UNIVERSITY OF CALICUT

(Abstract)

B.Sc Programme in Biochemistry – under Choice based Credit Semester System – Scheme and Syllabus – implemented with effect from 2009 admission onwards – approved - Orders issued.

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GENERAL & ACADEMIC BRANCH – 1 ‘J’ SECTION

No.GA.I/J1/2560/06 Dated, Calicut University P.O., 25-06-2009-----------------------------

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   3. Item No.2(ix) of the minutes of meeting of Faculty of Science held on 05.05.2009.
   4. Item No.IIA.10 of the minutes of meeting of the Academic Council held on 14.05.2009.

ORDER

Choice based Credit Semester System and Grading has been introduced for UG Curriculum in all affiliated colleges under the University with effect from 2009 admission onwards and the regulations for the same implemented vide paper cited (1) above.

As per paper read as (2) above, the Board of Studies has resolved to approve the scheme and syllabus of B.Sc. Programme in Biochemistry under Choice based Credit Semester System.

As per paper read as (3) and (4) above, the faculty of Science held on 05.05.2009 endorsed the minutes of Board of Studies and the Academic Council held on 14.05.2009 approved the same.

Sanction has therefore been accorded to implement the Scheme and Syllabus of B.Sc. Programme in Biochemistry under Choice based Credit Semester System in this University with effect from 2009 admission onwards.

Orders are issued accordingly. Scheme & Syllabus appended.

Sd/-

DEPUTY REGISTRAR (G & A I)
For REGISTRAR

To

The Principals of all affiliated Colleges
Offering B.Sc. Programme in Biochemistry.

Copy to:
CE/EXI/EGI/DR. B.Sc.
System Administrator with a request to upload in the University Website/Tabulation Sn./Enquiry/GA.I – FSn./SF/DF/FC.

Forwarded / By order

Sd/-

SECTION OFFICER
### UNIVERSITY OF CALICUT

**Scheme for B.Sc. Biochemistry Degree under the**

**Course and Credit- Semester System (CCSS)**

(6 Semesters; 36 Courses; 120 Credits)

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course code</th>
<th>Course Title</th>
<th>Hours/week</th>
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**Fifth Semester**

**Sixth Semester**

**Distribution of different courses offered**

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<th>Description</th>
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<td>Total common courses offered</td>
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<tr>
<td>Total core courses offered in the science stream including Bioinformatics and Methodology</td>
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<td>Total core courses offered in the area of specialization (biochemistry)</td>
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<td>Total Complementary courses offered (two complementary subjects)</td>
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<td>Total open courses offered for other departments (to choose one out of the three offered)</td>
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<td>Total open courses offered for the same departments (to choose one out of the three offered)</td>
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<td>Total courses offered in the in the 6 semesters</td>
<td>36</td>
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<tr>
<td>Total credits required for qualifying Degree</td>
<td>120</td>
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**Open courses offered to students of other Departments with credits (5th Semester)**

1. Health and nutrition: 4 credits.
2. General Biochemistry: 4 credits.

**Open Courses for B.Sc. Biochemistry Main Students with credits (6th Semester)**


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**UNIVERSITY OF CALICUT**

**Syllabus for B.Sc. Biochemistry Course**

**Course Code: BC 1B 01. Introduction to Biochemistry.**

Total hours of instruction: 54. Hours/week: 3. Credit: 2

**Unit I. General Introduction (3h.)**

Brief study of the foundations of biochemistry (cellular, chemical and physical foundations-fundamental study only)

**Unit II. Nuclear chemistry: (3h.)**
Nature and properties of α, β and γ rays. Measurement of radioactivity, natural radioactivity, isotopes, isobars. Principle and applications of radioactive isotopes as tracers in biochemistry.

Unit-III. Water, Acids, Bases and Buffer (12h.)

Unit IV. Colloids (10h.)

Unit V. Aspects of Organic Chemistry (6h.)
Classification of isomerism, hydrogen bonds and weak interactions, oxidation reduction reactions, substitution, addition, elimination, condensation and decarboxylation with one example each.

Unit VI. Chemical Equilibrium and Catalysis (10h.)
Introduction to chemical kinetics, equilibrium reactions, law of mass action, equilibrium constant, definition of catalysis, characteristics of catalytic reaction- explanation of positive negative and auto catalysis. Fundamental ideas of promoters and catalytic poisoning, basic principles of thermodynamics, free energy, enthalpy, entropy, reversible and irreversible reactions- examples from biochemistry.

Unit VII. Solutions (10h.)
Meaning of normality, molarity, molality, percentage solution, mole fractions, simple numerical problems from the above. Fundamental principles of diffusion and osmosis, definition of osmotic pressure, isotonic, hypotonic and hyper tonic solutions. Biological importance of osmosis. Relationship of osmotic pressure to gas laws. General equation for dilute solutions, influence of ionization and molecular size on osmotic pressure.

Reference
Course Code: BC 2B 02. Cellular Biochemistry and Methods in Biochemistry

Total hours of instruction: 54. Hours/week: 3. Credit: 2

Part I: Cellular Biochemistry

Unit I. (10 h.)

Unit II. (6 h.)
Plasma membrane- structure and composition, simple diffusion- definition, egs. Facilitated transport- definition, types with examples. Symport, uniport and antiport. Active transport- Primary active transport, secondary active transport, ion channels, sodium potassium ATPase. V type, P type and F type transports.

Unit III. (5h.)
Cell- cell interaction and cell matrix interaction, extracellular matrix, proteoglycan and collagen, Cell – cell adhesion, catherins, desmosomes, gap junction and tight junction.

Unit IV. (6 h.)
Cell cycle- different phases including cell division - Mitosis and meiosis (fundamental study), Apoptosis- definition, difference between apoptosis and necrosis and out line study of apotoptic pathways, role of caspas; tumor - benign and malignant. Properties of malignant cells.

Practicals
Staining of chromatin, prokaryotic and eukaryotic cell, vital staining

References
4. Cell and Molecular Biology: E.D.P. Robertis and De Robertis

Part II. Methods in Biochemistry

Unit I. (2 h.)
Methods of tissue homogenization. Salt and organic solvent extraction and fractionation. Dialysis, Reverse dialysis, ultra filtration, lyophilization.
Unit II. (5h.)
Chromatography:- principle, procedure and application of partition chromatography, adsorption chromatography, ion exchange chromatography, gel chromatography, affinity chromatography, GLC and HPLC.

Unit III. (5h.)
Electrophoresis:- Principle, procedure and application of free flow, zone electrophoresis (Paper electrophoresis, Gel electrophoresis, PAGE, SDS-PAGE and Disc PAGE). Isoelectric focussing, High voltage electrophoresis, Pulse field electrophoresis, Immunoelectrophoresis.

Unit IV. (5h.)
Centrifugation:- Principle of sedimentation technique. Different types of centrifuge and rotors. Principle, procedure and application of differential centrifugation, density gradient centrifugation, ultracentrifugation, rate zonal centrifugation, isopycnic centrifugation.

Unit V. (5h.)

Unit VI. (5h.)
Important stable radioisotopes used in biochemical research. P$^{32}$, I$^{125}$, I$^{131}$, Co$^{60}$, C$^{14}$ etc. Radiation hazards and precautions taken while handling radioisotopes. Principle and application of RIA. Measurement of radioactivity by GM counter and Scintillation counter.

Pracaticals
1. Fractional precipitation of protein from crude tissue extracts
2. Separation of sugars and amino acids by paper chromatography
3. Separation of lipids and amino acids by thin layer chromatography (TLIC)
4. Separation of serum protein by agarose gel electrophoresis (Demonstration)
5. Dialysis using dialysis membrane
6. Verification of Beer’s law
7. Experimental verification of molar extinction coefficient of any known compound.
8. SDS- PAGE ( Demonstration )

References
1. Physical Biochemistry- Application to Biochemistry and Molecular Biology: Friefelder D. WH Freeman and Company
2. The Tools of Biochemistry: Cooper T.G., John Wiley and Sons Publication.

**Course Code: BC 3B 03. Biomolecules**

Total hours of instruction: 36. Hours/week: 2. Credit: 2

Unit I. Carbohydrates (10 h.)
Definition and classification. Isomerism of carbohydrates, relation ship of D and L forms of glyceraldehyde, examples of epimers, mutarotation and its explanation, anomic forms, classification of monosaccharides, linear and cyclic structure (glucose, galactose, mannose, ribose and fructose). Reactions and characteristics of aldehyde and keto group, action of acids and alkalies on sugars, reactions of sugars due to hydroxyl group. Disaccharides- structure, occurrence, chemistry and functions of sucrose, lactose, trehalose, maltose, isomaltose and cellobiose.

Homopolysachrides: Occurrence, structure, chemistry and functions of cellulose, starch, glycogen, chitin, dextrin and inulin.

Heteropolysachrides: Occurrence, types, composition and function
Sugar derivatives: Sugar alcohols, sugar acids, amino sugars, deoxy sugars

Unit II. Lipids (6h.)
Definition, basic ideas about the biochemical functions of lipids. Classification of lipids with examples, classification of fatty acids, physical and chemical properties of fatty acids-saponification number, acid number and iodine number and their application. Essential and non essential fatty acids with examples, prostaglandin, eicosanoids.
Compound lipids: storage and membrane lipids. Structure and functions of phospholipids and glycolipids,
Steroids: Structure of steroid nucleus, cholesterol, ergosterol, stigmasterol, calciferol

Unit III. Amino acids and Proteins (12 h.)
Proteins: Basic ideas about the classification (including solubility characteristics) and functions of proteins.


**Unit IV. Nucleic acids (6h.)**

Structure of common purine and pyrimidine bases, tautomeric forms of bases, structure of nucleosides and nucleotides. DNA: Double helix (Watson and Crick model)

A, B, and Z forms of DNA, physical properties of DNA (conformational variants). Types of RNA- (t-RNA, r-RNA,m-RN(A) unusual bases in nucleic acids.

**Unit V. Vitamins and Minerals (2h.)**

Definition, classification- fat soluble and water soluble- , sources, chemical nature (without structure), functions of vitamins.

Minerals: requirements, macro and micro minerals (source and functions).

**References**


**Practicals**

Preparation of solutions:
1)percentage solutions, 2) molar solutions, 3) normal solutions
Standardisation of pH meter, preparation of buffers, emulsions.

Qualitative analysis:
Carbohydrates- general reactions of carbohydrates. Schematic analysis of biochemical substance (carbohydrate, protein, amino acid, lipids)

Quantitative analysis:
Estimation of sugars – Glucose by anthrone or arsenomolybdate methods
Aminoacid estimation by ninhydrin method
Protein estimation by Biuret method.
Protein estimation by Lowry et.al method.
Cholesterol estimation by Zak’s method or any other convenient method.

References:
1) Practical Biochemistry: Plummer

Course Code: BC 3B 04. Bioinformatics

Total hours of instruction: 18. Hours/week: 1. Credit: 1

Bioinformatics (10 h)
Unit I.
Basic bioinformatics- Introduction to bioinformatics, its importance and scope, Pattern recognition and prediction, internet concepts, data mining and its methods.
Unit II.
Detailed study of various data banks- Biological data bases, primary and secondary sequence databases, Genbank, EMBL, DDBJ, PDB, MMDB, CATH, SCOP, VIDA and KEGG.
Unit III.
Genome analysis - Comparative genomics- Sequence alignment and analysis, pair wise alignment, MSA, methods, scoring matrices, alignment algorithms, tools for alignment of sequences.
Unit IV.
Application of bioinformatics- Drug designing and molecular docking, Homology modeling, Phylogenetics, Micro arrays.

Practical (8 h)
1. Exposure to tools and softwares
2. Sequence alignment tools- BLAST, FASTA, CLUSTALW, MULTALIN.
4. Homology modeling software- Swiss PDB.
5. Transmembrane prediction-DAS
6. Phylogenetics analysis- PHYLIP
7. Structure visualization- Rasmol, Cn3D
8. Docking software-HEX

Reference:
1. Introduction to Bioinformatics: T.K. Attwood, D.J. Parry-Smith and S. Phukan
2. Bioinformatics: Sequence and Genome analysis. David W. Mount
Course Code: BC 4B 05. Physiological Aspects of Biochemistry

Total hours of instruction: 36. Hours/week: 2. Credit: 2

Unit I. (4 h.)


Unit II. (6 h.)


Unit III. (6 h.)


Unit IV. (6 h.)


Unit V. (6 h.)


Unit VI. (8 h.)

Endocrinology: Organization of endocrine system. Classification of hormones and hormone action- type I and type II. Brief study of the site of biosynthesis and major physiological functions of insulin, glucagon, epinephrine, thyroxine, glucocorticoids, mineralocorticoids, androgen, estrogen, growth hormone, corticotropic hormone, thyroid stimulating hormone, gonadotropic hormone, vasopressin, oxytocin, parathyroid hormone and calcitonin. Nerve growth factor, Insulin growth factor, epidermal growth factor, gastrointestinal hormones.

References
Course Code: BC 5B 07.   Immunology and Immunological Techniques

Total hours of instruction: 54.  Hours/week: 3.  Credit: 3

Unit I. (6 h.)
Organs of Immune system: Primary and secondary lymphoid organs, Cells of Immune system- lymphoid cells, stem cells, B and T lymphocytes, Null cells, Mononuclear cells, granulocytic cells

Unit II. (8 h.)

Unit III. (10 h.)

Unit IV. (10 h.)
Antigen-antibody interactions: Precipitation reaction, agglutination, ELISA, RIA, Immunoprecipitation, Immunofluorescence. T-cell receptors, maturation, activation and differentiation. B-cell receptors, maturation, activation and proliferation. Cytokinins- structure and function, Antagonists

Unit V. (10 h.)
Complement system: The function of complement, complement activation. Hyper-sensitivity- Gell and Coombs classification- IgE mediated Type I hypersensitivity, Antibody-mediated cytotoxic (Type II) hypersensitivity, Immune complex mediated (Type III) Hypersensitivity, TDTH mediated (Type IV) hypersensitivity.

Unit VI. (10 h.)
References:
1. Immunology – Kubey

Course Code: BC 5B 08. Enzymology and Enzyme Techniques

Total hours of instruction: 72. Hours/week: 4. Credit: 3

Unit I 10hr
Introduction to enzymes: Holoenzyme, apoenzyme, prosthetic group. Interaction between enzyme and substrate- lock and key model, induced fit model. Features of active site, activation energy, enzyme specificity and types. IUB system of classification and nomenclature of enzymes (Class and subclass with one example) Ribozymes, Abzymes. Coenzymes and their functions - NAD, NADP+, FAD, FMN, lipoic acid, TPP, pyridoxal phosphate and biotin.

Unit II- 15 hr
Enzyme kinetics: Importance, order of reaction, study of the factors affecting the velocity of enzyme catalyzed reaction- enzyme concentration, temperature, pH, substrate concentration, inhibitors and activators (explanation with graphical representation). Derivation of Michaelis-Menten equation and Km value determination and its significance. Definition of $V_{\text{max}}$ value of enzyme and its significance. Lineweaver-Burk plot (Only for single substrate enzyme catalyzed reaction).

Elementary study – isolation of enzymes and the criteria of purity. Methods of measurements and expression of enzyme activity. Unit of enzyme activity - definition and importance.

Enzyme inhibition: Reversible and irreversible – examples. Reversible- competitive, noncompetitive and uncompetitive inhibition- explanation of double reciprocal plot with examples

Unit III- 11 hr
Enzyme regulation – covalently modulated enzymes with examples of adenylation and phosphorylation and allosteric regulation- example Aspartate trascarbamoylase. Isoenzymes- Lactate dehydrogenase and creatine phosphokinase. Zymogens

Unit IV- 10 hr
Immobilization of enzymes, methods of immobilization. Industrial uses of enzymes: Detergent enzymes, thermo stable alpha amylase, papain, chymotrypsin

Practical
1. Assay of $\alpha$- amylase activity in saliva
2. Determination of optimum pH of a plant/animal or microbial enzyme.
3. Studying the effect of different temperatures during enzyme activity measurements.
4. Studying the effect of different pH during enzyme activity measurements.
5. Substrate saturation and determination of Km value from Michaelis-Menten curve.

References

1. Enzymes: M. Dixon and E. C. Webb. Longman Publication
2. Enzymology: Nicholas and Price
   ISBN -0-7167-4684-0
   ISBN 81-7671-046-6

Course Code: BC 5B 09. Metabolism and Bioenergetics

Total hours of instruction: 54. Hours/week: 3. Credit: 3

Unit I. (5h.)
- Bioenergetics: Laws of thermodynamics- Role of high energy phosphates in energy transfer, free energy concept, Biological oxidation, redox potential, phosphate potential, coupled reactions.
- Introduction to energetics of metabolism: Approaches to study metabolism, introduction to metabolic regulation (preliminary study only)

Unit II. (16 h.)
- Carbohydrate metabolism: Glycolysis, oxidation of pyruvate, fate of pyruvate in alcoholic fermentation, TCA cycle, metabolism of glycogen, gluconeogenesis, pentose phosphate pathway, C3, C4 and CAM pathway, glyoxylate pathway, activators and inhibitors of committed steps. Mitochondrial electron transport, oxidative phosphorylation, inhibitors. Details on committed steps in metabolic pathway.

Unit III- (12 h.)
- Metabolism of lipids: Biosynthesis of fatty acids, Fatty acid elongation. Difference in fatty acid synthesis in plants and animals. β- oxidation of palmitic acid and its energy balance sheet. Ketogenesis; Cholesterol synthesis (structure not needed) and significance. Synthesis of steroid hormones from cholesterol. Details on committed steps in metabolic pathway.

Unit IV. (12 h.)
- Metabolism of proteins: Protein turnover, proteolytic enzymes. Trasamination, oxidative deamination, reductive amination, non-oxidative deamination and decarboxylation of amino acids and GS/GOGAT pathway. Brief outline of metabolism of phenylalanine, valine and methionine. Metabolic
fate of amino acids- glucogenic, ketogenic and gluco-ketogenic, Urea cycle. Details on committed steps in the metabolic pathway.

Unit V.(9 h.)
Metabolism of nucleotide - Biosynthesis of purine and pyrimidine nucleotides –de novo and salvage pathway (no structure required) end products of purine and pyrimidine metabolism. Details on committed steps in the metabolic pathway.

References


Course Code: BC 6B 13. Genetics and Molecular Biology

Total hours of instruction: 72. Hours/week: 4. Credit: 3

Unit I. (15h.)

Unit II. (10 h.)
Preliminary study of gene mapping in haploid and diploids, recombination mapping, complementation analysis, physical mapping and restriction mapping, gene transfer in bacterial conjugation, transformation and transduction.
Sex determination in Drosophila and humans, pedigree analysis.

Unit III (13h.)
Chemical nature of gene, central dogma of molecular biology, C- value paradox, chromatin organization. Messelson and Stahl experiment. DNA replication in prokaryotes.
Mutation and its types. Mutagens- Physical and chemical, Mutagenesis, DNA damage and repair.

Unit IV. (16 h.)
Unit V. (18h.)

Regulation of gene expression in prokaryotes. Operon concept, Lac operon, tryptophan operon.
Introduction to recombinant DNA technology: Vectors- plasmids, cosmids, phages, restriction endonucleases
Polymerase chain reaction, DNA finger-printing, blotting techniques, Application of genetic engineering (Brief study).

Practicals
Problems in monohybrid, dihybrid and test cross

References

1. Genes : Benjamin Lewin, Pearson education Inc. upper Siddle River NJ.
   ISBN 0-13-123826-4
4. Lehninger’s principles of Biochemistry -: D. L. Nelson and M. M. Cox, Worth
5. Essential of genetics : William S Klug


Total hours of instruction: 72. Hours/week: 4. Credit: 3

Unit I. (4 h.)
Sample collection and preservation
Collection and preservation procedures of blood, plasma, serum, cerebrospinal fluid, urine, faeces, pleural fluid, peritoneal fluid and semen. Familiarization of biochemical charts from clinical labs.

Unit II. (14h.)
Blood analysis and Hematology: Principles of estimation, normal values and clinical significance of the following parameters of blood - glucose, hemoglobin, uric acid, lipid profiles, acid phosphatase, creatine phosphokinase, Na+, K+, Cl− and phosphate.
Principles of determination, clinical significance of the following parameters- Total count, Differential count, Erythrocyte sedimentation rate, packed cell volume and prothrombin time. Brief study of blood groups, anticoagulants, storage and transfusion of blood.

Unit III. (16 h.)
Organ function tests: Function of liver, Biochemical mechanism of detoxification with examples.
Principles of the following test of liver function and the interpretation of the results- Total protein, albumin, globulin, albumin – globulin ratio. Total and conjugated bilirubin, AST, ALT, alkaline phosphate, 5’-NT and glucose tolerance test.
Thyroid function test- T3, T4, TSH.
Renal function tests: Urea, creatinine, urea clearance test, creatinine clearance test.

**Unit IV. (12h.)**
Analysis of urine, cerebrospinal fluid and semen.
Urine and CSF- Normal and abnormal constituents, procedures of qualitative analysis and interpretation and their clinical significance. Principle of estimation of semen fructose and acid phosphatase.

**Unit V. (12 h.)**
Nutritional and hormonal disorders.
Starvation, PCM, pellagra, beriberi, riboflavinosis, scurvy, vitamin B deficiency, deficiency of fat soluble vitamins and water soluble vitamins. Hypervitaminosis A and D. Disturbances in metabolism of trace elements - iron, iodine, copper and fluorine. Diabetes mellitus, GTT, hyperinsulinism and hypoglycemia.

**Unit VI. (14 h.)**
Inborn errors of glycogen and amino acid metabolism, galactosemia, lactose intolerance, pentosuria, hyperlipidemia, atherosclerosis, sphingolipidosis. Disorders of purine and pyrimidine metabolism, porphyrias.

Practical:-
Biochemical analysis of blood.
1. Quantitative estimation of glucose, urea, total protein, albumin, cholesterol, creatinine, calcium, uric acid and bilirubin (Conjugated and unconjugated)
2. Serum enzyme analysis AST, ALT, ACP,ALP (avoid kit method)
3. Qualitative tests for the normal and abnormal constituents of urine
4. Hematology; determination of hemoglobin, packed cell volume, erythrocyte sedimentation rate, total count, differential count, blood grouping, clotting and bleeding time.

References
1. Preventive and social medicine  K. Park
2. Nutrition and dietetics  Davidson S and Pasmor J.R
3. Essentials of food an nutrients  M. Swaminathan
4. Food science  B. Sreelakshmi
5. Food facts and principles - Sakunthala Manay, Sadhakshara Swami.
OPEN COURSES FOR OTHER DEPARTMENTS

Course Code: BC 5D 01. Health and Nutrition

Total hours of instruction: 54. Hours/week: 3. Credit: 2

Unit I. (20h.)

Health: Concept of health- Biomedical, ecological, psychosocial, Holistic (1 h.)
Definition of health- WHO, operational, new philosophy of health (1h)
Dimensions of health- Physical, mental, social, spiritual and vocational (1h.)
Positive health- Standard of living, level of living, quality of life. (1h.)
Physical quality of life- Life index, human development index calculation (1h.)
Spectrum of health- biological, behavioral, environmental, socio-economic, health service, aging, gender and other factors (2h.)
Right to health- responsibility for healthy, individual responsibility, common responsibility, state responsibility and international responsibility. (1h.)
Indicators of health- Mortality, morbidity, disability rates, Sullivan’s index, Hale, Daly index. Nutritional status indicators (2h.)
Health status in Kerala (2h.)
Concept of disease- causative factors (only agent factor) (1h.)

Unit II. (34 h.)

Nutrition: Concepts of nutrition, classification, protein, fat, carbohydrate, fiber, vitamin, mineral and trace elements (7h.)
Nutritional profile principal foods- Cereals, pulses, vegetables, fruits, nuts, oil seeds, animal foods, milk and milk products, egg, fish, meat, drinks and spices (6h.)
Nutritional requirements- concepts, energy, Indian reference men and women. Energy requirements protein quality, fat carbohydrate. (3h.)
Balanced diet- For different ages, sex, occupation etc. (2h.)
Nutritional problems- PEM, anemia, iron deficiency, life style diseases CVD, diabetes, obesity, and cancer (2h.)
Social aspects of nutrition – problems, ecology, social action (1h.)
Food hygiene- Milk, fish, meat, fruits and vegetables (2h.)
Food borne diseases (2h.)
Food additives- colors, preservatives (2h.)
Food adulteration (2h.)
Community nutrition programme (1h.)

References

1. Preventive and social medicine  K. Park
2. Nutrition and dietetics Davidson S and Pasmor J.R
3. Essentials of food an nutrients M. Swaminathan
4. Food science B. Sreelakshmi
Course Code: BC 5D 02. General Biochemistry

Total hours of instruction: 54. Hours/week: 4. Credit: 2

Unit I. 30 h.
Scope of Biochemistry (1h.)
Molecular basis of life (2h.)
Origin of life (2h.)
Biochemical evolution- 3h.
Water as solvent of life- 2h.
Biomolecules- carbohydrates, protein, lipids, nucleic acids, vitamins, minerals (16 h.)
Biochemistry in day-to-day life (4h.)
Application of biochemistry in fields like medicine, industry, pharmaceuticals, agriculture, food, health and nutrition, environmental studies, enzyme technology, biotechnology, bioengineering, bioinformatics, toxicology, microbiology, drug designing and sports medicine.

References
2. Text book of biochemistry JL Jain

Course Code: BC 5D 03. Waste Management

Total hours of instruction: 54. Hours/week: 3. Credit: 2

Unit I. (15 h.)
Introduction, Characterization & Monitoring of Solid Waste: Origin of solid waste: Sources of Solid Waste. Waste generation, trends, quality and quantity of solid waste, Types of solid waste – Municipal, urban, rural and industrial wastes; Special waste: tyres, household hazardous wastes, debris, demolition waste, wet batteries; factory waste; domestic waste; sewage sludge and municipal waste; slaughterhouse waste; agricultural waste; dredged material; mining waste. Hazardous wastes: Types of Hazardous wastes – nuclear, hospital, electronic wastes; Solid waste characterization and monitoring. Waste identification; Environment monitoring; biomonitoring of solid wastes and their disposal facilities; Evaluation of ground water pollution and protection at disposal sites; susceptibility to aquifers; designs of ground water protection systems at hazardous waste disposal sites and facilities.
Unit III (10h.)

Waste Management: Need, Planning & Techniques: Waste minimization; waste reduction and materials recovery; waste reduction at source; Collection techniques, Materials and resource recovery/recycling, Transport of solid waste and its optimization; Waste management practices; Public education; Solid waste management policies for 21st century; Treatment and disposal techniques - The concept, technique, sound technical option, environmental impacts, and problems of the following techniques: Open dumping, Simple Landfill, Environmentally safe landfill, Simple composting, Vermicomposting, Incineration, non-incineration thermal techniques, Burning, Refuse derived fuels, Deep burying, recycling and re-use, volume reduction, Value addition Individual vs. common treatment / disposal practices; Integrated waste management; Concept of industrial symbiosis and industrial ecology

Unit IV (9 h.)

Environmental Toxicology and Management of Hazardous Waste: Environmental problems of hazardous wastes; Health risks associated with hazardous wastes; management of radioactive waste; Precautions required and procedures involved; Public education; Training of health care personnel; Dangers of dumping of hazardous wastes; Collection, segregation, treatment, transport, and disposal of hazardous waste; evaluation of toxicity. Biochemical Effects of Heavy Metals Hg, Pb, As, CN, Cd Lead and Mercury poisoning Toxic Chemical in the Environment.

Unit V (9 h.)


Unit VI (11 h.)

Biomedical waste: What are they? Hospital Waste: definition Classification of hospital wastes; their types and composition, Types of solids, liquids, sharps, blood and blood tissue, radioactive material, biological and chemical material. Requirement of management Hospital effluents: Nature and composition; Documentation of Biomedical waste- types; Guidelines for storage of hospital waste; Types of bags and containers used for storage; Segregation of biomedical waste into different type; Handling and transport of hospital waste; Transport of medical waste: Methods of treatments required for disposal of pathogens. Waste reduction activities; Waste recycling, Waste disposal; disposal methods; On-site and off-site management; Techniques of waste management; Protocols for hospital waste management: incineration, autoclaving; microwave radiations, chemical treatments; Biomedical Waste treatment facility: location, land requirements, coverage area, types of equipment, infrastructure requirements; collection, transport and storage facilities. Precautions required. Hospital Effluent treatment plant: its structure and functioning

References
10. Integrated Modelling of Solid Waste in India Published by IIED ISBN 1843693046, 9781843693048
Course Code: BC 6B 17 (E).  Health and Nutrition

Total hours of instruction: 54.       Hours/week: 3.       Credit: 4

Unit I.  (20h.)

Health: Concept of health- Biomedical, ecological, psychosocial, Holistic    (1 h.)
Definition of health- WHO, operational, new philosophy of health (1h)
Dimensions of health- Physical, mental, social, spiritual and vocational (1h.)
Positive health- Standard of living, level of living, quality of life.  (1h.)
Physical quality of life- Life index, human development index calculation (1h.)
Spectrum of health- biological, behavioral, environmental, socio-economic, health service, aging, gender and other factors (2h.)
Right to health- responsibility for healthy, individual responsibility, common responsibility, state responsibility and international responsibility.  (1h.)
Indicators of health- Mortality, morbidity, disability rates, Sullivan’s index, Hale, Daly index. Nutritional status indicators (2h.)
Health status in Kerala (2h.)
Concept of disease- causative factors (only agent factor) (1h.)

Unit II.  (34 h.)

Nutrition: Concepts of nutrition, classification, protein, fat, carbohydrate, fiber, vitamin, mineral and trace elements (7h.)
Nutritional profile principal foods- Cereals, pulses, vegetables, fruits, nuts, oil seeds, animal foods, milk and milk products, egg, fish, meat, drinks and spices (6h.)
Nutritional requirements- concepts, energy, Indian reference men and women. Energy requirements protein quality, fat carbohydrate. (3h.)
Balanced diet- For different ages, sex, occupation etc. (2h.)
Nutritional problems- PEM, anemia, iron deficiency, life style diseases CVD, diabetes, obesity, and cancer (2h.)
Social aspects of nutrition – problems, ecology, social action (1h.)
Food hygiene- Milk, fish, meat, fruits and vegetables (2h.)
Food borne diseases (2h.)
Food additives- colors, preservatives (2h.)
Food adulteration (2h.)
Community nutrition programme (1h.)

References:

1. Preventive and social medicine:   K. Park
2. Nutrition and dietetics:   Davidson S and Pasmor J.R
3. Essentials of food an nutrients:  M. Swaminathan
4. Food science:   B. Sreelakshmi
5. Food facts and principles:-  Sakunthala Manay, Sadhakshara Swami.
Course Code: BC 6B 18 (E). Applied Immunology

Total hours of instruction: 54. Hours/week: 3. Credit: 4

Unit I: (12 h.)
Organisation of Immune system – lymphoid organs, cells involved in immune response, types of immunity – innate and acquired; humoral and cell mediated immunity.

Unit II: (12 h.)
Antigens- types and properties, epitope, paratope, hapten, adjuvants, types of antibodies, theories of antibody formation, antibody diversity, complement pathway.

Unit III (15h.)
Antigen antibody reaction – agglutination, immunoprecipitations, immunodiffusions, RIA, ELISA, blood group antigens, monoclonal antibody production and its applications.

Unit IV: (15h.)
Outline study of viral etiology – HIV, Vaccines – live, attenuated, killed, toxoids. MHC complex and HLA (Brief account only); Hypersensitivity (Brief account only)

References:
1. Immunology – Kubey

Course Code: BC 6B 19 (E). Secondary Metabolism in Plants

Total hours of instruction: 54. Hours/week: 3. Credit: 4

Unit 1. (6 h.)
Distinction between primary and secondary metabolites. Occurrence and distribution of secondary metabolites in taxonomically distinct plants. Distribution in various plant parts and at different developmental stages in plants.

Importance of secondary metabolites. Protection of the producer plant from predators and insects; importance to man as active principles exerting physiological effects to mammalian systems.
Uses of secondary metabolites to man as drugs, precursors of drugs in pharmaceutical industry, as natural pesticides/insecticides; other uses of secondary metabolites.

Unit 2. (15h.)

Biosynthetic origin of secondary metabolites from primary metabolites (Prepare a chart to illustrate the relationships).

Major chemical classes of secondary metabolites: A brief account of the following classes: Alkaloids, terpenoids, flavonoids, phenolics and phenolic acids, steroids, coumarins, quinines, acetylenes, cyanogenic glycosides, amines and non-protein amino acids, gums, mucilages, resins etc. (Structures not necessary. Give examples of the compounds and the plants in which present and their importance).

Unit 3. (20 h)

General biosynthetic pathways and functions of the following classes of secondary metabolites (structures of intermediates not necessary):

Terpenoids: Isoprene as precursor, hemi, mono, sesqui, di, triperenes and polyterpenes with examples and important members; their functions.

Phenols: simple phenols, phenol carboxylic acids, phenylpropanes, flavan derivatives, and phenolic glycosides. Broad outline of their biosynthesis and functions in plants and uses.

Alkaloids: Definition of true and pseudo alkaloids; phenylethylamines, pyrrolidine alkaloids, piperidine alkaloids, pyridine alkaloids, tropane alkaloids, quinoline and isoquinoline alkaloids, indole alkaloids, purine alkaloids, isoprenoid alkaloids, steroidal alkaloids. Important plant alkaloids of pharmacological importance. Biosynthesis and functions.

Unit 4. (8h)


Allelopathy: detrimental biochemical effects of phytotoxic compounds of producer plant to other plants; inhibition of germination, growth and development.

Unit 5. (5h)


References


**PROJECTS FOR CORE COURSE** (Suggestions)

To be conducted on group basis (4 or 5 students) and submission in a group

1) pH determination of water samples collected from polluted, non polluted and drinking water sources.

2) Sulphate levels of water from different locations, nitrates and phosphates.

3) Reducing sugar content in cereals, fruits, etc.

4) Amino acid content in cereals, fruits, etc.

5) Protein content in cereals, fruits, etc.

6) Salinity of water.

7) Papain digestion of proteins.

8) Digestibility of proteins.

9) Bromoline from pineapple.

10) Buffer preparation methods.

11) Preparation of Emulsion using soap, albumin, etc.

12) Extraction and estimation of starch from various sources.
13) Enzyme purification using salting out.
14) Extraction of total lipids.
15) Saponification number of various fats.
16) Boundouin test using dalda.

Note: In addition to the above projects proposed, the individual departments in colleges may also undertake projects of their choice.

It is also recommended for the submission of reports even in hand written forms.

**SYLLABUS FOR BIOCHEMISTRY AS COMPLEMENTARY SUBJECT FOR B.Sc. COURSE**

**Course Code: BC 1C 01. Elementary Biochemistry**

Total hours of instruction: 36. Hours/week: 2. Credit: 2

**Unit I. Physical Aspects (20h.)**
Fundamentals of the following: Law of mass action- statements and explanations, the equilibrium constants of ions, electrolytes and non-electrolytes. Brönsted’s definition of acids and bases. Meaning of normality, molarity, molality, actual acidity and titrable acidity of solutions. Dissociation of water. Concept of pH and pOH. Simple numerical problems involving determination of $H^+$, $OH^-$, pH and pOH. Elementary study of methods to determine the pH (a) theoretical calculations, (b) using indicators, (c) using pH meter.


Classification of isomerism with examples. Basic ideas about hydrogen bonds and weak interactions. An example for the following type of reactions – oxidation, reduction, substitution, addition, elimination, condensation and decarboxylation.

**Unit II. Blood and other body fluids (8h.)**

Unit III. Modern techniques in Biochemistry (8h.)

Principles and application of: (a) chromatography (paper, thin layer, gas, HPLC, gel filtration), (b) electrophoresis (paper, PAGE, immunoelectrophoresis), (c) absorption photometry (colorimetry and spectrophotometry), (d) centri-fugation, (e) radio immunoassay.

Course Code: BC 2C 05. Elementary Biochemistry- 2

Total hours of instruction: 36. Hours/week: 2. Credit: 2

Unit I. Carbohydrates (10h.)


Structure of the following disaccharides (Haworth perspective formulas - maltose, isomaltose, sucrose, lactose trehalose and cellobiose (elucidation of the structures of mono-, di-, and polysaccharides is not include(d). Structure and important properties of the following polysaccharides – amylose, amylopectin, glycogen, cellulose and chitin. Heteropolysaccharides, classification and functions.

Unit II. Lipids (6h.)


Unit III Aminoacids and Proteins (12h.)

Basic ideas about physiological functions of proteins – Name (with abbrevia-tion) and structures of the 20 important aminoacids occurring in proteins. General chemical reactions of aminoacids. Representation of alanine, in the zwitter ionic form. Elementary study of primary, secondary, tertiary and quaternary structure of proteins. The general methods of proteolysis. Identification and estimation of aminoacids. Sequencing of proteins (only basic principles of the methods employe(d). Denaturation of proteins, precipitation reactions and colour reactions of proteins.

Unit IV Nucleic acids (8h.)

COURSE CODE: BC 3C 09.  ENZYMOLGY AND METABOLISM -1

Total hours of instruction: 54.  Hours/week: 3.  Credit: 2

Unit I. Enzymes (20h.)

History of Enzymology. Classification of enzymes; six major classes of enzymes with one example each.

Elementary study of the following factors affecting velocity of enzyme-catalysed reactions – effect of substrate concentration, enzyme concentration, temperature and pH; Michaelis Menten equation (without derivation), Km and its significance. The Lineweaver-Burk plot.

Definition of enzyme specificity – an example each for group specificity, optical specificity, geometrical specificity and cofactor specificity of enzymes from the pathways to be studied this year. Explanation of competitive and non-competitive type of inhibition, their destination on the basis of double reciprocal plot, brief study of allosteric inhibition with an example.

Brief study of the activation of zymogen form of enzymes. Activation of SH enzymes and activation of enzymes by prosthetic groups, coenzymes and metal activators. Brief study of allosteric activation with example. Industrial enzymes (preliminary study).

Unit II. Anaerobic Metabolism of Carbohydrates (15h.)

Introduction to metabolism. Digestion of carbohydrates and absorption. Reactions of glycolytic sequences with the names of enzymes and intermediates (without structures). Fate of pyruvate in alcoholic fermentation. Outline study of glycogenesis and glycogenolysis. Role of cyclic AMP and hormones in glycogen metabolism. Gluconeogenesis and pentose phosphate pathway (only outlines without structures of intermediates).

Unit III. Muscular contractions (3h.)

Name of different proteins in muscles – the sliding filament theory – energy source for muscle contraction.

Unit IV. Aerobic Oxidation of Carbohydrates (10h.)

Decarboxylation of pyruvate – reactions of citric acid cycle (without structures of intermediates) only outline expected. Calculation of energy yield (as ATP) of aerobic and anaerobic oxidation of carbohydrates. The mitochondria – arrangement of electron carriers in the electron transport chain. Substrate level phosphorylation – site of ATP formation in the chain (Mechanism of ATP formation not expected). Classification of high energy compounds with an example each. Phosphate potential, principle of reversible reaction.

Unit V. Photosynthesis (6h.)

Outline of cyclic and non-cyclic photophosphorylation – outline study (without structures) of the path of carbon in the dark reaction (Calvin cycle), glyoxylate cycle, significance.
**COURSE CODE:** BC 4 13.  **ENZYMOLGY AND METABOLISM- 2**

Total hours of instruction: 54.  
Hours/week: 3.  
Credit: 2

**Unit I. Metabolism of Lipids (10h.)**


**Unit II Metabolism of Aminoacids and Proteins (10h.)**

Proteolytic enzymes of the gastrointestinal tract and their activation (from zymogen forms). Classification of proteins based on catabolism. Absorption of aminoacids from the intestine – an example each indicating decarboxylation, deamination and transamination of aminoacids (without molecular mechanisms). Urea cycle. Metabolism of glycine, phenylalanine, tyrosine, ammonia.

**Unit III Genetic aspects of metabolism (16hrs)**

Central dogma, the chemical nature of gene- replication of DNA, coding for aminoacids by triplets of bases and transcription of DNA. Types of RNA, their structural features, their role in protein biosynthesis- fundamental study, translation of mRNA – the ribosomal events. Post transcriptional and translational modifications, genetic code, inhibitors.

**Unit IV Vitamins and Hormones (9h.)**

Classification, source, chemical nature and deficiency disorders of vitamins. Basic physiological functions of vitamin C, B₁, B₂, pyridoxine and niacinamide (chemical structures not expected). Biochemical reactions involving TPP, FMN, FAD, NAD⁺, NADP⁺, PLP, CoA and biotin from metabolic sequences prescribed to be studied in other chapters. Fat soluble vitamins A,D,E,K. Physiological functions daily requirements, etc.

Classification, mechanism of action (preliminary study), site of biosynthesis, important physiological functions of thyroxine, insulin, glucagon, epinephrine, glucocorticoids and growth hormones.

**Unit V: Mineral Metabolism (9h.)**

Sodium, potassium, iron, copper, iodine, fluorine, selenium – biological role and nutritional importance. Introduction to Secondary Plant Products (types, source, and functions)

**References**

2) Medical Biochemistry: Ramakrishnan
3) Text Book of Biochemistry: D.M. Vasudevan
4) Text Book of Biochemistry: A.C. Deb
Principals:

1. **Preparation of solutions**
   - (i) percentage solutions, (ii) molar solutions, (iii) normal solutions
   - Standardisation of pH meter, preparation of buffer, principles of colorimetry and verification of Beer-Lambert law.

2. **Qualitative analysis**
   - Carbohydrates - general reactions of carbohydrates (mono, di and polysaccharides)
     - Molisch test, anthrone reaction, phenol-sulphuric acid reaction. Specific reactions of reducing sugars – Benedict’s test, Fehling’s test, picric acid test, ferricyanide test.
   - Scheme for analysis of biochemical solution containing a single component; carbohydrate (starch, reducing sugar, ketose), protein (Biuret test, ninhydrin, solubility pattern, xanthoproteic test, millons test, glyoxylic acid test, nitroprusside test, precipitation by heavy metal ions and alkaloidal reagents)

3. **Quantitative analysis**
   - Glucose estimation by Benedict’s method, anthrone or arsenomolybdate methods)
   - Aminoacid estimation by Ninhydrin method
   - Protein estimation by Biuret method.
   - Protein estimation by Lowry *et al.* method.
   - Cholesterol estimation by Zak’s method.
   - DNA estimation by diphenylamine method & RNA estimation by orcinol method

4. **Demonstration experiments:**
   - Demonstration of paper chromatography and TLC
   - Digestion of starch by salivary amylase.

**References:**

1. **Practical Biochemistry:** Plummer
3. **Practical Biochemistry:** K.E. Van Holde
MODEL QUESTION PAPERS

B.Sc. BIOCHEMISTRY : CORE COURSES

Course Code: BC 1B 01: Introduction To Biochemistry

Section -A Objective Questions
Attempt all 20 questions. (Weightage –1)

I.
1. Maleic acid and fumaric acid are examples of ....................... isomers
2. Atoms with the same atomic number and different mass numbers are called ...........
3. The type of hydrogen bond in water is:
   (a) intermolecular  (b) intramolecular  (c) both of these  (d) none of these
4. Solutions of equal osmolarity are said to be ......................

II.
5. The term pH is defined by the expression...........................................
6. ............... is a substance that increases the rate of a reaction.
7. Buffers are the mixtures of ...........................
8. ................... is very high energy photons

III.
9. The first law of thermodynamics deals with:
   (a) energy  (b) entropy  (c) enthalpy   (d) all the three
10. Which of the following is negatively charged ?
    (a) α- particles  (b) β- particles  (c) γ- rays  (d) ω-rays
11. The size of a colloidal particle ranges from:
    (a) 10 Aο - 2000 Aο  (b) 10 nm - 2000 nm
    (c) 10 pm -2000pm  (d) 10μ - 2000 μ
12. –log Ka is:
    (a) pKa     (b) Ka     (c) pH    (d) pOH

IV.
13. Importance of Henderson –Hasselbalch equation is in:
    (a) pH   (b) preparation of buffer  (c) ionic strength   (d) all the three
14. Acid is a proton donor and base is a proton acceptor according to
    (a) Bronsted-Lowry theory  (b) Arrhenius theory
    (c) Lewis concept  (d) none of the three
15. One litre of a normal solution of NaOH contains ..........grams NaOH:
    (a) 40    (b) 400   (c) 4    (d) 0.4
16. ............... is an optical property of colloidal systems

V.
17. Of the following ................. is a natural emulsion
    (a) starch solution in water  (b) alloys  (c) shaving foam  (d) milk
18. The H+ concentration in a solution having pH 10 is:
19. ................................ discovered natural radioactivity
20. Radiotherapy of cancer uses the isotope ......................

Section-B Short answer questions
Answer any six Weightage 1

21. What is meant by natural radioactivity?
22. State the Law of Mass action
23. What is zeta potential?
24. What is osmosis?
25. State Bronsted theory of acids and bases
26. What is a buffer?
27. What is autocatalysis?
28. Define the terms free energy and enthalpy

Section- C Short Essay.
Attempt any four Weightage 2

29. Explain the applications of Donnan membrane equilibrium in biological systems.
30. Explain the different types of isomerisms
31. Distinguish between lyophilic and lyophobic sols.
32. Explain the titration curve of a weak acid with strong base.
33. Explain the mechanism of osmosis.
34. Derive the Henderson-Hasselbalch equation.

Section- D Long essay
Answer any two Weightage 4

35. Explain the determination of pH by different methods
36. Explain the application of radioactive isotopes as tracers in biological studies.
37. (a) Calculate the pH of a 0.2N acetic acid. (Ka of acetic acid is 1.8 x 10^-5)
     (b) Calculate the osmotic pressure of a 205 solution of sucrose at 27°C
     (Gas constant, R is: 0.0821litre atm. K^-1mol^-1)

Course Code: BC 2B 02: Cellular Biochemistry and Methods in Biochemistry
Part I : Cellular Biochemistry
Section A Objective Questions
Attempt all 20 questions. (Weightage –1)

I. 1. The site of dark reaction during photosynthesis is
   (a) Chloroplast      (b) Stroma       (c) Grana      (d) Thylakoids
2. Name the protein synthesizing machinery in the cell
3. Energy dependant transport of molecules across membranes is called as ...........
4. Cell drinking is otherwise known as ...............

II.
5. Name the triplet alpha helical structure percent in ECM
6. DNA synthesis take place during .......... phase of cell cycle
7. Fluid mosaic model of plasma membrane was proposed by ..........
8. Name the protein which is abundant in microtubules

III.
9. The site of of rRNA synthesis is
   (a) Nucleoplasm    (b) Nucleolus      (c) Cytosol    (d) Mitochondria
10. The DNA containing region with in the cytoplasm in the cytoplasm in prokaryotic cell is .......... 
    (a) Nucleus         (b) Nucleoplasm     (c) Nucliod    (d) Mitochondria
11. Uncontrolled growth of a cell leads to .......... 
12. ATP synthesis take place inside ................. 
    (a) Mitochondria     (b) Nucleus      (c) Cytoplasm    (d) Lysosomes

IV.
13. The cancer cell which grows into a multicellular mass is called .............. 
14. Name the gene responsible for the cancer formation
15. Programmed cell death is ............... 
    (a) Apoptosis        (b) Necrosis     (c) Cell death    (d) Cell digestion
16. Glucose transporter is an example for 
    (a) Active transport   (b) facilitated diffusion   (c) Diffusion      (d) Osmosis

V.
17. The organelle which is associated with programmed cell death 
    (a) Mitochondria     (b) Peroxisomes     (c) Ribosome    (d) Lysosomes
18. The subunit composition of Eukaryotic Ribosome 
    (a) 40S&50S         (b) 40S&60S      (c)50S&30S      (d) 30S&60S
19. The marker enzyme of the nucleus is: 
    (a) DNA polymerase    (b) Succinate Dehydrogenize    (c) Peroxidase  
    (d) Alkaline Phosphatase
19. Malate synthase is associated with the ------------------------ metabolic pathway 
    (a) Pentose phosphate     (b) glyoxylate     (c) C₄    (d) Krebs cycle

Section B   Short answer questions.
Attempt any six           (Weightage- 1)

21. Differentiate symport and antiport?
22. Name any two marker enzymes of lysosome?
23. What are ion channels?
24. Write a note on gap junction?
25. Differentiate between benign and malignant tumors?
26. Define apoptosis?
27. Define simple diffusion?
28. Write a note on Glyoxysomes?

Section C   Short Essay.
Attempt any four        Weightage 2
29. Differentiate between prokaryotic and Eukaryotic cells?
30. Write a note on mitochondrial and intermediate filaments?
31. Write a note on facilitated diffusion?
32. Explain different components of ECM?
33. Differentiate cancer cells from normal cells?
34. Explain Fluid mosaic model of plasma membrane?

Section D  Long essay
Answer any two               Weightage  4

35. Explain Apoptosis?
36. Explain Active transport?
37. Explain the major Sub cellular organelles of Eukaryotic cell?

Course Code: BC 2B 02:  Cellular Biochemistry and Methods in Biochemistry

Part II: Methods in Biochemistry

Section A Objective Questions
Attempt all 20 questions. (Weightage –1)

I.
1. DEAE- cellulose column chromatography works on the principle of:
   (a) Adsorption  (b) Partition  (c) Ion exchange (d) Affinity
2. Cross linking agent in PAGE is:
   (a) Ammonium persulfate   (b) TEMED   (c) Bis-acrylamide   (d) acrylamide
3. Wall effect is observed in centrifugation when the rotor is of ............... type
4. In isoelectric electric focusing the anode is .........................

II.
5. Column chromatography can work on the principle of
   (a) Partition (b) Adsorption  (c) Ion exchange  (d) All these
6. Rf value of a compound will always be:
   (a) Less than one  (b) greater than one  (c) equal to one  (d) zero
7. In gel chromatography the spaces between gel beads represents: ...............volume
8. The commonest adsorbent used in thin layer chromatography is..........

III.
9. In ultracentrifuges the rotors are made up of ................. alloys:
    (a). titanium  (b) steel  (c) Iron  (d) copper
10. Colorimeter works on the principle of:
     (a) Beer-Lambert law   (b) Beer’s law   (c) Lambert’s law   (d) Snell’s law
11. Carboxymethyl cellulose is a ..............exchanger
12. Of the following which one is not used as a carrier gas in Gas liquid chromatography
    (a) Nitrogen  (b) Chloride  (c)Argon  (d) Helium
IV.
13. Purpose of guard column in HPLC is
   (a) Separation of components  (b) removal of impurities
   (c) Concentrating sample         (d) Dilution of sample
14. Protein subunit studies can be done by
   (a) Native PAGE  (b) ion exchange  (c) Isoelectric focusing  (d) SDS- PAGE
15. Lyophilization is based on the principle of...............
16. ................salt is most commonly used in the salting out of proteins

V.
17. In gel chromatographic procedure of the following proteins having 15Kd, 43Kd, 65Kd 100KD which one will be eluted first.
   (a) 15KD            (b). 43KD          (c)   65KD      (d)   100KD
18. Of the following chemicals which one is not used for preparing density gradient
   (a) CsCl2       (b) Sucrose  (c) Sodium bromide  (d) ethanol
19. The major factor which determines the mobility of molecules in electrophoresis
    is ...........
20. ............. is the determining characteristic in dialysis membranes

Section B  Short answer questions.
Attempt any six  (Weightage - 1)

21. What are the factors which influence the electrophoretic mobility of a molecule?.
22. Define Beer - Lambert Law
23. Write the principle of dialysis
24. What are the different methods used for tissue homogenization?
25. Name four radioactive isotopes used as tracers in biological studies
26. What are the precautionary measures adopted while handling radioisotopes?.
27. What is disc gel electrophoresis?
28. Give two examples of anion and cation exchange resins.

Section C Short Essay.
Attempt any four  Weightage 2

29. Give a brief account of the steps involved in column chromatographic separation.
30. Describe the principle and application of affinity chromatography.
31. Describe the principle and application of radio immunoassay.
32. Explain the principle and instrumentation of atomic absorption chromatography.
33. Give a short notes on different detectors used in GLC
34. What are the applications of HPLC

Section D  Long essay
Answer any two  Weightage 4

35. Explain the principle, procedure and application of PAGE
36. What are the different types of centrifuges? What are the major applications in biology?

37. Describe the chromatographic technique of volatile compounds in detail.

**Course Code: BC 3B 03: Biomolecules**

**Section A Objective Questions**

Attempt all 20 questions. (Weightage –1)

I.

1) D and L represents:
   (a) Configuration (b) Conformation (c) Confirmation (d) Rotation

2. The 2” epimer of D glucose is:
   (a) D Ribose (b) D galactose (c) D mannose (d) D fructose

3. D Ribulose is --------- isomer of D xylulose?

4. D Fructose is --------- isomer of D glucose?

II.

5. The glycosidic linkage in sucrose is.
   (a) α 1-2 (b) β 1-2 (c) α 1-4 (d) α 1-3

6. Maltose is a reducing sugar True or False?

7. Lactose is composed of D Glucose and:
   (a) β -D galactose (b) D -galactose (c) Fructose (d) ribose

8. Cellobiose is a partial hydrolytic product of.
   (a) Cellobiose (b) starch (c) glycogen (d) chitin

III.

9. Heparin is a------------------------- polysaccharide?

10. Sugar present in DNA is.
    (a) β D ribose (b) β D deoxy ribose (c) 2 β D deoxy ribofuranose (d) deoxy ribose

11. Linoleic acid is ------- fatty acid.

12. Vitamin A is water soluble (True or False).

IV.

13. The coenzyme form of thiamine is:
    (a) NAD (b) TPP (c) CoA (d) EDTA

14. Oxidation of fatty acid causes-------- of fats

15. Cholesterol is ------------------ type of lipid

16. Vitamin D is formed form
    (a) Cholesterol (b) Lanosterol (c) fatty acid (d) ergosterol

V.

17. Metal ion in Myoglobin is --------.

18. Simplest amino acid is-----------------

19. Additional functional group present in histidine is
    (a) Indole (b) imidazole (c) amino (d) phenolic

20. Denaturation of protein is due to the loss of
    (a) primary structure (b) secondary (c) Tertiary forces (d) all these

**Section B Short answer questions.**
Attempt any six  (Weightage - 1)

21. What are epimeres?
22. Write the structure of 4" epimer of D glucose?
23. Differentiate D and L form?
24. What do you mean by invert sugar?
25. What are essential fatty acids?
26. Write the structure of cholesterol?
27. Write the structure of AMP?
28. What are unusual bases?

Section C  Short Essay.
Attempt any four  Weightage 2

29. Write the structure of sucrose and maltose?
30. Differentiate starch and Cellulose?
31. Note on primary structure of protein?
32. Classify lipids?
33. Explain the structure of tRNA?
34. Note on denaturation of protein?

Section D  Long essay
Answer any two  Weightage 4

35. Explain secondary and tertiary structure of proteins?
36. Note on Watson and Crick model of DNA?
35. Write the reactions of amino acids?

Course Code: BC 3B 04: Bioinformatics

Section A Objective Questions
Attempt all 20 questions.  (Weightage -1)

I. Choose the correct answer
1. The program which compares an amino acid sequence against a protein sequence database.
   (a) Blast n  (b) Blast p  (c) Blast x  (d) t Blast n
2. Which one is a 3D structure database?
   (a) PDB  (b) Swiss-prot  (c) Genbank  (d) DDBJ
3. ........................................
   (a)  (b)  (c)  (d)
4. ........................................
   (a)  (b)  (c)  (d)

II. State True or False.

5. Needleman-Wunsch is the algorithm used for global alignment of sequences.
6. KEGG is a 3D structure database.
7. Boot strapping strategies are used for predicting sequence patterns.
8. Gaps in alignments can be thought of as representing mutational changes in sequences.

III. Fill in the blanks.

9. In phylogenetic evaluation, sequences which are assumed to be derived from a common ---------------- sequence
10. -----------------are the protein coding regions in a gene sequence.
11. -----------------is a straight forward way to access the sequence databases in NCBI.
12. In an evolutionary tree, separate sequences are referred to as ---------------- defined as phylogenitically distinct units on the tree.

IV. Rearrange column B to match Column A.

<table>
<thead>
<tr>
<th>Q. No.</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.</td>
<td>Maximum Parsimony</td>
<td>KEGG</td>
</tr>
<tr>
<td>14</td>
<td>Expasy</td>
<td>Molecular Visualization tool</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>Distance Method</td>
</tr>
<tr>
<td>16</td>
<td>Rasmol</td>
<td></td>
</tr>
</tbody>
</table>

V. Answer in one word or in one sentence.

17. Expand KEGG.
18. DDBJ.
19. OMIM.
20. -------------------

Section B Short answer questions.
Attempt any six (Weightage - 1)

Differentiate between the following
21. t Blast n and t Blast x.
22. ------------------------
23. ------------------------
24. State the difference between global and local alignment
25. Motifs and Profiles.
26. ------------------------
27. ------------------------
28. CATH and SCOPE

Section C Short Essay.
Attempt any four Weightage 2

29. Distinguish between rooted and unrooted trees with examples.
30. ------------------------
31. Dot matrix analysis and Dynamic programming algorithm.
32. Smith-Waterman and Needleman-Wunsch algorithms.
33. What is the significance of multiple sequence alignment?
34. Mention the use of the software FASTA and define the features available in this software.
35. List the different programs in Blast and mention the use of each program.
36. Define the term Bioinformatics and its various fields of application.

Course Code: BC 4B 05: Physiological aspects of Biochemistry

Section A Objective Questions
Attempt all 20 questions. (Weightage –1)

I.
1. Digestion of carbohydrates starts in
   (a) stomach  (b) mouth  (c) small intestine  (d) oesophagus
2. Vitamin involved in blood coagulation
   (a) Vitamin K  (b) Vitamin C  (c) Vitamin E  (d) Vitamin D
3. The reversible reaction between water and carbon-di-oxide in blood is catalysed by --------
4. The pH of human blood is ----------

II.
5. Which of the following is not a female sex hormone
   (a) estradiol  (b) estriol  (c) progesterone  (d) testosterone
6. Chymotrypsinogen is converted to its active form by -----------.
7. The factor IV in the extrinsic pathway of blood coagulation is
   (a) prothrombin  (b) calcium  (c) thrombin  (d) TPA
8. Glucagon is secreted by ----------- cells of islets of Langerhans.
   (a) alpha cells  (b) beta cells  (c) acinar cells  (d) gamma cells

III.
9. HCl is secreted by ----------- cells of the stomach
10. ATP is converted to cAMP by
    (a) ATP synthase  (b) phosphodiesterase  (c) adenelyl cyclase  (d) ATPase
11. In sickle cell anemia, glucose -6 of β globin chain is replaced by -----------.
12. Testosterone is secreted by
    (a) Leydig cells  (b) Corpus luteum  (c) vas deferens  (d) Cowper's gland

IV.
13. The concentration in blood of a substance, above which if is excreted in urine is known as its -----------.
14. Of the following the thickest filament in muscle is
    (a) actin  (b) myosin  (c) collagen  (d) keratin
15. Deficiency of lactase leads to the condition called ------------------.
16. Renin is secreted by
    (a) juxta glomerular apparatus  (b) intestinal mucosa  (c) pancreas  (d) chromaffin cells
V.
17. Of the following --------------is a neurotransmitter
   (a) EGF   (b) NGF   (c) IGF   (d) GABA
18. When colustrum is heated ----------is precipitated
19. -------------------is a preservative for blood samples meant for glucose estimation.
20. Seratonin is synthesised from the aminoacid
   (a) glycine (b) alanine (c) tryptophan (d) tyrosine

Section B Short answer questions.
Attempt any six (Weightage- 1)

21. What are the functions of bile?
22. Name any four anticoagulants.
23. Explain the etiology of sickle cell anemia in brief.
24. What is chloride shift? Give its significance.
25. Which are the muscle proteins?
26. Give a schematic diagram of Nephron and label the parts.
27. Explain the chromosomal determination of sex.
28. Write short note on milk and colustrum.

Section C Short Essay.
Attempt any four Weightage 2

29. What are the physiological roles of parathyroid hormone?
30. Give the role of Vitamin D in the metabolism of bone.
31. Explain gastric HCl production in detail.
32. Explain the structure of villi.
33. What is the reason for hyperglycemia followed by the administration of epinephrine?
34. Why does ketonuria occur in a diabetic patient?

Section D Long essay
Answer any two Weightage 4

35. Explain the intrinsic and extrinsic pathway of blood coagulation.
36. Explain the process involved in the transmission of nerve impulses.
37. Explain the endocrine functions of ovary during puberty, pregnancy and lactation.

Course Code: BC 5B 07: Immunology and Immunological Techniques

Section A Objective Questions
Attempt all 20 questions (Weightage –1)

I.
1. Epitope is also known as:
   (a) paratope   (b) immunogen   (c) antibody   (d) antigenic determinant
2. $\text{Al(OH)}_3$ is an example for
   (a) epitope       (b) paratope    (c) isotope       (d) adjuvant
3. Antibody is bivalent, antigen is ......................
4. When antigen concentration is plotted against precipitate formed, complete precipitation of antigen and antibody takes place in ................. zone.
5. In some persons who show reaction against penicillin, penicillin acts as
   (a) epitope       (b) hapten     (c) vaccine       (d) immunogen
6. Lysozymal action is
   (a) innate immunity   (b) artificial passive immunity
   (c) acquired immunity  (d) natural passive immunity
7. Complements are
   (a) heat resistant   (b) reactive     (c) heat labile   (d) non reactive
8. Macrophages are ................. in nature.
   (a) homocentric    (b) photocytic  (c) heterocentric (d) phagocytic
9. Expand RASF
10. Reagin is the other name of
    (a) IgA          (b) IgG        (c) IgE          (d) IgD
11. Wintrobe’s tube is used for .................
12. Tritium is used in
    (a) RIA         (b) FIA        (c) ELISA       (d) agglutination
13. MHC class I molecules bind to.................cells.
14. Cells that directly kill viruses
    (a) NK cells      (b) Mast cells  (c) Killer cells  (d) Neutrophils
15. Who is the father of Immunology?
16. The concept of phagocytosis was discovered by
    (a) Paul Ehrlich (b) Metchnikoff   (c) Robert Koch (d) Karl Landsteiner
17. Salk polio vaccine is prepared as
    (a) toxoid       (b) killed vaccine  (c) live attenuated vaccine (d) none of these
18. Chemical substance produced by mast cells is .................
19. Name the antibody that can cross the placental barrier.
20. Transfer of immunity from mother to foetus is
    (a) active - natural       (b) passive – natural  (c) active – artificial (d) passive – artificial

Section B  Short answer questions.
Attempt any six   (Weightage- 1)

21. What are toxoids?
22. What is the difference between hapten and complete antigen.
23. What are leukocytes? Why are they named so?
24. What are blood group antigens?
25. How are memory cells formed?
26. List out the cells that arise from lymphoid lineage.
27. List out the various types of hypersensitive reactions.
28. Write short note on HIV.

Section C  Short Essay.
29. Write on classical pathway.
30. What is the role of MHC in immune system?
31. Write a note on Antibody diversity.
32. Write the theories of antibody formation.
33. Give an account on thymus.
34. What are the different types of Immunoglobulins.

Section D  Long essay
Answer any two               Weightage  4

35. What are the different types of Immunity?
36. Illustrate the methods for detecting and estimation of Antigen- Antibody reactions.
37. Write a note on Monoclonal antibody production. Give its applications.

Course Code: BC 5B 08: Enzymology and Enzyme Techniques

Section A Objective Questions
Attempt all 20 questions. (Weightage –1)

I.
1. Coenzyme involved in carboxylation reaction is 
   (a) TPP  (b) Pyridoxal phosphate  (c) Biotin  (d) NADP
2. Ribozymes are by nature 
   (a) heteropolysaccharide  (b) ribosomal protein  (c) lipoproteins  (d) ribonucleic acids
3. Urease is an example for 
   (a) group specificity  (b) absolute specificity  (c) reaction specificity  (d) stereo specificity
4. With the increase in enzyme concentration (when the substrate concentration is not limiting) the 
   rate of the reaction: 
   (a) increases  (b) increases and then decreases  (c) decreases  (d) decreases and then increases

II.
5. In uncompetitive inhibition 
   (a) Km and Vmax increases  (b) Km increase, Vmax decrease  
   (c) Km and Vmax increases  (d) Km decrease, Vmax increase
6. Monoclonal antibodies that catalyse the hydrolysis of ester or carbonates are-------
7. Name the Scientist who first proposed that enzymes by nature are proteins
8. According to IUB, the EC number for alcohol dehydrogenase is .............

III.
9. Sucrose is hydrolysed by the enzyme     -----------
10. Enzyme that removes group from substrates or break bonds by mechanism other than hydrolysis are classified under -----------
11. LDH is a 
   (a) monomeric enzyme  (b) dimeric enzyme  (c) oligomeric enzyme  (d) multi enzyme
12. Coenzyme involved in transketolase reaction is ..........................

IV.
13. Which type of vitamin functions as coenzymes
(a) Fat soluble  (b) Water soluble  (c) Both of these  (d) None of these
14. Coenzyme involved in the conversion of glutamine to GABA
   (a) TPP  (b) Biotin  (c) Lipoic acid  (d) PLP
15. Enzyme accelerate reaction by
   (a) increasing $E_a$  (b) decreasing $E_a$  (c) increasing $\Delta H$  (d) increasing $\Delta G$
16. An activator for salivary amylase enzyme is
   (a) Mg$^{2+}$  (b) Mn$^{2+}$  (c) Zn$^{2+}$  (d) Cl$^{-}$
V.
17. Glycogen synthetase is regulated by
   (a) covalent modification  (b) zymogen activation  (c) allosteric regulation  (d) none of these
18. Malonate inhibits succinate dehydrogenase by -------- type inhibition
19. Specificity where the enzyme act on closely related substrates is ------------
20. The enzyme is more efficient in catalysis when Km value is
   (a) low  (b) high  (c) zero  (d) infinity

Section B Short answer questions.
Attempt any six  (Weightage - 1)

21. Give two examples for NAD$^+$ catalysed reaction.
22. What are zymogens? How they are activated?
23. Why ammonium sulphate is the most commonly used salt for enzyme fractionations?
24. What is the significance of Km value?
25. What are artificial enzymes?
26. What is the difference between apoenzyme and holoenzyme?
27. What are Biosensors?
28. List two major distinctions between $\alpha$-amylase and $\beta$-amylase

Section C Short Essay.
Attempt any four  Weightage  2

29. What are the factors affecting enzyme activity?
30. How is pyramidine biosynthesis allosterically regulated?
31. Derive Michaelis Menten Equation.
32. Explain Photometric Biosensors.
33. What are the characteristic features of active site?
34. How are coenzymes classified? Give two examples of each.

Section D Long essay
Answer any two  Weightage  4

35. Explain the various methods of Enzyme Immobilisation.
36. Based on Lineweaver- Burk plot compare competitive and non-competitive inhibition. Give example.
37. Write a note on isolation and purification of enzymes. Give the criteria of purity.

Course Code: BC 5B 09: Metabolism and Bioenergetics

Section A Objective Questions

Attempt all 20 questions. (Weightage –1)

I.
1. Glucose-1-phosphate is formed in cells by
   (a) Glycolysis  (b) Glycogenesis  (c) Glycogenolysis  (d) Pentose phosphate pathway
2. Carnitine is
   (a) β-hydroxy-γ-trimethylammoniumbutyrate  (b) γ-hydroxy-β-trimethylammoniumbutyrate
   (c) α-hydroxy-β-trimethylammoniumbutyrate  (d) β-hydroxy-α-trimethylammoniumbutyrate
3. Which of the following is not a ketone body?
   (a) acetone  (b) acetoacetate  (c) acetic acid  (d) β-hydroxybutyrate
4. For a reaction to be feasible ∆G value should be
   (a) zero  (b) high  (c) positive  (d) negative

II.
5. Which aminoacid is not involved in purine biosynthesis?
   (a) glycine  (b) aspartate  (c) serine  (d) glutamine
6. In humans, the end product of purine metabolism is
   (a) β-alanine  (b) allantoin  (c) uric acid  (d) lipoic acid
7. Which of these lipoproteins help in reverse cholesterol transport?
   (a) LDL  (b) HDL  (c) VLDL  (d) chylomicrons
8. Photosystem I generates
   (a) strong oxidant, strong reductant  (b) weak oxidant, strong reductant
   (c) weak oxidant, weak reductant  (d) strong oxidant, weak reductant

III.
9. According to increasing order of positive redox potential, cytochromes in electron transport chain are
   in the order
   (a) cyt b → cyt c → cyt c₁ → cyt aa₃  (b) cyt b → cyt c₁ → cyt c → cyt aa₃
   (c) cyt aa₃ → cyt b → cyt c → cyt c₁  (d) cyt c → cyt b → cyt c₁ → cyt aa₃
10. Identify the odd one
    (a) creatine phosphate  (b) phosphoenol pyruvate  (c) ATP  (d) creatine

11. Which of the following is not a multienzyme complex?
    (a) fatty acid synthase  (b) α-ketoglutarate dehydrogenase
    (c) pyruvate dehydrogenase  (d) isocitrate dehydrogenase
12. Which of the following aminoacid is both ketogenic and glucogenic?
    (a) alanine  (b) histidine  (c) cysteine  (d) phenylalanine

IV.
13. The key cholesterol precursor is
    (a) Succinyl CoA  (b) HMG CoA  (c) Propionyl CoA  (d) Acyl CoA
14. Urea cycle takes place in
    (a) liver mitochondria  (b) liver cytosol  (c) both of these  (d) none of these
15. Carbamyl phosphate synthase II is involved in
(a) pyrimidine biosynthesis (b) purine biosynthesis
(c) urea cycle (d) lipid biosynthesis
16. Sedoheptulose-7-phosphate is the result of
(a) transaldolase (b) transketolase (c) isomerase (d) epimerase

V.
17. Which of these is non-essential?
(a) linolenic acid (b) arachidonic acid (c) stearic acid (d) linoleic acid
18. Complex III in Electron transport chain is
(a) cyt oxidase (b) NADH dehydrogenase (c) cyt reductase (d) Succinate dehydrogenase
19. End product of alcoholic fermentation of glucose is
(a) ethanol and water (b) ethanol and CO₂ (c) acetone and water (d) acetone and CO₂
20. Calvin cycle is also known as
(a) reductive hexose phosphate cycle (b) reductive pentose phosphate cycle
(c) oxidative hexose phosphate cycle (d) oxidative pentose phosphate cycle

Section B  Short answer questions.
Attempt any six  (Weightage-1)

21. What is transamination? Give 2 examples.
22. How is AMP synthesised from IMP?
23. List out the enzymes and coenzymes involved in the conversion of pyruvate to acetyl Co(a)
24. Which are the enzymes constituting fatty acid synthase complex?
26. What are the enzymes and reactions involved in the Salvage pathway?
27. What are the enzymes and compounds involved in the transport of long chain fatty acid from cytosol to mitochondria for β-oxidation?
28. What is meant by entropy and enthalpy?

Section C  Short Essay.
Attempt any four  Weightage 2

29. Write a note on β-oxidation of fatty acids.
30. What is glycogenesis?
31. Give an account on urea cycle.
32. Enumerate UMP synthesis.
33. What are light reactions?
34. What is the role of pentoses in purine biosynthesis?

Section D  Long essay
Answer any two  Weightage 4

35. How are the following aminoacids synthesised?
Glycine, Phenylalanine, Tyrosine, Asparagine.
36. How is glucose oxidised to CO₂? Give the energetics.
37. Write a note on biosynthesis of fatty acids.

**Course Code: BC 6B 13: Genetics and Molecular Biology**

Section A Objective Questions

Attempt all 20 questions. (Weightage: -1)

I.
1. What is the unit of inheritance?
2. Chromosome pattern in normal human males
   - (a) 44XX
   - (b) 44XY
   - (c) 44XO
   - (d) 45XY
3. The site of continuous unwinding and synthesis during replication is called---------
4. Xeroderma pigmentosum is related to
   - (a) base excision repair
   - (b) nucleotide excision repair
   - (c) photo reactivation
   - (d) recombination repair

II.
5. The termination codons include
   - (a) UAA, UAG, UGA
   - (b) UAA, UAC, UGA
   - (c) UUU, UCA, UAU
   - (d) AUG, AAA, UUU
6. Name the enzyme responsible for the joining of adjacent aminoacids during translation.
7. Unvarying expression of a gene is called ---------.
8. The plasmid which can be integrated into bacterial chromosome is ------------
   - (a) phagosome
   - (b) episome
   - (c) lysosome
   - (d) prophage

III.
9. The phenotypic ratio in monohybrid cross is
   - (a) 3:1
   - (b) 1:2:1
   - (c) 9:3:3:1
   - (d) 2:2
10. Trisomy at 21st chromosome leads to
    - (a) Down’s syndrome
    - (b) Kleinfelter’s syndrome
    - (c) Cri-du-chat syndrome
    - (d) Edward’s syndrome
11. The point in chromosomes where crossing over takes place is ..........
12. Genetic code was elucidated by .....

IV.
13. Name the enzyme responsible for the activation of aminoacids during translation
14. An example for base analogs –
   - (a) 6-aminopurine
   - (b) 5-bromouracil
   - (c) guanine
   - (d) uracil
15. The linker histone is
   - (a) H₁
   - (b) H₃
   - (c) H₂A
   - (d) H₄
16. The enzyme responsible for the synthesis of DNA from RNA

V.
17. The non-coding sequences on a gene are called
   - (a) intron
   - (b) exon
   - (c) recon
   - (d) muton
18. The codon in t RNA which is complementary to mRNA is called----------.
19. The condition in which a cell of organism possess three haploid set of chromosomes is called .....
20. Name the enzyme responsible for the unwinding of double stranded DNA during replication.
Section B  Short answer questions.
Attempt any six  (Weightage - 1)

21. What is the role of $\sigma$ factor during transcription?
22. Define operon.
23. Differentiate between test cross and back cross.
24. Define crossing over.
25. What is meant by central dogma of molecular biology?
26. What are cosmids?
27. What is the role of DNA ligase during replication?
28. Differentiate between genotype and phenotype.

Section C  Short Essay.
Attempt any four  Weightage  2

29. Explain reverse transcription.
30. Explain physical mapping.
31. Explain the terms codominance and incomplete dominance with examples.
32. Explain transcription bubble.
33. Explain mutation.
34. Explain PCR.

Section D  Long essay
Attempt any two  Weightage  4

35. Briefly explain chromosomal aberrations.
36. Explain translation in prokaryotes.
37. Explain DNA repair mechanisms.

Course Code: BC 6B 14: Clinical Biochemistry

Section A  Objective Questions
Attempt all 20 questions.  (Weightage -1)

I.
1. Of the following enzyme which is used as a prostatic tumour marker?
   (a) AST  (b) Acid phosphatase  (c) ALT  (d) Alkaline phosphatase
2. The normal serum calcium level is.........................
3. Phenylketonuria is due to the deficiency of ................ enzyme
4. The albumin/globulin ration is reversed in :
   (a) liver disorder  (b) kidney failure  (c) myeloma  (d) all the above
II.
5. The normal average RBC count in human blood is..................
6. Of the following which is not an inborn error of amino acid metabolism:
   (a) Alkaptonuria  (b) Phenylketonuria  (c) Galactosemia  (d) Albinism
7. Conjugation of bilirubin takes place in .........................
8. Lactose intolerance is due to the deficiency of the enzyme
   (a) Invertase  (b) Lactase  (c) Maltase  (d) Amylase

III.
9. The anticoagulant EDTA is a.................. agent.
10. Gout is due to the accumulation of
    (a) urea  (b) uric acid  (c) creatinine  (d) onnithine
11. Of the following which is not involved in the regulation of blood calcium level?
    (a) Vitamin A  (b) parathyroid hormone  (c) thyroxine  (d) calcitonin
12. Deficiency of vitamin B_{12} causes ..................

IV.
13. Scurvy is due to the deficiency of
    (a) vitamin A  (b) vitamin D  (c) vitamin C  (d) vitamin K
14. Normal value of semen fructose is .................. mg/dl
15. Renal threshold of glucose is................. mg/dl
    (a) 160  (b) 100  (c) 180  (d) 140
16. Which of the following is an abnormal constituent of urine?
    (a) chloride ion  (b) sulphate  (c) albumin  (d) urea

V.
17. Normal serum level of AST is .................
18. Group of inborn errors of metabolism due to defective sphingolipid metabolism is called..............
19. Of the following which does not affect ESR?
    (a) Number of RBC  (b) size of RBC  (c) pH  (d) Rouleox formation
20. Good cholesterol is
    (a) LDL  (b) VLDL  (c) HDL  (d) IDL

Section B  Short answer questions.
Attempt any six  (Weightage- 1)

21. Comment on alkaptonuria
22. Write the normal value and clinical significance of serum sodium
23. What is fluorosis
24. Give a short note on anticoagulants
25. What is lactose intolerance?
26. Write the principle of estimation of serum urea
27. What is the biochemical basis of pentosurea?
28. Write a short note on myocardial marker enzymes.

Section C  Short Essay.
Attempt any four  Weightage  2

29. Give an account of blood lipid profile
30. Explain the abnormal constituents in urine
31. Write on renal function tests
32. Explain the factors regulating blood calcium levels
33. Write an account of transfusion of blood and hazards of transfusion.
34. Comment of the errors of purine metabolism

Section D Long essay
Attempt any two Weightage 4

35. Write on the types of diabetes mellitus. Add a note on OGTT.
36. Give a detailed account on the inborn errors of amino acid metabolism.
37. Explain the detoxification mechanisms by liver.

MODEL QUESTION PAPERS: OPEN COURSES

Course Code: BC 5D 01/ BC 6B 17 (E): Health and Nutrition
(Common to other departments and the parent department)

Section A. Objective Questions
Attempt all 20 questions. (Weightage –1)

I. 1 The year of Alma Atta declaration is:
   (a) 1979    (b) 1978    (c) 1976    (d) 1975

2. The WHO’s definition of health includes:
   (a) physical state.    (b) Mental state.    (c) social state of well being.    (d) all these

3. Human development index is the average of:
   (a) life expectancy    (b) education index    (c) per capita GDP    (d) all the three

4. Male life expectancy in Kerala
   (a) 70 years    (b) 71.7 years    (c) 60 years    (d) 65 years

II. 5. The higher rate of Human Development index is above --------------.

   6. Sullivan's index is related to --------------.
   7. Child mortality rate is assessed between -------------- aged children.
   8. Prevalence of low birth rate is included in ----------- status indicator.

III. 9. The essential nutrient is
   (a) Protein    (b) Glucose    (c) Linoleic acid    (d) Lipid

   10. The amount of energy in 1 gram of fat is ----------- Kcal.
11. Linoleic acid is --------- fatty acid.
12. Vitamin A is water soluble (True or False).

IV. 13. The coenzyme form of thiamine is
   
   (a) NAD      (b) TPP      (c) CoA       (d) EDTA

14. Pellagra is due to the deficiency of --------------.
15. Vitamin with hormone function is --------------
   (a) Insulin      (b) Vit D      (c) Vit K    (d) Vit E

16. Vitamin helps blood clotting is
   (a) Vit A       (b) Vit C      (c) Vit K    (d) Vit B₆

V. 17. Metal ion in Myoglobin is --------------.
18. Excess of fluorine causes --------------.
19. A compound present in cabbage affect ---------- gland.
20. A natural food colour is ...........

Section B. Short answer questions.
Attempt any six (Weightage- 1)

21. Write the biochemical concept of Human health.
22. What are the environmental determinants to Health?
23. How Vitamin A is related to vision?
24. What do you mean by BMR?
25. Role of Vitamin D in bone formation.
26. Note on food fortification.
27. How to calculate body mass index?
28. What are Aflatoxins?

Section C. Short Essay.

Attempt any four Weightage 2

29. Calculate the Human Development Index of a Nation.
30. Write note on determinants of Human health.
31. Note on protein energy malnutrition.
32. Comment on nutritional profile of milk and milk products.
33. Explain natural Anemia.
34. What are Community Nutrition Programmes?

Section D

Answer any two Weightage 4

35. Explain various indicators of Health.
37. Write an essay on Food Hygiene.

Course Code: BC 6B 18 (E).  Applied Immunology

Section A Objective Questions
Attempt all 20 questions. (Weightage –1)

I.
1. Epitope is also known as
   (a) paratope  (b) immunogen  (c) antibody  (d) antigenic determinant
2. Al(OH)₃ is an example for
   (a) epitope  (b) paratope  (c) isotope  (d) adjuvant
3. Antibody is bivalent, antigen is -------------------.
4. When antigen concentration is plotted against precipitate formed, complete precipitation of antigen and antibody takes place in which zone.

II.
5. In some persons who show reaction against penicillin, penicillin acts as
   (a) epitope  (b) hapten  (c) vaccine  (d) immunogen
6. Lysozymal action is
   (a) innate immunity  (b) artificial passive immunity
   (c) acquired immunity  (d) natural passive immunity
7. Complements are
   (a) heat resistant  (b) reactive  (c) heat labile  (d) non reactive
8. Macrophages are -------------- in nature.
   (a) homocentric  (b) photocytic  (c) heterocentric  (d) phagocytic

III.
9. Expand RASF
10. Reagin is the other name of
    (a) IgA  (b) IgG  (c) IgE  (d) IgD
11. Wintrobe’s tube is used for -------------------.
12. Tritium is used in  (a) RIA  (b) FIA  (c) ELISA  (d) agglutination

IV.
13. MHC class I molecules bind to -------- cells.
14. Cells that directly kill viruses
    (a) NK cells  (b) Mast cells  (c) Killer cells  (d) Neutrophils
15. Who is the father of Immunology?
16. The concept of phagocytosis was discovered by
    (a) Paul Ehrlich  (b) Metchnikoff  (c) Robert Koch  (d) Karl Landsteiner

V.
17. Salk polio vaccine is prepared as
    (a) toxoid  (b) killed vaccine  (c) live attenuated vaccine  (d) none of these
18. Chemical substance produced by mast cells.
19. Name the antibody that can cross the placental barrier.
20. Transfer of immunity from mother to foetus is
    (a) active – natural  (b) passive – natural  (c) active - artificial  (d) passive – artificial
Section B  Short answer questions.
Attempt any six   (Weightage- 1)

21. What are toxoids?
22. What is the difference between hapten and complete antigen.
23. What are leukocytes? Why are they named so?
24. What are blood group antigens?
25. How are memory cells formed?
26. List out the cells that arise from lymphoid lineage.
27. List out the various types of hypersensitive reactions.
28. Write short note on HIV.

Section C  Short essays
Attempt any four   (Weightage- 2)

29. Write on classical pathway.
30. What is the role of MHC in immune system?
31. Write a note on Antibody diversity.
32. Write the theories of antibody formation.
33. Give an account on thymus.
34. What are the different types of Immunoglobulins.

Section D  Long essay
Attempt any two   Weightage  4

35. What are the different types of Immunity?
36. Illustrate the methods for detecting and estimation of Antigen- Antibody reactions.
37. Write a note on Monoclonal antibody production. Give its applications.

Course Code: BC 6B 19 (E)  : Secondary Metabolism in Plants

Section A. Objective Questions
Attempt all 20 questions.  (Weightage –1)

I.
1. β-alanine is:
   (a) protein amino acid  (b) non-protein amino acid  (c) storage form of nitrogen in legumes  
   (d) none of these
2. An isoprene unit contains : 
   (a) 6 carbon  (b) 2 carbon and 2 nitrogen atoms  (c) 5 carbon  (d) 4 carbon
3. Digitalin, a cardia glycoside  is found in abundance in the plant .................
4. Lignins are polymers of ...............units

II.
5. In plants, secondary metabolites may be present in:
(a) roots  (b) leaves  (c) fruits  (d) any of these
6. Which of the following is an essential oil:
   (a) sunflower oil  (b) lemon grass oil  (c) cod liver oil  (d) palm oil
7. Tryptophan is the precursor for--------family of alkaloids
8. -------------- is a potent insecticide produced by the Neem plant.

III.
9. Amygdalin is
   (a) mono terpene  (b) cyanogenic glycoside  (c) non-protein amino acid
      (d) phytosterol
10. Of the following which is not an opium alkaloid: (a) morphine (b) papaverine
      (c) atropine (d) codeine
11. One of the principal alkaloids of the tobacco plant is ..............
12. Proline is the precursor for ..........alkaloids.

IV.
13. The analgesic effect of “oil of wintergreen” is due to (a) methyl salicylate
    (b) benzoic acid  (c) shikimic acid  (d) p-coumaric acid
14. The active principle in ginseng is
    (a) saponin  (b) terpenoid  (c) phenol  (d) mannitol
15. Reserpine is produced by the plant ....................
16. Geraniol is a ...............derivative

V.
17. Flavones contain
    (a) 3 ring systems  (b) 4 ring systems  (c) 5 ring systems  (d) no ring systems
18. The yellow color of flowers and fruits is due to:
    (a) anthocyanins  (b) terpenoids  (c) flavonoids  (d) indole alkaloids
19. In animals the main site of xenobiotic metabolism is ............
20. A major site of compartmentation of secondary metabolites in plants is ...........

Section B. Short answer questions.
Attempt any six (Weightage- 1)

21. What is meant by xenobiotics?
22. What is allelopathy?
23. Name any two non-protein amino acids and their importance
24. What are anthocyanins?
25. Write a short note on diterpenes
26. What are the major amino acids from which the various alkaloids are mostly formed?
27. To which classes of secondary metabolites the following compounds belong:
   (a) Scopoletin  (b) Ecdysone  (c) Linamarin  (d) Caffeine
28. What are the important alkaloids of Cinchona and Rauwolfia plants Mention their uses.

Section C. Short Essay.
Attempt any four  Weightage 2
29. Write the pathway of isoprene biosynthesis
30. Briefly outline the biosynthesis of pyridine-pyrrolidine alkaloids
31. What are the functions of alkaloids in plants?
32. What are cyanogenic glycosides? What are their functions in plants?
33. Mention two each of hemi, mono, sesqui and diterpenes and their functions.
34. How are phenol carboxylic acids biosynthesized?

Section D. Long Essay

Answer any two Weightage 4

35. Outline the pathway of di and tri terpenes formation, starting from acetyl CoA. What are the major uses of terpenoids?
36. Starting from glucose 6 phosphate, outline the biosynthesis of p-coumaric acid.
37. Explain how genetic engineering and biotechnology can be applied in the field of secondary plant products.
6. Which sugar is present in seminal fluid?
   (a) Glucose   (b) Fucose   (c) Fructose  (d) Mannose

7. log $K_a$ is  --------------
   (a) $-K_a$   (b) pH   (c) pOH  (d) $pK_a$

8. Importance of Henderson-Hasselbalch equation is in  --------------
   (a) Buffer (b) Acid base balance    (c) Ionic strength   (d) Dissociation

III.
9. Which enzyme activates trypsinogen to trypsin?
   (a) Chymotrypsin    (b) Pepsin   (c) Enteropeptidase    (d) Proelastase

10. The isomers having same molecular formula but difference in the spatial arrangement
      of atom/groups are called
    (a) Structural isomers      (b) Stereoisomers
        (c) Geometrical isomers  (d) Positional isomers

11. -----------------Chromatography is used to desalt a protein solution.

12. -----------------is the most widely used salt for salting out of proteins

IV.
13. -----------------chromatography is used form the determination of molecular mass.

14. -----------------leucocyte is responsible for engulfing bacteria

15. HCl is synthesized from ------------------------cells of gastric lining.

16. -----------------leucocyte is responsible for specific immune mechanism.

V.
17. The enzyme that hydrolyzes sucrose to component sugars------------------.

18. Which plasma protein helps in the transport of bilirubin.

19. -----------------is the ultrafiltration of plasma

20. The chemical component that is present especially in smoker's saliva is--------.

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Section -B  Short answer questions.
Attempt any six  (Weightage - 1)

21. State the Beer-Lambert’s law

22. Write down the composition and function of synovial fluid

23. What is a buffer? Give example.

24. What is oxidation and reduction reaction? Give an example for each

25. Write the principle of affinity chromatography

26. Distinguish between colloidal solution and coarse suspension

27. Write the principle of gel filtration chromatography

28. Give the principle of adsorption chromatography

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Section -C  Short Essay.
Attempt any four  Weightage 2

29. Write the functions of plasma proteins

30. Explain the classification of isomerism

31. Explain the working principle of pH meter

32. Distinguish between lyophilic and lyophobic colloids

33. Derive Henderson-Hasselbalch equation

34. Write the composition and functions of cerebrospinal fluid
Section - D  Long essay
Answer any two  Weightage  4

35. Explain the process of blood coagulation in detail
36. Discuss the functions of blood
37. Explain briefly the techniques involved in macromolecular separation.

Course Code: BC 2C 05: Elementary Biochemistry- 2

Section- A  Objective Questions
Attempt all 20 questions. (Weightage –1)

I.  
1. Mannose is the epimer of
   (a) Galactose (b) Glucose (c) Fructose (d) Ribose
2. Which of the following is an essential fatty acid
   (a) Linolenic (b) Stearic (c) Palmitic (d) Oleic
3. Which is not an aromatic amino acid
   (a) Tryptophan (b) Histidine (c) Proline (d) Phenylalanine
4. Which form of RNA is abundant in cell
   (a) rRNA (b) tRNA (c) mRNA (d) hnRNA

II. 
5. Which diasaccharide is having α1→6 linkage
   (a) Maltose (b) Isomaltose (c) Lactose (d) Sucrose
6. Which polysaccharide acts as an anticoagulant
   (a) Hyaluronic acid (b) Heparin (c) Chondroitin (d) Keratan sulphate
7. Diphosphatidylglycerol is known as
   (a) Lecithin (b) Cephalin (c) Cardiolipin (d) Plasmalogen
8. Which of the following is a monoamino dicarboxylic acid
   (a) Aspartic acid (b) Asparagine (c) Glutamine (d) Glutathione

III. 
9. Which of the following is not a pyrimidine base
   (a) Uracil (b) Thymine (c) Cytosine (d) Adenine
10. Which anomeric form of sugar exists in ribonucleotides
    (a) β-D- ribofuranose (b) α-D- ribofuranose. (c) α-L-ribofuranose (d) α- D- ribopyranose
11. ---------------- is a non reducing disaccharide
12. ---------------- is the most abundant carbohydrate in nature

IV. 
13. ---------------- amino acid is optically inactive
14. ---------------- is a calcium binding protein
15. ---------------- is the sweetest sugar
16. Steroid nucleus is ----------------

V. 
17. Lipids are soluble in ----------------
18. The major esterified fatty acid component in coconut oil is -----------------
19. Transport form of lipid is ------------------
20. Sugar present in DNA is ------------------

Section - B  Short answer questions.
Attempt any six  (Weightage - 1)

21. What is an essential amino acid?. Give examples .
22. Give the structure of phosphatidic acid
23. What are epimers? Give examples
24. Give the cyclic structure of fructose.
25. Write the functions of lipids
26. Draw the general structure of tRNA
27. Write the structure of cholesterol
28. What is meant by saponification number?

Section - C  Short Essay.
Attempt any four  Weightage 2

29. What is mutarotation- give explanation with one example
30. Give the structure of following compound lipids
   (a) lecithin  (b) cephalin  (c) Phosphatidyl serine
31. Explain the structure of DNA
32. Explain the classification of fatty acids
33. Explain the colour reactions of proteins
34. Explain the heterocyclic compounds present in nucleic acids.

Section - D  Long essay
Answer any two  Weightage 4

35. Explain the structural organization of protein
36. Explain different types of RNA
37. Compare the structure of starch and cellulose and add a note of enzymatic breakdown of starch.

CourseCode: BC 3C09: Enzymology and Metabolism-I

Section -A  Objective Questions
Attempt all 20 questions.  (Weightage -1)

I.
1. Which is the key enzyme in glycolytic pathway
   (a) Pyruvate kinase  (b) glyceraldehyde 3-phosphate (c) Glucokinase (d) Phosphofructokinase
2. In glycogen metabolism which enzyme is inactive in dephosphorylated form?
   (a) Glycogen phosphorylase  (b) Glucose phosphatase  (c) Glycogen synthase (d) Glycogen phosphates
3. In aerobic glycolysis how many molecules of ATP are produced
   (a) 10 (b) 2 (c) 3 (d) 8
4. Major significance of pentose phosphate pathway is the production of
   (a) NADP  (b) NADPH  (c)ATP  (d) NADH
II.
5. Which is the essential cofactor for pyruvate decarboxylase
   (a) TPP   (b) PLP   (c) Biotin (d) FAD
6. Which enzyme is not present in animal tissue
   (a) Pyruvate carboxylase (b) Pyruvate decarboxylase (c) Alcohol dehydrogenase (d) None of the above
7. In TCA cycle how many ATPs are produced
   (a) 12  (b) 15  (c) 8  (d) 10
8. Synthesis of carbohydrate from non-carbohydrate sources is called
   (a) Glycolysis  (b) Glycogenesis     (c) Glycogenogenesis  (d) All the above
III.
9. Which hormone regulate glycogenesis
   (a) Glucagon  (b) Epinephrin  (c) Insulin (d) Cortisol
10. Gluconeogenesis takes place in
    (a) Cytosol  (b) Mitochondria  (c) Both cytosol and mitochondria (d) Golgi complex
11. Name the ketopentose synthesized in oxidative stage of pentose phosphate pathway.
12. The catalytic activity of the enolase is inhibited by.------------------
IV.
13. Tricarboxylic acid cycle takes place in.----------------------
14. The pathway that is involved in the synthesis of glucose from acetyl CoA in plant is.---------------------
15. Which aldose sugar is synthesized from pentose phosphate pathway?
16. Retenone is the inhibitor of.-------------------------
V.
17. Marker enzyme of mitochondria is
18. The protein part of an enzyme is.--------------------
19. ------------------------ coenzyme involved in carboxylation reaction
20. ------------------------ group of enzyme involved in joining of two molecules

Section- B  Short answer questions
Attempt any six                        (Weightage- 1)

21. What is mean by allosteric enzyme?. Give one example.
22. Which are the key enzymes in gluconeogenesis
23. What is covalent modification of enzymes? Give one example
24. What is competitive inhibition? Give examples
25. Outline alcoholic fermentation
26. Name the enzymes and catalytic cofactors involved in decarboxylation of pyruvate.
27. Write Michaelis Menten equation, explain the term Km.
28. What do you mean by retro inhibition. Give one example

Section- C  Short Essay.
Attempt any four                        Weightage 2
29. Explain the role of cAMP in glycogen metabolism
30. Write a short note on enzyme specificity with examples.
31. Explain the factors which affect the rate of the enzyme catalyzed reactions
32. Schematically write the pentose phosphate pathway. Mention its significance
33. Explain the classification of high energy compounds with examples
34. What is multienzyme complex? Explain with one example

Section - D  Long essay
Answer any two  Weightage  4

35. Explain the structure of mitochondria and arrangements of electron carriers in electron transport chain
36. Write short notes on:  (a) competitive inhibition, (b) Noncompetitive inhibition, (c) Allosteric inhibition.
37. Explain aerobic and anaerobic glycolysis.

Course Code: BC 4C 13: Enzymology and Metabolism-II

Section - A  Objective Questions
Attempt all 20 questions.  (Weightage –1)

1. Rickets is due to the deficiency of.-----------------
   (a) Vitamin C (b) Vitamin D (c) Vitamin E (d)Vitamin A
2. ATP yield during the β oxidation of palmitic acid is
   (a) 149   (b) 131 (c) 129  (d) 12
3. The coenzyme needed for fatty acid oxidation is
   (a) NAD (b) NADP (c) TPP (d) Biotin
4. Transamination reaction is carried out by.-----------------
   (a) Aminotransferases (b) Aminoacid carboxylase (c) Aminoacid oxidases (d) Dehydrogenase
5. Rate limiting enzyme in cholesterol biosynthesis is
   (a) HMG CoA reductase  (b) HMG CoA synthase  (c) Acetyl CoA carboxylase  (d) Cholesterol synthase
6. The metal ion present in hemoglobin is
   (a) Mg^{2+}  (b) Fe^{2+}  (c) Mn^{2+}  (d) Cu^{2+}
7. Which vitamin is an antioxidant
   (a) Vitamin E   (b) Vitamin A  (c) Vitamin B_{1}  (d) Vitamin B_{12}
8. Diabetes mellitus is due to the deficiency of
   (a) Insulin (b) Glucagon (c) Epinephrine (d) Inulin
9. ---------------- is the trace element deficient in milk
   (a) Copper (b) Calcium  (c) Iron  (d) Sodium
10. The coenzyme form of thiamine is
    (a) TPP (b) CoA (c) Biotin  (d) FAD
11. Active form of vitamin D is.-----------------  
12. ---------------- is the codon of methionine
13. Name the site of β-oxidation of fatty acids
14. -------------------- enzyme involve in the activation of amino acid during translation
15. The cluster of ribosomes associated with single mRNA is called--------------------
16. -------------------- is the rate limiting enzyme in the de novo synthesis of fatty acids.
17. -------------------- is the key enzyme in urea cycle
18. -------------------- is the trace element present in glutathione reductase
19. Deficiency of iodine causes--------------------
20. -------------------- is an example of provitamin.

Section-B Short answer questions
Answer any six Weightage 1

21. What is the function of carnitine
22. Explain the term pellagra
23. What are zymogens?
24. What are non-sense codons?
25. Explain the term ‘central dogma’
26. Name out the fat soluble vitamins
27. What are the factors that retard iron absorption.
28. What are Okazaki fragments?

Section-C Short essay
Attempt any four Weightage 2

29. Describe the cholesterol synthesis
30. Explain physiological function of phospholipids
31. Give an account of genetic code
32. Explain termination of transcription in detail
33. Explain the biological role of iodine and fluorine
34. Discuss about Wobble hypothesis.

Section-D Long essay
Answer any two Weightage 4

35. Explain the urea cycle and its significance.
36. Explain the fatty acid biosynthesis.
37. Explain the translation process in prokaryotes.