methods of Microbiology. Pelczar MJ, Chan ECS. Tokyo: Kogakusha-McGraw Hill, 1981.
- Textbook of Microbiology and Immunology, 2 nd edition by SC Parija. Reed Elsevier India Pvt Ltd. ISBN-978-81-312-2810-4.

Module VI **(10 hrs)**

Pharmacology

Pharmacology, drugs, dosage forms (definitions only), sources of drugs, routes of administration, absorption and distribution. Mechanism of action (mention the target site), types of receptors and their mode of action. General mode of action of antibiotics- penicillin, streptomycin, tetracycline, chloramphenicol (outline only).

Core Text:

- Basic & Clinical Pharmacology by Bertram G. Katzung (2006) Publisher: Mcgraw-hill Medical Publishing ISBN: 0071451536 ISBN-13: 9780071451536, 978-0071451536

Suggested Readings

- Notes on Clinical Biochemistry by John K. Candlish (1992) Publisher: World Scientific Publishing Company ISBN: 9810210663 ISBN-13: 9789810210663, 978-9810210663.
- Clinical Biochemistry: Metabolic And Clinical Aspects by William J. Marshall, Stephen K. Bangert, Elizabeth S.M. Ed. SM. Ed. Marshall (2008) Publisher: Elsevier Science Health Science Div ISBN: 0443101868 ISBN-13: 9780443101861, 978-0443101861.
- Biochemistry by John K. Joseph (2006) Publisher: Campus Books International ISBN: 8180301109 ISBN-13: 9788180301100, 978-8180301100.
- Basic Medical Biochemistry: A Clinical Approach by Dawn B., PH.D. Marks, Allan D. Marks Colleen M. Smith (1996) Publisher: Lippincott Williams & Wilkins; illustrated edition ISBN-10: 068305595X ISBN-13: 978-0683055955.
- Clinical Chemistry, 6/e IE by William J Marshall, Stephen K Bangert (2008) Publisher: Else ISBN: 0723434603, ISBN-13: 9780723434603, 978-0723434603.
- Handbook of Experimental Pharmacology by Kulkarni SK (2007) Publisher: Vallabh Publications / Prakashan ISBN: 8185731128, ISBN-13: 9788185731124, 978-8185731124.

Model Question Paper
Core Course-X
BC 1641: Clinical Biochemistry

Time: **3 Hours** Maximum Marks**: 80**

Section A

Answer **all** the questions. Each question carries **1mark**.

1. Name the enzyme used in blood glucose estimation.
2. The normal serum concentration of urea is --------.
3. Name any two gram negative bacteria.
4. Define Clearance.
5. Mention the difference between direct and indirect bilirubin.
6. Name a Cardiac marker.
7. Creatine Clearance test is associated with ----------.
8. Mention any two antibiotics.
9. Expand GPCR.

10. Normal level of fasting blood glucose is ----------.

(10×1=10 marks**)**

Section B

Answer any **8** questions. Each question carries **2 marks**

11. Mention the action of any two anticoagulants.
12. Write the normal values of lipid profile.
13. Mention the clinical significance of Albumin-Globulin ratio.
14. Give a brief account of biological hazards and their management.
15. Mention the difference between specificity and sensitivity.
16. Give the clinical interpretation of increased serum GPT.
17. Differentiate Nephlometry and Turbidometry.
18. Name the abnormal constituents of urine.
19. Mention the types of sterilization methods.
20. Define GFR.
21. Mention the mechanism of action of Chloramphenicol.
22. List the functions of kidney

(8×2=16 marks)

Section C

Answer any **6** questions. Each question carries **4 marks**

23. Explain the renal function tests.
24. Give an account of staining techniques.
25. Write a note on atherosclerosis.
26. Explain van den Bergh test.
27. Differentiate obstructive and hemolytic jaundice.
28. Explain automation in clinical Laboratory
29. Explain thyroid function tests.
30. Give an account of administration and distribution of drugs
31. Explain briefly the characteristics used for the identification of bacteria.

(6 x 4 =24 marks)

Section D

Answer any **2** questions. Each question carries **15 marks**

32. Explain the principle procedure and clinical significance of Glucose tolerance test.
33. Write an essay on Liver Function tests.
34. Discuss in detail the causes, symptoms and management of any one Life style disease.
35. Explain the management of different types of errors in clinical laboratory.

(2 x 15=30 marks)

SEMESTER VI

BC 1642: Core Course-XI
Course Title: Metabolism-II

No. of Credits: 4 **No. of Contact Hours: 72**
Hours/week: 4 **(L, T, P, C – 4, 1, 0, 4)**

Objective of the course: To detail the metabolic events occurring in the biological system by explaining the different pathways of energy production and biosynthesis and to discuss different inborn errors of metabolism.

Course outcome: Student will be able to

- Describe the metabolism of lipids, nucleic acids, amino acids and heme.

- Explain the role of enzymes involved under physiological and pathophysiological conditions.
- List out the inborn errors of metabolism of above mentioned biomolecules.
- Detail the processes involved in biological nitrogen fixation.
- Enumerate the important detoxification processes in the body.

Course Outline

Module I **(15 hrs)**

Lipid Metabolism

Digestion and absorption of lipids, sources of body fat, hydrolysis of triacylglycerol, transport of fatty acid into mitochondria, α-, β- and ω- oxidation of saturated fatty acid, oxidation of monounsaturated and odd chain fatty acid. Sources of acetyl CoA, metabolism of ketone bodies, ketonuria. Biosynthesis of saturated fatty acid, biosynthesis of triglycerides, biosynthesis of important phospholipids (Lecithin and Cephalin), glycolipids (glucocerebroside), sphingolipids (sphingomyelin) and cholesterol, regulation of cholesterol metabolism, degradation of cholesterol to bile acids and formation of steroid hormones (glucocorticoids-cortisol, mineralocorticoids-aldosterone, sex hormones-testosterone, estrone and estradiol), disorders of lipid metabolism- Zellweger syndrome, Refsum's disease, Sudden infant death syndrome (SIDS).

Core Text:

- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.
- Principles of biochemistry, by Albert Lehninger, David L Nelson, Michael M Cox, CBS Publishers & Distributors Delhi ISBN 81-239-0295-6.

Module II **(15 hrs)**

Nucleic Acid Metabolism

Sources of atoms of purines and pyrimidines, *de novo* and salvage pathways of purine and pyrimidine with regulation, formation of adenylate (AMP), guanylate (GMP), uridylate (UMP), CTP, deoxy ribonucleotides, thymidylate (TMP) and nucleotide di- and triphosphates (Brief outline only), excretory products of purine and pyrimidine degradation. Gout. Disorders of purine or pyrimidine metabolism: Lesch-Nyhan syndrome, SCID.

Core Text:

- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.
- Principles of biochemistry, by Albert Lehninger, David L Nelson, Michael M Cox, CBS Publishers & Distributors Delhi ISBN 81-239-0295-6.

Module III **(8 hrs)**

Nitrogen Metabolism

Nitrogen cycle, Biological nitrogen fixation**:** symbiotic nitrogen fixation- leguminous plants (rhizobium as example), leghemoglobin, nitrogenase complex, non-symbiotic nitrogen fixation one example (only outline). Conversion of nitrate to ammonia by plants- nitrate reductase and nitrite reductase.

Core Text:

- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.
- Principles of Biochemistry, by Albert Lehninger, David L Nelson, Michael M Cox, CBS Publishers & Distributors Delhi ISBN 81-239-0295-6.

Module IV **(15 hrs)**

Amino Acid Metabolism

Nitrogen balance (positive, negative), general reactions of amino acid metabolism- transamination, oxidative deamination, transdeamination, and decarboxylation. Urea cycle and regulation. Glucogenic and ketogenic amino acids. Biosynthesis and degradation of glycine and phenylalanine (brief outline of formation of epinephrine, norepinephrine and melanin from tyrosine). Disorders of amino acid

metabolism (Alkaptonuria, phenylketonuria, maple syrup urine disease, Hartnup disease, tyrosinosis, albinism).

Core Text:

- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.
- Principles of biochemistry, by Albert Lehninger, David L Nelson, Michael M Cox, CBS Publishers & Distributors Delhi ISBN 81-239-0295-6.

Module V **(15 hrs)**

Heme Metabolism

Heme synthesis and degradation, abnormal hemoglobin, disorders of heme metabolism (porphyria - erythropoietic and hepatic, Criggler Najjar syndrome). Iron metabolism, iron absorption and transport, anemia.

Core Text:

- Biochemistry by Lubert Stryer, 4th Edition, W.H Freeman and Company ISBN 0-7167-2009-4.
- Principles of Biochemistry, by Albert Lehninger, David L Nelson, Michael M Cox, CBS Publishers & Distributors Delhi ISBN 81-239-0295-6.

Module VI **(4 hrs)**

Xenobiotic Metabolism

Biotransformation, detoxification process in the liver- phase I reactions- oxidation (alcohol detoxification), hydrolysis (hydrolysis of aspirin), reduction and phase II reactions -conjugation with glucuronic acid, sulphate, glycine, acetyl group with one example each (brief study), role of cytochrome P_{450} in detoxification.

Core Text:

- Textbook of Medical Biochemistry for Medical Students by DM Vasudevan and Sreekumari S. 5th edition, Japee Brothers, Medical Publishers, ISBN 81-8448-124-1:9788184481242.
- Biochemistry by U. Styanarayana and U. Chakrapani, 5th edition, Elsevier publication, ISBN: 9788131248850.

Suggested Readings:

- 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: Pearsarson ISBN: 0131977369, ISBN-13:9780131977365, 978-0131977365
- Biochemistry (2008) by Rastogi Publisher: McGraw Hill ISBN: 0070527954 ISBN-13: 9780070527959, 978-0070527959.

Model Question Paper
BC 1642: Core Course - XI
Course Title: METABOLISM - II

Time**: 3 Hours** Maximum Marks**: 80**

Section A

Answer **all** questions in **a** word or in **one** or **two** sentences. **Each** question carries **one** mark.

1. Name the starting material for cholesterol biosynthesis
2. Name the major pathway for the oxidation of fatty acids
3. Name two ketone bodies.
4. Mention the main sites of lipogenesis.
5. Which is the major pathway for the production of NADPH?
6. Name the key regulatory enzyme of fatty acid synthesis.
7. Name the enzyme which regulates the urea cycle.
8. Define oxidative deamination.
9. Dopamine is synthesized from which amino acid?
10. Name the end product of purine catabolism in humans.

(10 ×1= 10 marks)

Section B

Write a paragraph on **any eight** of the following. **Each** question carries **two** marks.

11. Outline the synthesis of glycine from serine & threonine
12. Write about the cause of albinism.
13. How is cholesterol biosynthesis regulated?
14. Illustrate transamination reaction.
15. How is gout caused?
16. Mention two inborn errors of amino acid metabolism and its cause.
17. How are methylated fatty acids oxidized?
18. Write the significance of salvage pathway.
19. Name the rate limiting enzymes involved in cholesterol biosynthesis and fatty acid synthesis.
20. Write the mechanism of action of statins.
21. Give the symptoms of ammonia toxicity.
22. Name any three biologically important compounds derived from cholesterol.

(8 ×2= 16 marks)

Section C

Answer **any six** of the following. **Each** question carries **four** marks.

23. Explain α–oxidation and the cause of Refsum's disease.
24. Write note on ketogenesis
25. How are triglycerides synthesized?
26. Write a note on the degradation of purine nucleotides.
27. How the fatty acids are elongated?
28. Discuss any two reactions involved in amino acid metabolism.
29. Explain Phase-I detoxification reaction
30. Discuss the causes & consequences of SIDS and Zellweger syndrome
31. Write a note on the disorders of nucleic acid metabolism.

(6 ×4= 24 marks)

Section D

Answer **any two** of the following. **Each** question carries **fifteen** marks

32. Describe the β-oxidation of Palmitic acid. Give an account of its energetics
33. Describe the pathway for the synthesis of Purine nucleotides.
34. Describe the cytoplasmic system of fatty acid biosynthesis
35. Enumerate the major steps involved in the synthesis of Cholesterol.

(2 ×15= 30 marks)

SEMESTER-VI

BC 1643: Core Course-XII - Practical
Course Title: Clinical Biochemistry and Enzymology

No. of Credits: 4 **No. of Contact Hours: 108**
Hours/week: 6

Objective of the course: The course aims to develop skill in quantitative analysis of different parameters of clinical significance in blood/urine and detection of abnormal constituents in urine.

Course outcome: Student will be able to

- Quantitatively analyze parameters of clinical significance in blood and urine.
- Detect the presence of abnormal constituents in the urine sample.

1. **Collection of blood and separation of serum & plasma**
2. **Quantitative estimation in Blood/ Serum:**
    - Glucose by Nelson-Somogyi method
    - Cholesterol by Zak & Henly's method
    - Total Protein by Biuret method
    - Albumin: Globulin ratio
    - Creatinine by Jaffe's method
    - Urea by Diacetylmonoxime method
    - Uric acid by Caraway method
    - Bilirubin by van den Bergh method
    - Hemoglobin content by Cyanmethaemoglobin method
    - Phosphorus by Fiske and Subbarow method
    - Iron by ά ά dipyridyl method
3. **Hematology -** ESR, PCV, TC/DC count, Blood Grouping, Hemoglobin.
4. **Urine Analysis**

    Qualitative tests of urine: detection of abnormal constituents

    Proteins (Coagulation test, sulfosalicylic acid test, test for Bence-Jones proteins), Sugars (Benedicts test), Hemoglobin (o-toluidine test), Ketone bodies (Rothera's test, Gerhardt's test), Bile pigments (Fouchet's test, Gmelin's test) and Bile salts (Hay's sulphur test).

    Quantitative estimation in urine

    - Urea by Diacetylmonoxime method
    - Uric acid by Caraway method
    - Creatinine by Jaffe's method

5. Clinical Enzymology:

- Assay of serum alkaline phosphatase
- Assay of serum alanine amino transferases (ALT/SGPT)
- Assay of serum aspartate amino transferases (AST/SGOT)
- Assay of serum lactate dehydrogenases.

References

- Experimental Biochemistry: A Student Companion, Beedu Sasidhar 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.
- Practical Clinical Chemistry, Harold Varley, CBS Publishers and Distributors, New Delhi

SEMESTER-VI

BC 1644: Core Course-XIII- Practical
Course Title: Food Analysis

No. of Credits: 4 **No. of Contact Hours: 90**
Hours/week: 5

Objective of the course: The course aims at developing skill in the quantitative analysis of specific biomolecule in the food sample and detection of common adulterants.

Course outcome: Student will be able to

- Quantitatively estimate the specific biomolecule in any given food sample.
- Detect the presence of adulterants in different food samples.

1. Quantitative Food Analysis

- Estimation of cholesterol in egg.
- Estimation of fructose in honey.
- Estimation of pentose in grapes.
- Estimation of glycogen from liver.
- Estimation of sucrose in jaggery.
- Estimation of ascorbic acid in orange juice.
- Isolation of protein from milk.
- Isolation and estimation of starch from potato

2. Détection of Adulterants in Food (Qualitative Analysis)

Milk- detection ofcane sugar, starch, cellulose, added urea, formalin, gelatin, ammonium compounds, sulphates, anionic detergents, skimmed milk powder, sodium chloride and neutralizers (any 8).

Testing of adulterants like metanil yellow (in turmeric & jaggery), rhodamine-B (in chilli powder),chicory (in coffee), sodium bicarbonate (in flour & jaggery), lead chromate (in pulses), vanaspati, coal tar dye &starch (in ghee), added sugar (in honey) prohibited colors, argemone oil & cotton seed oil (in edible oil).

3. Phytochemical Screening in Plant extract

Alkaloids (Wagner's test), Cardiac glycosides (Keller Kelliani's test), Flavonoids (Alkaline reagent test), Phenols (Ferric chloride test) Phlobatannins (Precipitation test), Amino acids (Ninhydrin test), Saponins (Foam test) Sterols (Zaks test), Tannins (Braemer's test), Terpenoids (Salkowski test) Anthroquinones (Borutrager's test), Coumarins and Carboxylic acids.

4. Quantitative Analysis of Phytochemicals

- Total Phenolic Content (Modified Folin-Ciocalteau method)
- Total Flavonoid Content (Zhishen et al method)
- Total Alkaloid Content (Sodium metaperiodate method)

References

- Food Safety and Standards Authority of India. Ministry of Health and Family Welfare, Government of India
- Food Science. 2nd edition, SR Mudambi, SM Rao and MV Rajagopal (2006). New Age International Pvt.Ltd. ISBN-81-224-1779-5
- Laboratory Handbook on Biochemistry. S.Shanmugam, J.Satish Kumar,K. Paneer Selvan Publisher: PHI Learning Private Limited New Delhi ISBN 976-81-2030-4103-6.

SEMESTER –VI

BC 1661.1: Elective Course
Course Title: Analytical Biochemistry

No. of credits: 2 **No. of contact hours: 54**

Hours/ Week: 3 **(L, T, P, C- 3, 1, 0, 2)**

Objective of the course: The course aims at enabling the students to understand the fundamentals of Analytical Biochemistry. A sound knowledge of analytical biochemistry will help in understanding the analysis of phytochemicals, food adulterants, water and toxicants in food and biological samples.

Course outcome: Student will be able to

- Perform phytochemical analysis.
- Identify the importance and impact of pesticides in life
- Detect food adulteration
- Elaborate standards for respective category of water
- Recognize the effect of toxic metals in foods
- Analyze toxicants in biological samples

Course Outline

Module I **(10 hrs)**

Phytochemical Analysis

Pre-washing, drying of plant materials or freeze drying, grinding, methods of solvent extraction (sonification, heating under reflux, soxhlet extraction, maceration using solvents in the increasing order of polarity). Experimental procedures for the various phytochemical screening methods for the secondary metabolites - Alkaloid (Dragendorff's test, Wagner test), Anthraquinone (Borntrager's test), Cardiac glycosides (Kellar – Kiliani test), Flavonoid (Shinoda test), Phenol (Phenol test), Reducing sugar (Fehling test), Saponin (Frothing test / Foam test), Steroid (Liebermann- Burchard test), Tannin (Braemer's test), Terpenoid Salkowski test). Quantitative estimation of phenols, flavonoids, tannins and alkaloids. Isolation of bioactive compounds using separation techniques such as TLC, column chromatography, flash chromatography, Sephadex chromatography and HPLC.

Core Text:

- Laboratory Handbook on Biochemistry. S.Shanmugam, J.Satish Kumar,K. Paneer Selvan Publisher: PHI Learning Private Limited New Delhi ISBN 976-81-2030-4103-6.

Module II **(10 hrs)**

Pesticides and Health Risks

Classification of Pesticides- based on chemical nature- (organochlorine, organophosphate, carbamates, pyrethrum, biopesticides), by site of action (stomach toxicants, contact toxicants, fumigants, systemic toxicants, chemical repellents). Pesticide formulation. Pesticide labels and labelling, Material Safety Data Sheet (MSDS), determination of the signal word-based on toxicity category (category I, II, III and IV), importance of reading and understanding pesticide labels. Tests on pesticides for determining human health risk- types of toxicity- (acute - LD_{50} or LC_{50}), chronic, teratogenicity, gene mutation, chromosome aberration, neurotoxicity, immunotoxicity). Pesticide residue in foods: Maximum residue level (MRL), Acceptable daily intake (ADI), analysis of pesticide residue in foods- Gas chromatography.

Core Text:

- Toxicology: Principles and methods. M. A. Subramanian. Publisher: MJP Publishers; 2 nd edition. ISBN-10**:** 9788180940781.

Module III **(8 hrs)**

Analysis of Food Adulterants

Elementary study- detection of adulterants in- milk, edible oils and fats, spices and condiments (turmeric powder, chilli powder, coriander powder, black pepper powder, asafoetida, saffron), cereal flour, sugar, pulses, cereals, green vegetables and honey.

Core Text:

- Food Science Chemistry and Experimental Foods. Dr. M.S. Swaminathan Publisher: The Bangalore Printing and Publishing Co. Ltd. SBN-13 5551234022180.

Module IV **(10 hrs)**

Water Analysis

Physical parameters-temperature, pH, color, odour, turbidity, total dissolved solids. Chemical parameters- total hardness (titrimetric method), detection of chloride (Argentometric method), Nitrate (Phenoldisulphonic acid (PDA) method, fluoride (zirconium alizarin method).Organic, nutrient and demand- Dissolved oxygen, BOD (Winkler method), COD (dichromate method), pesticide residue (gas chromatography).Toxic metal detection- Cadmium, Lead, Mercury (Atomic Absorption Spectroscopy (AAS). Bacteriological analysis- test for coliform bacteria-multiple tube dilution method (presumptive, confirmed and completed test).

Core Text:

- Microbiology by Lansing M. Prescott, John P. Harley and Donald A. Klien. 5 th edition. Publisher: McGraw- Hill Higher Education. ISBN- 13: 978-0072320411.

Module V **(8 hrs)**

Analysis of Toxic Metals in Foods

Toxicology of metals - analysis of metal elements in food using colorimetry- copper (carbamate method), lead and mercury - by dithizone method, arsenic (molybdenum blue method) Outline study of action and detection of alcohol in beverage (colorimetric method using sodium dichromate), copper (carbamate method), lead, mercury(dithizone method) and arsenic (molybdenum blue method).

Core Text:

- Parikh's Text book of Medical Jurisprudence Forensic Medicine and Toxicology, 6 th edition, Dr. C. K. Parikh. CBS Publishers & Distributors. ISBN-13: 978-8123906751.

Module VI **(8 hrs)**

Toxicological Analysis of Biological Samples

Mechanism of toxicity action of lead, mercury, arsenic, cyanide and carbon monoxide (outline only). Detection of copper, lead, mercury, arsenic, cyanide and carbon monoxide in biological samples.

Core Text:

- Parikh's Text book of Medical Jurisprudence Forensic Medicine and Toxicology, 6 th edition, Dr. C. K. Parikh. CBS Publishers & Distributors. ISBN-13: 978-8123906751.

Suggested readings

- Food and Nutrition: Medical, Nursing and Allied Sciences 2nd edition Harbans Lal. Publisher: CBS publishers and Distributers Pvt. Ltd. ISBN 10: 8123922671.
- Food Science Experiments and Applications Mohini Sethi, Eram S. Rao, 2 nd edition CBS Publishers and Distributors ISBN 10: 81-239-16930.
- Textbook of Toxicology. Balram Pani Publisher: I K International Publishing House Pvt. Ltd. ISBN-10: 9789380578408.
- Environmental Toxicology. Satake M. Publisher: Discovery Publishing Pvt. Ltd. ISBN: 8171413501.
- The Essentials of Forensic Medicine and Toxicology, Dr. K. S. Narayan Reddy and O.P. Murty, 34th Edition. Jaypee Brothers Medical Publishers. ISBN-10: 9789352701032.
- Microbiology, Michael J. Pelczar, E. C. S. Chan, Noel R. Krieg. Mc Graw-Hill: New York ISBN: 0- 07- 049234-4.
- Food Science, B. Sreelakshmi, 3rd edition, New Age International Pvt. Ltd. ISBN- 8122420222.
- Text Book of Microbiology. R. C. DUBEY AND D.K. Maheswary**.** Revised Ediition **.**Publisher: S. Chand ISBN-10: 8121925592.

Model Question Paper
BC 1661.1 Elective Course
Course Title: Analytical Biochemistry

Time: **3hours** Maximum Marks: **80**

Section -A

Answer **all** questions in **a word** or in **one** or **two sentences**. Each question carries **one** mark.

1. Name the test for detection of alkaloids.
2. Expand FSSAI.
3. List the method for analysis of lead in foods.
4. Give two examples for organo phosphorous pesticides.
5. Define MRL.
6. Define $LC_{50.}$
7. Give the common adulterants in chilli powder.
8. Name the method for detection of mercury in water.
9. List two methods for the isolation of bioactive compounds.
10. Define MSDS.

(10 ×1= 10 marks)

Section-B

Write a paragraph on **any eight** of the following. Each question carries **two** marks.

11. Define ADI and mention its significance in human health.
12. List the adulterants found in cereal flour and pulses.
13. Give the test to detect anthraquinones and flavonoids.
14. Differentiate between acute and chronic toxicity.
15. Mention how adulterants in green vegetables are detected.
16. Outline the colorimetric method for detection of alcohol in beverage.

17. Give the classification of pesticide based on site of action.
18. A pesticide product has the signal word CAUTION on its label. Categorize it and state its LD_{50}.
19. Give the method for detection of arsenic in biological sample.
20. Write on the importance of biopesticides.
21. Define teratogenicity and state its importance.
22. Define BOD.

(8×2=16 marks)

Section-C

Write **Short essay** not exceeding 120 words. Answer **any six**. Each question carries **four** marks

23. Explain the relevance of chromatography in phytochemical analysis.
24. Give an account of pesticide labels and labeling.
25. Colorimetric method for detection of copper and mercury in foods.
26. Give an account of the detection of adulteration in condiments.
27. Discuss on the classification of pesticides on chemical nature.
28. Write on the mechanism of lead poisoning.
29. Explain bacteriological analysis in water.
30. How adulteration in milk is detected?
31. Write on pesticide formulation.

(6×4=24 marks)

Section-D

Write **Long Essay**. Answer **any two** questions. Each question carries **fifteen** marks.

32. Explain the different steps involved in phytochemical analysis.
33. Elaborate on the types of toxicity induced by pesticides.
34. Discuss the mechanism of carbon monoxide poisoning and its detection.
35. Detail the methods for determining chemical parameters in water analysis.

(2×15=30 marks)

SEMESTER-VI

BC 1661.2: Elective Course
Course Title: Immunology and Immunological Techniques

No. of Credits: 2 **No. of Contact Hours: 54**
Hours/week: 3 **(L, T, P, C - 3, 1, 0, 2)**

Objective of the course: It aims at enabling the students to understand the fundamentals of Immunology and Immunological techniques. A proper understanding of life processes requires familiarity with the discipline of immunology. A sound knowledge of immunology and techniques will help in understanding assessment of functions, disordered functions, diagnosis and treatment of diseases

Course outcome: Student will be able to

- Describe various aspects in basic immunology
- Identify the applications of various techniques involved in immunology.

Course Outline

Module I **(10 hrs)**

Introduction to General Immunology

Organs of Immune system, Primary and Secondary lymphoid organs-bone marrow, spleen, lymph nodes, thymus and MALT. Cells of Immune system, Hemopoietic stem cells, B and T lymphocytes, NK cells, mononuclear phagocytes and Granulocytic cells.

Core Text:

- Kuby Immunology by Thomas J. Kindt (2006) Publisher: W H Freeman & Co ISBN: 0716785900, ISBN-13: 9780716785903, 978-0716785903

Module II **(10 hrs)**

Immunity

Types of Immunity-innate immunity - mechanical protection and chemical protection, phagocytosis, inflammation. Adaptive immunity-humoral and cell mediated immunity. Cells of adaptive immune system, Antigen presenting cells, clonal selection of lymphocytes, Cellular interaction for generation of humoral and cell mediated responses (Brief outline only)

Core Text:

- Kuby Immunology by Thomas J. Kindt (2006) Publisher: W H Freeman & Co ISBN: 0716785900, ISBN-13: 9780716785903, 978-0716785903

Module III **(10 hrs)**

Antigens

Chemical nature of antigens, antigenic determinants, haptens, Immunoglobulins-class, structure and functions of Immunoglobulins. Complement system (outline only).

Core Text:

- Kuby Immunology by Thomas J. Kindt (2006) Publisher: W H Freeman & Co ISBN: 0716785900, ISBN-13: 9780716785903, 978-0716785903

Module IV **(6 hrs)**

Molecular Basis of Immune Function

T-cell and B-cell receptor, activation and proliferation of T and B-cells. (Brief outline only). MHC antigens, functions of cytokines, lymphokines and interleukins (Brief outline only).

Core Text:

- Kuby Immunology by Thomas J. Kindt (2006) Publisher: W H Freeman & Co ISBN: 0716785900, ISBN-13: 9780716785903, 978-0716785903

Module V **(6 hrs)**

Disease Related to Immune Function

Allergy and Hypersensitivity-immediate and delayed type hypersensitivity, Autoimmunity, autoimmune diseases. Immunodeficiency disorders, AIDS, Vaccines and Immunization (brief study).

Core Text:

- Kuby Immunology by Thomas J. Kindt (2006) Publisher: W H Freeman & Co ISBN: 0716785900, ISBN-13: 9780716785903, 978-0716785903

Module VI **(12 hrs)**

Antigen -Antibody Interactions

Precipitation reactions, Agglutination. ELISA, RIA, Immunodiffusion, Immunofluorescence, Production of monoclonal antibodies (Hybridoma technology), Monoclonal antibodies in diagnosis and therapy (Brief outline).

Core Text:

- Kuby Immunology by Thomas J. Kindt (2006) Publisher: W H Freeman & Co ISBN: 0716785900, ISBN-13: 9780716785903, 978-0716785903

Suggested Readings

- Immunology: An Introduction by Ian R Tizard (2006) Publisher: Cengage Learning (Thompson) ISBN: 8131500039, ISBN-13: 9788131500033, 978-8131500033

- Immunology and Immunotechnology by Chakravarty (2006) Publisher: Oxford University Press N Delhi ISBN: 0195676882, ISBN-13: 9780195676884**,** 978-0195676884
- Immunology by K.R. Joshi **(**2007) Publisher: Agrobios (India) ISBN**:** 8177541749, ISBN-13: 9788177541748**,** 978-8177541748
- Basic Immunology, 3ed by: Abbas Publisher: Elser ISBN: 8131217477, ISBN-13: 9788131217474**,** 978-8131217474
- Immunology by P.R. Yadav **(**2004) Publisher: Discovery Publishing House ISBN: 8171418570, ISBN-13: 9788171418572**,** 978-8171418572
- Immunology by David A. Marcus, Richard A. Goldsby, Barbara A. Osborne **(**2003) Publisher: WH. Freeman & Company ISBN: 0716749475 ISBN-13: 9780716749479**,** 978-0716749479.

Model Question Paper
BC 1661.2: Elective Course
Course Title: Immunology and Immunological Techniques

Time: **3 Hours** Max. Marks: **80**

Section-A

Answer all questions in a word or in **one** or **two** sentences. Each question carries **one** mark.

1. Which immunoglobulin is involved in allergic reaction?
2. Antibody secreting cells are called……..
3. Define Epitope.
4. How is allergy caused?
5. The class of antibody synthesized in primary immune response
6. Name a phagocytic cell.
7. Lymphocytes originate from
8. A technology used to produce monoclonal antibody.
9. Name a primary lymphoid organ.
10. Define agglutination.

(10 × 1 = 10 Marks)

Section- B

Write a paragraph on **any eight** of the following. **Each** question carries **2 marks**

11. Differentiate between humoral immunity and cell mediated immunity.
12. Write short note on interleukins
13. Mention the role of NK cells
14. Define a hapten.
15. Differentiate between primary immune response and secondary immune response
16. Define immunofluorescence
17. Write about antigen presenting cells.
18. Define complement system
19. Differentiate between affinity and avidity.
20. Mention the type of force involved in antigen – antibody interactions.
21. How do the T lymphocyte originate?
22. How does spleen act as blood filtering organ?

(8 × 2 = 16 Marks)

SECTION- C

. Answer **any six** of the following. **Each** question carries **four marks**

23. Briefly describe the principle and methodology of ELISA.
24. Comment on B cell and T cell receptors.
25. Briefly describe the production of monoclonal antibodies.
26. Briefly explain Major Histocompatibility Complex.
27. Write about the different types of vaccines.
28. Briefly describe innate immunity.
29. Write on immunodiffusion.
30. Briefly describe the major events in the inflammatory response.
31. Write short note on autoimmune response.

(6 × 4= 24 Marks)

SECTION- D

Answer **any two** of the following. **Each** question carries **15 marks**

32. Describe the principal cells and tissues of the immune system.
33. Give an account on hypersensitivity reaction.
34. Describe the structure, classification and function of immunoglobulins
35. Discuss about any three immunological techniques.

(2× 15 = 30 Marks)

SEMESTER-V

BC 1551.1: Open Course
Course Title: Clinical Diagnosis of Common Diseases

No. of Credits: 2 **No. of Contact Hours: 54**
Hours/week: 3 **(L, T, P, C -3, 1, 0, 2)**

Open courses are offered to students of various other diciplines like arts, humanities and languages. Hence the approach to open course should be made only at a peripheral level. Indepth approach is not expected in this course.

Objective of the course: To provide the fundamental basis for the interpretation of various biochemical tests of diseased conditions.

Course outcome: Student should be able to
- Explain the importance of each clinical parameter studied.
- List out the parameters measured under various disease conditions.
- Gain knowledge about the normal levels of different clinical parameters
- Identify the diseases by interpreting the variations in clinical data.

Course Outline

Module I **(10 hrs)**

Hematological parameters

Components of blood, function, routine hematological tests – (normal values, brief outline of procedure and clinical significance). TC/DC count, ESR, PCV, hemoglobin concentration, platelet count, bleeding time and clotting time.

Core Text:

- Medical Laboratory Technology Volume I, Kanai. L. Mukharjee, Page No. 215-218; 228-307.

Module II **(10 hrs)**

Blood Analysis

(Normal values, brief outline of procedure and clinical significance).

Glucose- fasting blood sugar, random blood sugar, post prandial blood sugar. Protein- Clinical significance, normal values, total protein, albumin, globulin, A/G ratio. Lipid Profile- Cholesterol, Triglycerides, HDL and LDL.

Core Text:

- Medical Laboratory Technology Volume III, Kanai. L. Mukharjee, Page No. 985-1029.

Module III **(10 hrs)**

Enzymes of clinical interest

Function, clinical significance and location in body: Amylase, Phosphatases (acid and alkaline), Transaminase (AST&ALT), Creatine kinase (CK), Glucose 6 phosphate dehydrogenase (G-6-PD) and Lactate dehydrogenase (LDH).

Core Text:

- Fundamentals of Biochemistry for Medical Students, Dr. Ambika Shanmugam, Page No. 140-144.

Module IV **(6 hrs)**

Blood banking: Human blood groups, importance of blood transfusion, collection of blood for blood transfusion, blood grouping, transfusion reactions, hemolytic disease of the new born (erythroblastosis foetalis).

Core Text:

- Medical Laboratory Technology Volume I, Kanai. L. Mukharjee.

Module V **(6 hrs)**

Clinical Pathology

Brief outline of the following:

Urine analysis- routine examination for abnormal constituents (Glucose, Protein, Ketone bodies, Bilirubin, Occult blood),

Body fluid analysis- Normal value and clinical significance of glucose and protein in cerebrospinal fluid (CSF). Detection of microbes in CSF through culture.

Gastric juice- Total acidity

Core Text:

- Medical Laboratory Technology Volume II, Kanai. L. Mukharjee, Page No. 801-850.

Module VI **(12 hrs)**

Functions of Different Organs, Associated Diseases & their Diagnosis

Liver- jaundice, fatty liver and cirrhosis. *Kidney*- Nephritis. Heart- Atherosclerosis. *Pancreas*- Pancreatitis. *Lungs*- Acidosis and alkalosis. *Brain*- Tumor and hemorrhage.

Core Text:

- Medical Laboratory Technology Volume III, Kanai. L. Mukharjee, Page No. 905-908.

Suggested Readings:

- A procedure for routine diagnostic tests, Tata Mc. Graw- Hill Publishing Company Ltd., New Delhi, 12 th reprint, 1988)
- Bauer J.D. Clinical Laboratory Methods, C.V. Mosby, St. Louis 1982.
- Bowley C. C., K.L.G. Goldsmith & Wd'A Maycock, Blood Transfusion: A guide to the formation & operation of a transfusion service, World Health Organisation, 1971.
- Bishop M.L.-J.L. Dlaufer & E.P. Fody, Clinical Chemistry, Lippincott Company, Philadelphia, 1985.

Model Question Paper
BC 1551.1: OPEN COURSE-I

Course Title: Clinical Diagnosis of Common Diseases

Time**: 3 hours** Max. Marks: **80**

Section-A

Answer **all** questions in a word or in **one** or **two** sentences. Each question carries **one** mark.

1. ECG is --------.
2. Serum Glutamate Oxaloacetate Transaminase is a marker enzyme of --------.
3. Albumin is synthesized in……
4. Bilirubin originates from the breakdown of ……
5. Normal level of serum total cholesterol is ……
6. Good cholesterol is Polyuria is the symptom of ……
7. The Van den Bergh test is used in ……
8. The main constituent of urine is …….
9. The hormone deficient in type I diabetes is ……
10. ESR is measured by ……..

(10 x 1 = 10 Marks)

Section-B

Write a paragraph on **any eight** of the following. **Each** question carries **2 marks**

11. Mention the causes of nephritis.
12. Give any two functions of liver.
13. Write about the hemolytic disease of newborn.
14. Name the enzymes elevated in acute MI.
15. Name any two risk factors associated with cardiovascular disorders.
16. List the causes of fatty liver.
17. Name the important liver function tests.
18. Name any two abnormal constituents of urine.
19. Define diabetes.
20. Differentiate bleeding time and clotting time.
21. Write the significance of coronary angiography.
22. Differentiate between acidosis and alkalosis.

(8x2 = 16 marks)

Section-C

. Answer **any six** of the following. **Each** question carries **four marks**

23. Briefly describe the enzymes used in liver function test.
24. Comment on clearance tests.
25. Discuss on the management of nephritis
26. Briefly explain different types of Jaundice.
27. Explain GTT.
28. Briefly describe the glomerular filtration rate
29. Write a note on plasma proteins.
30. Briefly describe the routine hematological tests.
31. Write short note on components and functions of blood.

(6 x 4= 24 Marks)

Section-D

Answer **any two** of the following. **Each** question carries **15 marks**

32. Comment on the importance of blood transfusion.
33. Discuss about the symptoms, causes, diagnosis and prevention of atherosclerosis
34. Write an essay on different hematological parameters.
35. Write an essay on enzymes of clinical interest

(15x 2 = 30 Marks)

SEMESTER-V

BC 1551.2: Open Course
Course Title: Lifestyle Diseases

No. of Credits: 2 **No. of Contact Hours: 54**
Hours/week: 3 **(L, T, P, C - 3, 1, 0, 2)**

Open courses are offered to students of various other diciplines like arts, humanities and languages. Hence the approach to open course should be made only at a peripheral level. Indepth approach is not expected in this course.

Objective of the course: To create general awareness among students about the various diseases associated with lifestyle and which could be prevented by managing life style.

Course Outcome: Student will be able to

- Enumerate the different causes and risk factors of life style diseases like atherosclerosis, hypertension, stroke, diabetes, obesity, nephritis and liver diseases.
- List out the methods to diagnose the diseases and gain a basic knowledge regarding interpretation of the test results.
- Spell out the methods of prevention, treatment and management of the diseases.
- Identify healthy and unhealthy life habits and adopt better life style.

Course Outline

Module I **(4 hrs)**

Introduction to Healthy Lifestyle

Life style, food habits, healthy habits, exercise and unhealthy habits (brief description only). Basic biochemistry (Biomolecules- carbohydrates, lipids, proteins, nucleic acids, vitamins, minerals – brief outline).

Core Text:

- Biochemistry – U. Satyanarayana, U. Chakrapani , 3rd edition, ISBN 81-87134-80-1
- Textbook of Medical Biochemistry for Medical Students by DM Vasudevan and Sreekumari S. 5 th edition, Japee Brothers, Medical Publishers, ISBN 81-8448-124-1:9788184481242.
- Guide to Prevention of Lifestyle Diseases by R. Kumar (Author), M. Kumar (Author), Deep & Deep Publications, ISBN-13: 978-8176295185.

Module II **(16 hrs)**

Atherosclerosis, Hypertension and Stroke

*Atherosclerosi*s: characteristics, causes (confirmed & indirect risk factors – brief description only), ischemia, myocardial infarction (definition), diagnosis (electrocardiography, exercise stress test, echocardiography, coronary angiography, intravascular ultrasound, magnetic resonance imaging – brief description only), prevention (lifestyle, diet, drugs), management (drugs, angioplasty, stenting, bypass surgery- brief description only)

*Hypertension***:** characteristics, Causes, Diagnosis, Prevention and Management (brief description only)

*Stroke***:** characteristics (ischemic and hemorrhagic), causes, diagnosis (neurological examination, scanning - brief description only), management (drugs, mechanical thrombectomy, angioplasty and stenting - brief description only)

Core Text:

- Guide to Prevention of Lifestyle Diseases by R. Kumar (Author), M. Kumar (Author), Deep & Deep Publications, ISBN-13: 978-8176295185.
- Textbook of Medical Biochemistry for Medical Students by DM Vasudevan and Sreekumari S. 5 th edition, Japee Brothers, Medical Publishers, ISBN 81-8448-124-1:9788184481242.

Module III **(12 hrs)**

Diabetes mellitus and Obesity

Diabetes mellitus: classification (type 1, type 2, gestational- brief description only), symptoms (polyuria, polydypsia, polyphagia), causes, diagnosis (GTT, glycated haemoglobin- brief description only), management (diet, exercise, drugs).

*Obesity***:** classification according to BMI (brief description), symptoms, causes, diagnosis, treatment and management.

Core Text:

- Guide to Prevention of Lifestyle Diseases by R. Kumar (Author), M. Kumar (Author), Deep & Deep Publications, ISBN-13: 978-8176295185.
- Textbook of Medical Biochemistry for Medical Students by DM Vasudevan and Sreekumari S. 5 th edition, Japee Brothers, Medical Publishers, ISBN 81-8448-124-1:9788184481242.

Module IV **(8 hrs)**

Cancer

Types of cancer, benign and malignant tumor, metastasis (definition), causes, diagnosis (screening, blood tests, X-rays, CT scans & endoscopy - brief description only), prevention (dietary, medication, vaccination, screening- outline only), treatment and management (surgery, chemotherapy, radiation, palliative care).

Core Text:

- Cell and Molecular Biology by Gerald Karp, John Wiley & Son, Inc. New York ISBN 978 0470-16961-2, 5th Edition.
- Guide to Prevention of Lifestyle Diseases by R. Kumar (Author), M. Kumar (Author), Deep & Deep Publications, ISBN-13: 978-8176295185.

Module V **(7 hrs)**

Nephritis

Function of kidney (brief outline), GFR, nephritis (definition), causes, symptoms, diagnosis (kidney function test - brief outline of serum and urine creatinine, blood and urine urea, BUN, clearance test-creatinine and urea), treatment, management (dialysis- peritoneal and hemodialysis).

Module VI **(7hrs)**

Liver disease

Function of liver (brief outline), liver disease (viral hepatitis, alcoholic liver disease, and cirrhosis), symptoms, causes, diagnosis (liver function test- brief outline of serum bilirubin, serum albumin, serum alkaline phosphatase, ALT, AST and LDH), treatment and management.

Core Text:

- Guide to Prevention of Lifestyle Diseases by R. Kumar (Author), M. Kumar (Author), Deep & Deep Publications, ISBN-13: 978-8176295185.
- Textbook of Medical Biochemistry for Medical Students by DM Vasudevan and Sreekumari S. 5th edition, Japee Brothers, Medical Publishers, ISBN 81-8448-124-1:9788184481242.
- Biochemistry – U. Satyanarayana, U. Chakrapani , third edition, ISBN 81-87134-80-1

Suggested Reading

- Textbook of Medical Physiology, by Arthur C Guyton, John E Hall Prism Saunders 9th Edition ISBN: 81-7286-034-X.

Model Question Paper
BC 1551.2: Open Course
Course Title: Lifestyle Diseases

Time: **3 hours** Max. Marks: **80**

Section– A

Answer all the questions in a word or in **one** or **two** sentences. Each question carries **one** mark.

1. Mention one function of protein.
2. Define healthy life style.
3. Give the significance of ALT.
4. Give one method for diagnosing diabetes.
5. Myocardial infarction is commonly known as……
6. Mention one symptom of stroke.
7. In which condition does cancer cells spread from one site to another
8. Name the condition in which serum bilirubin is high.
9. Give the function of a stent.
10. Give the expansion of ECG.

(10 × 1 = 10 marks)

Section-B

Write a paragraph on **any eight** of the following. **Each** question carries **2 marks**

11. Define GFR.
12. Give any two unhealthy habits.
13. Distinguish between angiography and angioplasty.
14. Name any four biomolecules.
15. Name any two risk factors associated with cardiovascular disorders.
16. Define BUN. Give its clinical significance.
17. Which are the bases present in DNA?
18. Name the diseases associated with obesity.
19. Define diabetes.
20. Name two drugs used for the treatment of heart diseases.
21. Write any two methods in the treatment of cancer.
22. Write two characteristic features of stroke.

(8 × 2 = 16 marks)

Section- C

Answer **any six** of the following. **Each** question carries **four marks**

23. Briefly describe functions of liver.
24. Comment on clearance tests.

25. Discuss on the management of nephritis.
26. Distinguish between fasting, random and post prandial blood sugar.
27. Differentiate benign and malignant condition?
28. Define BMI. Give the chart relating BMI to obesity.
29. Write short notes on the different types of cancer.
30. Give a brief account of management of hypertension.
31. Briefly describe liver function tests.

(6 × 4= 24 marks)

Section-D

Answer **any two** of the following. Long essay. **Each** question carries **15 marks**

32. Describe the different types, symptoms, causes and the management of diabetes.
33. Discuss on the characteristics, causes, diagnosis and prevention of atherosclerosis.
34. escribe the causes, prevention and management of cancer
35. Explain the symptoms, causes and management of nephritis.

(2 × 15 = 30 marks)