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UNIVERSITY OF MYSORE

Estd. 1916

Vishwavidyanilaya Karyasoudha
Crawford Hall, Mysuru- 570 005

No.AC.2(S)/31/18-19 Dated: 15.06.2018

NOTIFICATION

Sub: Revision of syllabus for Biochemistry (UG) as per CBCS pattern from the Academic year 2018-19.

Ref: 1. Decision of Board of Studies in Biochemistry (UG) meeting held on 27.02.2018.
2. Decision of the Faculty of Science & Technology Meeting held on 21.04.2018.
3. Decision of the Deans Committee meeting held on 22.05.2018.

*****

The Board of Studies in Biochemistry (UG) which met on 27th February, 2018 has recommended to revise the syllabus for B.Sc. Biochemistry as per CBCS pattern from the academic year 2018-19.

The Faculty of Science and Technology and the Deans committee meetings held on 21-04-2018 and 22-05-2018 respectively have approved the above said proposal with pending ratification of Academic Council and the same is hereby notified.

The CBCS syllabus of B.Sc. Biochemistry course is annexed. The contents may be downloaded **from the University Website i.e., www.uni-mysore.ac.in**.

Draft approved by the Registrar

15/6

Deputy Registrar (Academic)

To:

1. The Registrar (Evaluation), University of Mysore, Mysore.
2. The Dean, Faculty of Science & Technology, DOS in Physics, Manasagangotri, Mysore.
3. The Chairperson, BOS in Biochemistry, DOS in Biochemistry, Manasagangotri, Mysore.
4. The Chairperson, Department of Studies in Biochemistry, Manasagangotri, Mysore.
5. The Director, College Development Council, Moulya Bhavan, Manasagangotri, Mysore.
6. The Principals of the Affiliated Colleges where UG Program is running in Science stream.
7. The Deputy/Assistant Registrar/Superintendent, AB and EB, UOM, Mysore.
8. The P.A. to the Vice-Chancellor/Registrar/Registrar (Evaluation), UOM, Mysore.
9. Office file.

UNIVERSITY OF MYSORE

GRADUATE COURSES – SEMESTER SCHEME

CBCS

2018-2019 ONWARDS

BIOCHEMISTRY

SYLLABUS

SEMESTER – I

CORE: CHEMISTRY OF BIOMOLECULES

CLASS DURATION- 04 HOURS PER WEEK

MARKS= Theory 50 marks + Internal Assessment 20 marks, Total= 70 marks

64 hrs

PART-A : BIOINORGANIC CHEMISTRY

Overview of Biochemistry: 3hrs

Definition, scope and significance of Biochemistry. Important discoveries in Biochemistry. An overview of elements, general reactions and biomolecules in living organisms.

Co-ordination compounds: 9hrs

Transition metals, Properties (Colour, Oxidation States, Magnetic Properties). Co-ordinate bond, double and complex salts – differences with examples. Co-ordination number.

Porphyrin nucleus, and classification. Important metallo porphyrins occurring in nature, structure and their biological importance (Hb, cytochrome, chlorophyll, Vit-B_{12}). Bile pigments chemical nature.

Radiochemistry: 4hrs

Natural and artificial radioactivity, Characteristics of radioactive elements, units of radioactivity, disintegration constant, Half-life, α, β and γ radiation. Detection of radioactivity by GM counter. Applications of radioisotopes – ^{3}H, ^{14}C, ^{131}I, ^{60}Co and ^{32}P. Biological effects of radiations. Safety measures in handling radioisotopes.

Nitrogen: 2hrs

Fixation of atmospheric nitrogen – symbiotic and non-symbiotic. Nitrogen cycle. Environmental pollution by nitrogen compounds.

Phosphorous: 1hr

Importance of phosphorus compounds in biological system, phosphorous cycle.

Oxygen: **2hrs**

Formation of ozone in atmosphere. Role of ozone in maintenance of life on earth. Effects of Environmental pollutants on ozone layer.

Sulphur and selenium : **2hrs**

Importance of compounds of sulphur and selenium in biological system. Effect of sulphur compounds on environmental pollution.

Biochemical Toxicology: **2hrs**

Toxicity of Lead, Mercury, Cadmium and Arsenic.

PART-B: BIO PHYSICAL CHEMISTRY

Concentration units: **2hrs**

Avagadro's number, molecular weight, mole, mole fraction, molarity, equivalent weight, normality, molality, percentage (problems to be worked out).

Properties of Water **2hrs**

Molecular structure of water, physical properties of water. Water as a universal solvent.

Colligative properties: **4hrs**

Osmotic pressure and its measurements by Berkely and Hartley's method. Laws of osmotic pressure. Hypo, hyper and isotonic solutions. Effects of osmotic pressure on living cells. Donnan membrane equilibrium. Relative lowering of vapour pressure. Raoult's law. Elevation of boiling point, depression of freezing point and their applications in determination of molecular weight.

Adsorption: **1 hr**

Freundlich and Langumuir's adsorption isotherm. Applications of adsorption.

Viscosity: **1hr**

Definition, determination of viscosity of liquids and solutions by Ostwals's viscometer (solutions of gums and proteins to be taken as examples).

Distribution law: **1hr**

Distribution law, partition coefficient, application of distribution law.

Acids, bases and buffers: **3hrs**

Lewis concept of acids and bases. Ionic product of water. pH scale, buffers, Henderson Hasselbalch equation, pK values, buffer capacity, preparation of acidic and basic buffer solutions. Theory of acid-base indicators. Choice of indicators. pH titration curve and isoelectric pH of aminoacids.

Electrochemistry: **5hrs**

Specific, Equivalent and Molar conductance. Reference electrodes (Hydrogen Electrode and Calomel electrode), Quinhydrone electrode, Glass electrode. Conductometric titrations [Strong acid against strong base, weak acid (amino acid) against NaOH]. Determination of pKa value of amino acid by pH meter.

Photochemistry: **4hrs**

Laws of photochemistry, quantum efficiency, light absorption, Beer-lambert's law, spectrophotometer, colorimeter, fluorescence, phosphorescence, chemilumineoscence, bioluminescence (Elementary treatment). Applications of UV-visible and fluorescence spectra. Principle of IR spectra and its application.

PART-C: BIO ORGANIC CHEMISTRY

Introduction to Organic Chemistry: **4hrs**

Classification of organic compounds, unique characteristics, IUPAC nomenclature of organic compounds (including bifunctional) and biomolecules.

Chemical Bonding: **6hrs**

Different types of bonds & bond characteristics. Ionic bonding, covalent bonding, co-ordinate bonding, Van der Waal's forces, ion-dipole, dipole–dipole interactions, London forces, hydrophobic interaction, hydrogen bonding. Effect of chemical forces on physical properties (Solubility, BP and MP).

Reaction mechanisms: **6 hrs**

Concept of inductive effect, resonance and hyperconjugation. Classification of organic reactions (substitution, addition, elimination and reaarangement), with two examples for each. Concepts of the following – carbanions, carbocations, free radicals, carbenes, nucleophiles and electophiles (Formation and Stability).

PRACTICALS

VOLUMETRIC ESTIMATIONS

Practical Duration – 04 Hours per week

Examination – 03 Hours

Marks=30

Practical Proper-20 marks and Internal Assessment-10 marks

Use of analytical balance and weighting.

Calculation, preparation of normal, molar and percentage solutions.

Calibration of volumetric glasswares (Burette, pipette and measuring cylinder).

Preparation of standard Sodium carbonate solution, standardization of HCl(Methyl orange) and estimation of NaOH in the given solution. (methyl orange or phenolphthalein).

Preparation of standard Oxalic acid. Standardization of NaOH and estimation of H_2SO_4 in the given solution (phenolphthalein).

Preparation of standard Oxalic acid. Standardization of $KMnO_4$ and estimation of H_2O_2 in the given solution.

Preparation of standard $K_2Cr_2O_7$. Standardization of $Na_2S_2O_3$ and estimation of $CuSO_4$ in the given solution.

Preparation of $ZnSo_4$. Standardization of EDTA and estimation of total hardness of water using Eriochrome black-T indicator.

Preparation of standard potassium bipthalate. Standardization of NaOH and estimation of HCl in the given solution. (Phenolphthalein).

Determination of rate constant of decomposition of H_2O_2 using $KMnO_4$ by volumetric analysis method.

Preparation of standard oxalic acid solution. Standardization of NaOH solution and estimation of acidity in vinegar.

Preparation of standard potassium biphthalate solution, standardization of sodium hydroxide solution and estimation of alkalinity of antacids.

Demonstration: Determination of density and viscosity of the given liquid using specific gravity bottle and Ostwald's viscometer.

Demonstration: Determination of miscibility temperature by water-phenol system.

SEMESTER – II

CORE: BIO-ORGANIC CHEMISTRY AND BIOMOLECULES– I

CLASS DURATION- 04 HOURS PER WEEK

MARKS= Theory 50 marks + Internal Assessment 20 marks, Total= 70 marks

64hrs

Aliphatic hydrocarbons: 3 hrs

Mechanism of Markownikoff and antimarkownikoff addition. Addition of HBr to propene. Dienes – types with examples, 1,3 butadiene – Preparation, stability and mechanism of addition of HBr. Diels-Alder reaction. Conformational analysis of ethane.

Cycloalkanes: 2hrs

Reactivities and relative stability. Bayer's strain theory. Sachse-Mohr theory. Boat and chair conformations of cyclohexanes. Axial and equatorial bonds and their relation with biological activities.

Arenes: 6hrs

Structure of benzene – by Resonance and molecular orbital theories. Aromaticity. Mechanism of Nitration and Friedel- craft reaction. Electronic interpretation of the orientating influence of substituents in the electrophilic substitution of toluene, chlorobenzene, nitrobenzene and phenol. Resonance structures of Naphthalene and Anthracene.

Alkyl halides and organomatallic compounds: 4 hrs

S_N1 and S_N2 reactions, their mechanism with one example each. Concepts of elimination reactions (E1 and E2 with an example). Applications of organometallic compounds – organo lead, organo lithium, cis-platin.

Alcohols: 5hrs

Definition, classification, monohydric alcohols- distinguishing reactions for primary, secondary and tertiary alcohols.

Dihydric alcohols: Glycol, preparation (any 2 methods) and uses.

Trihydric alcohols: glycerol, synthesis from propene, properties, (reaction with conc. H_2SO_4, HNO_3, oxalic acid and HI).

Phenols : Acidity of phenols, effect of substituents on acidity.

Stereochemistry: **6hrs**

Stereoisomerism, types, Fischer-projection formulae, chiral carbon atom, asymmetry and dissymmetry, chirality, conditions for optical isomerism ex: glyceraldehyde, lactic acid, tartaric acid, nomenclature of enantiomers, diastereomers. D and L notation, R and S systems, racemisation and resolution (biochemical, chemical and physical methods). geometrical isomerism.

Hydroxy acids and dicarboxylic acids. **4hrs**

Structure & properties of

a) Hydroxy Acids : Lactic acid, Citric acid and Isocitric acid
b) Dicarboxylic acid : Maleic and Fumaric acid.
c) Ketoacids : Pyruvic, α-Ketoglutaric, Oxalo acetic acids.

Amines: **3hrs**

Classification, properties, amino functional group – basicity of amines, acylation. reaction with HNO_2 & Schiff's base formation. Distinguishing reactions of primary, secondary and tertiary amines.

Heterocyclic compounds: **3hrs**

Definition, classification with examples, occurrence, structural formula and biological importance of Furan, Pyrrole, Thiophene, Pyridine, Pyran, Thiazole, Pyrimidine, Purine, Indole, Imidazole, Quinoline and Isoquionline. Basicity of pyrrole and pyridine.

Terpenes: **4hrs**

Definition, isoprene rule, classification, structure, occurrence and biological importance of:

a) Monoterpene – limonene, menthol and camphor.
b) Sesquiterpenes – Santonin. Juvenile hormone-I and Absciscin-II
c) Diterpenes – phytol
d) Triterpenes – lanosterol
e) Tetraterpenes –Lycopene
f) Polyprenols – Dolichols.

Steroids: **3hrs**

Basic ring system in steroids, structure & biological importance of cholesterol, ergosterol, phytosterols, bile acids [Mono, Di & Tri cholic acids] and ecdysone, testosterone, aldosterone, cortisol.

Alkaloids: **3hrs**

Definition, classification based on their structure and biological functions with examples, structure, physiological action of LSD, morphine, aristolochic acid, nicotine & atropine, synthesis of atropine.

Vitamins: **4hrs**

Classification- water soluble & fat soluble. Structural formulae and co-enzyme forms of B_1, B_2, B_6 and Niacin. Vitamin C as redox reagent, its properties and chemical synthesis. Structure formulae of vitamin A, D, E and K.

PART-B: BIOMOLECULES-1 **14Hrs**

1. **Carbohydrates:** Definition, empirical formulae, classification, biological importance.
2. **Monosaccharides:** Configuration relationship of D-aldoses, D-ketoses. General properties of aldoses and ketoses. Oxidation, reduction, reducing property, formation of glycosides, acylation, methylation, condensation – phenyl hydrazine, addition – HCN. Interconversion of aldoses and ketoses by chemical method. Ascending and descending series by chemical methods. Stereochemistry of monosaccharides, (+) and (-), D and L, epimers, anomers, and diastreoisomers.
3. **Glucose:** Elucidation of open chain structure and ring structure of glucose. Conformation of glucose (only structures), mutarotation. Structure of galactose, mannose, ribose and fructose. Structure and biological importance of amino sugars, deoxy sugars, sugar acids, neuraminic and muramic acid.
4. **Disaccharides:** Establishment of structures of Sucrose and Lactose, Biological Importance and structure of Isomaltose, Trehalose and Maltose.
5. **Polysaccharides:** Partial structure, occurrence and importance of Starch, Glycogen, Inulin, Cellulose, Chitin, and Pectin.
6. **Glycosaminoglycans:** Occurrence, importance and the structure of the repeating units of heparin, hyaluronic acid, teichoic acid and chondroitin sulphate. Bacterial cell wall polysaccharide, peptidoglycans.
7. **Qualitative tests**: Molisch, Benedicts, Fehling's, Picric acid, Barfoed's, Bial's, Seliwanoff's and Osazone tests.

PRACTICALS

ORGANIC COMPOUNDS

Practical Duration – 04 Hours per week

Examination – 03 Hours

Marks=30

Practical Proper-20 marks and Internal Assessment-10 marks

1. **Analysis of the following organic compounds:**
   Urea, Benzamide, Benzaldehyde, Aniline, Acetophenone, o-cresol, Nitrobenzene, Chlorobenzene, Naphthalene, Toluidine, Benzoic acid, Salicylic acid, Resorcinol, Benzyl alcohol and p-dichoro benzene.

2. **Qualitative tests** for ribose, deoxy ribose, mono, di and polysaccharides.

3. **Organic preparations of**

a) Benzoic acid from Benzaldehyde or Toluene.
b) Meta dinitrobezene from Nitrobenzene.
c) Aspirin from Salicylic acid.
d) Tribomophenol from Phenol.
e) P-Bromo Acetanilide from Acetanilide.

SEMESTER – III

CORE: BIOMOLECULES –II AND ENZYMOLOGY
CLASS DURATION- 04 HOURS PER WEEK

MARKS= Theory 50 marks + Internal Assessment 20 marks, Total= 70 marks

64 hrs

PART-A: BIOMOLECULES II. **40 Hours**

Amino acids: **6 hrs**

Structure and classification of amino acids based on polarity. Reactions of the amino groups with HNO2, $LiAlH_4$. Ninhydrin, Phenyl isothiocyante, DANSYL Chloride, Flurodinitro benzene. Zwitterionic properties. pKa values. Reaction of carboxyl group – Hydrazine. Chemical synthesis of amino acids, Gabriel-Malonic ester synthesis, Strecker synthesis. D & L notation.

Peptides **4 hrs**

Peptide bond, structure and biological importance of glutathione, Valinomycin. Leu-enkaphelin, Synthetic peptides- polyglutamic acid, polylysine. Chemical synthesis of di-peptides, Solid phase synthesis-Merrifield method

Proteins: **8 hrs**

Isolation, methods of purification-dialysis salting out, pH precipitation and solvent precipitation. Classification of proteins based on solubility, structure and functions with examples. Colour reactions of proteins – Biuret, Xanthoproteic, Millon's test.

Primary structure of proteins, methods of determining N- and C- terminal aminoacids, amino acid composition, sequencing by Edman's degradation method.

Secondary Structure – α helix. β-sheet, β-bend.

Tertiary and quaternary structures, 3D structure of hemoglobin, denaturation and renaturation of proteins. Anfinsen's experiment.

Lipids: **14 hrs**

Classification and biological role, fatty acids – nomenclature of saturated and unsaturated fatty acids.

Acylglycerols: Mono, di and triacylglycerols. Saponification, saponification value, iodine value, acid value and significance. Rancidity, hydrolysis.
Phosphoglycerides: Structure of lecithin, cephalins, phosphatidyl inositol, plasmalogens, and cardiolipin. Biological role of phosphoglycerides.
Sphingolipids: Structure and importance of sphingomyelin.
Glycerosphingolipids : Composition and importance of gangliosides and cerebrosides.
Prostaglandins: Structure of PGE_2, and PGF_2 Alpha. Biological roles of thromboxanes, leukotrienes and prostaglandins.

Plasma lipoproteins : Types and functions.

Biological membrane: Compositions of membrane, Fluid Mosaic Model, functions of the plasma membrane, endocytosis, phagocytosis, membrane receptors and their functions.

Nucleic acids: **8 hrs**

(a) Isolation of DNA and RNA. Composition of DNA. Nucleosides and Nucleotides. Chargaff's rule. Watson and Crick model of DNA. Melting of DNA (Tm).
(b) **RNA:** Composition, types (mRNA, tRNA and rRNA), Secondary structures of tRNA – clover leaf model. Chemical reactions of RNA and DNA with acid and alkali, colour reactions of DNA and RNA.

PART B: ENZYMOLOGY. **24 hrs**

ENZYMES: Definition, historical perspective, general characteristics. Co-factors – coenzymes and metal ions. Classification of enzymes based on IUB with examples. Unit of enzyme activity – definition of IU, enzyme turnover number and nature of non enzymatic and enzymatic catalysis. Specific activity. Enzyme specificity. Concept of active site.

- Theories of enzyme catalysis – Lock and key model, Koshland's induced fit theory.
- Enzyme kinetics: Factors affecting rate of enzyme catalyzed reactions.

Effect of enzyme concentraton, substrate concentration, pH and temperature.
Michaelis – Menten equation (derivation not required). Lineweaver – Burk (L-B) plot. Determination of Vmax & Km from L-B plot and their significance.
Enzyme inhibition –competitive, non competitive and uncompetitive.

Graphical representation by L-B plot. Evaluation of Km, Ki and Vmax in presence of inhibitor.

Allosteric enzymes – Sigmoidal curve, positive and negative modulators, with phosphofruoctokinase as an example.

Isoenzymes – Detection, nature, importance. LDH as an example.

Multienzyme complex – Pyruvate dehydrogenase complex. – Composition, subunits, assembly, enzymatic reaction functions.

RNA as an enzyme. (Ribozymes).

Industrial and medical applications of enzymes.

PRACTICALS

BIOMOLECULES II AND ENZYMOLOGY

Practical Duration – 04 Hours per week

Examination – 03 Hours

Marks=30

Practical Proper-20 marks and Internal Assessment-10 marks

I Qualitative analysis of Biomolecules

i) Proteins – Precipitation reactions of proteins, Colour reactions of proteins, Colour reactions of amino acids like tryptophan, tyrosine, cysteine, methionine, arginine, proline and histidine.

ii) Lipids– solubility, acrolein test, Salkowski test, Lieberman-Burchard test.

iii) Qualitative tests for nucleic acids.

II Enzyme Assays:

1. Isolation of Urease and demonstration of its activity.
2. Isolation of Acid phosphatase and demonstration of its activity.
3. Salivary amylase
   a. Determination of specific activity of salivary amylase by DNS method.
   b. Determination of pH optimum of salivary amylase.
   c. Determination of Km and Vmax of salivary amylase.
   d. Determination of initial velocity [time kinetics] of salivary amylase.
   e. Determination of optimum temperature of salivary amylase.
   f. Effect of sodium chloride on amylase.

SEMESTER – IV

CORE: METABOLISM AND HUMAN PHYSIOLOGY
CLASS DURATION- 04 HOURS PER WEEK

MARKS= Theory 50 marks + Internal Assessment 20 marks, Total= 70 marks

64hrs

PART – A : METABOLISM **32 hrs**

Metabolism: **1 hrs**

Anabolism and catabolism, compartmentalization of metabolic pathways.

Bio Energetics: **4 hrs**

Laws of Thermodynamics - first and second law. Concept of enthalphy, entropy and free energy. Standard free energy. Endergonic and exergonic reactions. Coupled reactions. High energy compounds – structural features of ATP and its free energy change during hydrolysis, other high energy compounds.

Biological oxidation: **5 hrs**

Ultra structure of mitochondrion, electron transport chain. Electron transport complexes Complex I, II, III and IV. Uncouplers and inhibitors of respiration (Rotenone, Antimycin, Cyanide and 2,4 DNP) Oxidative phosphorylation, P/O ratio. Formation of ATP-Outline of Mitchell's hypothesis. Substrate level phosphorylation with examples.

Metabolism of Carbohydrates: **8hrs**

Glycogen metabolism – glycogenolysis, glycogen synthesis. Glycolysis, energetics of glycolysis. Entry of other carbohydrates into glycolytic pathway. Fates of pyruvate – conversion of pyruvate to lactate, alcohol and acetyl Co-A. Citric acid cycle and it's energetics. Amphibolic integrating roles of TCA cycle. Anaplerotic reactions. Pentose phosphate pathway and its significance. Cori cycle. Gluconeogenesis.

Metabolism of Lipid **8hrs**

Oxidation of fatty acid – α, β and ω types, β-oxidation of even number saturated fatty acids. Energetics of β-oxidation. Schematic representation of biosynthesis of

even number saturated fatty acids and cholesterol biosynthesis. Formation of ketone bodies.

Metabolism of Amino acids: **6 hrs**

General reactions of amino acid degradation – Transamination, deamination and decarboxylation. Ketogenic and glucogenic amino acids.
Urea cycle and its significance.

PART-B : HUMAN PHYSIOLOGY **32 hrs**

Neurotransmission: **4 hrs**

Types of neurons, generalized structure of multipolar neuron. Resting membrane potential, action potential, transmission of nerve impulse along an axon and across a synapse. Excitatory and inhibitory neurotransmitters.

Muscle: **4hrs**

Types of muscles and their structure. Ultrastructure of skeletal muscle. Contractile and regulatory proteins of muscle. Sliding filament model of skeletal muscle contraction.

Bone : **4hrs**

Composition and structure of long bone, growth and remodeling of long bone. Factors affecting its growth.

Excretory system: **4 hrs**

Structure of the nephron, formation of urine – Glomerular filtration, tubular reabsorption and secretions. Role of kidney in acid-base balance.

Body fluids: **6 hrs**

Blood volume, composition and functions, RBC, WBC and platelets, their structure and functions. Mechanism of blood coagulation. Biochemical events in transport of CO_2 and O_2 in blood. Cerebrospinal fluid, lymph and their functions. Blood brain Barrier. Blood buffers.

Endocrine system: **8 hrs**

Endocrine organs, classification of hormones. Hierarchy, interplay and dynamic balance and regulation of hormone secretions. Functions of the hormones of hypothalamus, pituitary, adrenal, thyroid, pancreas and gonads.
General mechanism of peptide and steroid hormone action. Concept of second messengers. Eg: cAMP, DAG, IP3, G-protein.

Liver: **2 hrs**

Structure of a liver lobule. Role of liver in metabolic, storage and detoxification.

PRACTICALS
COLORIMETRIC ESTIMATIONS
Practical Duration – 04 Hours per week
Examination – 03 Hours
Marks=30

Practical Proper-20 marks and Internal Assessment-10 marks

Colorimetric estimation of

i) Glucose by DNS method.
ii) Glucose by Folin-Wu method.
iii) Glucose by Anthrone method.
iv) Ketoacid by DNPH method
v) Protein by Biuret method.
vi) Protein by Lowry's method.
vii) Protein by Bradford method.
viii) Uric acid by PMA method.
ix) Urea by DAMO method.
x) Creatinine by Jaffe's method.
xi) Phosphorous by Fiske and Subbarow's method.
xii) Iron by Wong's method.
xiii) Cholesterol by Zak method.
xiv) Amino acid by Ninhydrin method.

SEMESTER – V

DSE -1: NUTRITION

CLASS DURATION- 04 HOURS PER WEEK

MARKS= Theory 50 marks + Internal Assessment 20 marks, Total= 70 marks

64 hrs

Introduction: **8 hrs**

Concept of nutrition, calorific value of foods and its determination (Bomb calorimeter), different components of energy expenditure, measurement of energy expenditure by direct and indirect calorimetric method. Energy expenditure at rest and work, respiratory quotient, basal metabolic rate (BMR), determination of BMR by indirect calorimetric method, factors affecting BMR. Specific dynamic action of foods.

Carbohydrates: **4 hrs**

Dietary sources of carbohydrates, dietary fibers (types, beneficial & adverse effects) and protein sparing action. Glycemic index, importance with examples, lactose intolerance.

Proteins: **7 hrs**

Dietary sources of proteins, nutritional classification, nutritive value of proteins-PER and biological value (BV). Essential amino acids. Nitrogen balance, mutual Supplementation of proteins. Malnutrition-kwashiorkar and marasmus.

Fats: **4 hrs**

Dietary sources of fats, visible and invisible fat, trans fats, omega fatty acids and their biological importance, role of DHA and EPA. Effects of fried foods.

Vitamins: **10 hrs**

Dietary sources, requirements, deficiency symptoms and biological role of water soluble vitamins-thiamine, riboflavin, niacin, pantothenic acid, pyridoxine, biotin, folic acid, vitamin-B_{12} and vitamin-C.

Fat soluble vitamins-A, D, E and K, hypo and hypervitaminosis.

Minerals: **10 hrs**

Dietary sources, physiological functions, deficiency disorders, absorption and excretion.

Macronutrients-Ca, P, Na, Cl, Mg and K and Micronutrients-Fe, Zn, Cu, I_2, F, Se, Cr, Mn.

Balanced diet: **2 hrs**

Composition of balanced diet for infants, children, pregnancy and lactating women, old age.

Water Metabolism: **5 hrs**

Absorption, requirement, distribution of water in body fluid compartments. Factors influencing water metabolism, functions of water, deficiency and water intoxication in human body.

Antinutritional Factors: **4 hrs**

Sources and harmful effects of anti vitamins (example:- avidin, dicoumarol), natural toxicants (example:- Lathyrus sativus) and adultrants (Butter yellow, lead chromate & malachite green)

Digestion and absorption: **8 hrs**

GIT: secretion, composition and functions of saliva, gastric, bile, pancreatic and intestinal juices. Gastro intestinal hormones and its effects. Appetite, digestion, absorption and transport of carbohydrates, proteins and fats.

Nutraceuticals: **2hrs**

Introduction, functional foods and pre and pro-biotics in health and disease prevention.

PRACTICALS
NUTRITION
Practical Duration – 04 Hours per week
Examination – 03 Hours
Marks=30

Practical Proper-20 marks and Internal Assessment-10 marks

Determination of moisture content of foods and detection of adulterants in food.
Extraction and estimation of calcium in ragi.
Estimation of reducing sugars (From jams and jellies) by Fehling's method.
Extraction and estimation of vitamin – C in biological sample.
Extraction and estimation of iron from mustard.
Determination of saponification value of oil.
Determination of iodine/acid/peroxide value of oil or fat.
Estimation of amino acid by Sorensen's formal titration.
Determination of pH of the given sample of fruit juice. (Eg: lemon, papaya, apple, sugar cane, bejois juice etc).
Estimation of lactic acid in milk.

SEMESTER – V

DSE -2: MOLECULAR BASIS OF INFECTIOUS DISEASES

CLASS DURATION- 04 HOURS PER WEEK

MARKS= Theory 50 marks + Internal Assessment 20 marks, Total= 70 marks

64 hrs

Classification of Infectious agents **12 hrs**

Bacteria, viruses, protozoa and fungi. Past and present emerging and re-emerging infectious diseases and pathogens. Source, reservoir and transmission of pathogens, Antigenic shift and antigenic drift. Host parasite relationship, types of infections associated with parasitic organisms. Overview of viral and bacterial pathogenesis. Infection and evasion.

Overview of diseases caused by bacteria: **18 hrs**

Detailed study of tuberculosis: History, causative agent, molecular basis of host specificity, infection and pathogenicity, diagnostics, therapeutics, inhibitors and vaccines. Drug resistance and implications on public health. Other bacterial diseases including typhoid, diphtheria, pertussis, tetanus, typhoid and pneumonia.

Overview of diseases caused by viruses: **12 hrs**

Detailed study of AIDS, history, causative agent, pathogenesis, diagnostics, drugs and inhibitors. Other viral diseases including hepatitis, influenza, rabies, chikungunya, dengue and polio.

Overview of diseases caused by parasites: **11 hrs**

Detailed study of malaria, history, causative agents, vectors, life cycle, host parasite interactions, diagnostics, drugs and inhibitors, resistance, vaccine development. Other diseases including leishmaniasis, amoebiasis.

Overview of diseases caused by other organisms: **11 hrs**

Fungal diseases, general characteristics. Medical importance of major groups, pathogenesis, treatment.

PRACTICALS

CLINICAL BIOCHEMISTRY

Practical Duration – 04 Hours per week

Examination – 03 Hours

Marks=30

Practical Proper-20 marks and Internal Assessment-10 marks

Qualitative analysis of urine:

- Organic: urea, uric acid, creatinine and amino acid.
  Inorganic constituents: chlorides, sulfates, phosphates and ammonia
- Abnormal constituents -glucose, albumin, bile pigments, bile salts and ketone bodies.

Quantitative estimations:

- Titratable acidity and ammonia in urine.
- Creatinine in urine.
- Urea in blood.
- Blood glucose
- SGPT/SGOT.
- Alkaline phosphatase.
- Hemoglobin.
- Determination of antigen-antibody reaction by immunodiffusion technique.

SEMESTER – V

SEC-1: BIOCHEMICAL TECHNIQUES

CLASS DURATION- 02 HOURS PER WEEK

MARKS= Theory 35 marks + Internal Assessment 15 marks, Total= 50 marks

32 hrs

Biochemical reagents & solutions: 6 hrs

Safety practices in the laboratory. Preparation and storage of solutions. Concepts of solution concentration and storing solutions. Quantitative transfer of liquids. Concept of a buffer, Henderson-Hasselbach equation, working of a pH meter.

Exercise

Preparation of a buffer of given pH and molarity.

Chromatography- 12 hrs

Definition, types, principles of adsorption and partition chromatography. Techniques of circular, 2D chromatography, thin layer chromatography- and its advantages

Column chromatography – Principle, procedure and applications of gelfiltration, affinity, ion exchange, adsorption chromatography, principle and applications of HPLC and GLC.

Electrophoresis: 3 hrs

Principle, procedure and applications of electrophoresis technique- PAGE, SDS - PAGE

Centrifugation: 3 hrs

Principle of differential and density gradient centrifugation. Ultra centrifuge – construction and applications

Spectrophotometric techniques: 8 hrs

Principle instrumentation and applications of UV-visible, infra red and fluorescence spectroscopy.

Exercises

Determination of the absorption maxima and molar extinction coefficient (of a relevant organic molecule).

Measurement of fluorescence spectrum.

Determination of concentration of a protein solution by Lowry/BCA method.

SEMESTER – V

SEC-2: PROTEIN PURIFICATION TECHNIQUES

CLASS DURATION- 02 HOURS PER WEEK

MARKS= Theory 35 marks + Internal Assessment 15 marks, Total= 50 marks

Total 32 hrs

Unit 1: 24hrs

Purification and characterization of a protein from a complex mixture (native or heterologously expressed) involving the following methods/techniques.

Exercises

Preparation of the sample.
Ion-exchange chromatography.
Gel filtration chromatography.
Affinity chromatography.
Electrophoresis.

Unit 2 : 8hrs

Demonstration of High Performance Liquid Chromatography (HPLC)

SEMESTER – VI

DSE-1: MOLECULAR BIOLOGY AND IMMUNOLOGY (THEORY)

CLASS DURATION- 04 HOURS PER WEEK

MARKS= Theory 50 marks + Internal Assessment 20 marks, Total= 70 marks

Total 64 hrs

PART-A: MOLECULAR BIOLOGY **40hrs**

Introduction: **4 hrs**

Nucleic acids as genetic information carriers, experimental evidences ex: bacterial genetic transformation, Hershey-Chase experiment. Central dogma of molecular biology and its modification.

Replication of DNA: **4 hrs**

DNA replication in prokaryotes- conservative, semi conservative and dispersive types. Mechanism of semi conservative replication. DNA polymerases, other enzymes and protein factors involved in replication. Meselson and Stahl experiment. Mechanism of replication in prokaryotes.

Prokaryotic RNA Synthesis: **4 hrs**

Role of RNA polymerase. Initiation, elongation and termination, reverse transcription-replication of HIV virus.

Genetic code: **2 hrs**

General features, wobble hypothesis.

Prokaryotic Protein biosynthesis: **5 hrs**

Activation of Amino acids, amino acyl tRNA synthesis. Initiation, elongation and termination of protein synthesis. Inhibitors of protein synthesis. Post translational modifications.

Mutations: **3 hrs**

Concept of mutation and mutagens – effect of HNO_2, alkylating agents, intercalating agents and UV-radiation. Point mutations: Concept of missense, nonsense and frameshift mutations.

Repair of DNA: **3 hrs**

DNA damage and its repair. Types of damages, repair by direct reversal of damage, excision repair, SOS repair.

Concept of gene: **3 hrs**

(1) Gene expression in prokaryotes - concept of Lac operon and trp operon.
(2) Functional units in a typical eukaryotic gene-promoter, introns and exons.

Outline of techniques of genetic engineering: **10 hrs**

Historical development, aim and scope of genetic engineering. Cutting of DNA by restriction endonucleases –Types, staggered cut and blunt end. Vectors- plasmid (pBR 322), bacteriophage, viruses, cosmids, phagemid and plant vectors. Insertion of foreign DNA into vectors. Transfection of vectors into host cells. cDNA. Principle of polymerase chain reaction and applications.

Principle and applications of Southern, northern and western blotting. Dot blot. DNA finger printing.

Applications of Genetic engineering: **2 hrs**

(1) Transgenic plants, transgenic animals and gene therapy.
(2) Human genome project.

PART –B: <u>IMMUNOLOGY</u> **24 hrs**

Overview of the Immune system: **8 hrs**

Role of immunologically important organs and cells - bone marrow, thymus, spleen and lymphocytes. Innate and adaptive immunity. Passive and active immunity. Cellular and humoral immunity: formation and functions of T & B Lymphocytes. Helper T-cells and killer T-cells. Macrophages and dendritic cells.

Antigens: **2 hrs**

Definition, types, chemical nature and antigenicity. Epitopes, paratopes, haptens and adjuvants.

Antibodies: **4 hrs**

Definition, types and structure of a typical immunoglobulin (IgG – Light chain, heavy chain, hyper variable region, constant domains, Fab and Fc). Polyclonal and monoclonal antibodies. Production and applications of monoclonal antibodies.

Antigen –antibody reaction *in-vitro*: **3 hrs**

Formation of antigen-antibody complex. Agglutination and precipitation. Principle, procedure and applications of immunodiffusion, RIA, ELISA.

Immunization: **2 hrs**

Vaccines and their preparations, primary and secondary immune response.

Hypersensitivity: **2 hrs**

Immediate and delayed type of hypersensitivity.

Immunological disorders: **3 hrs**

Autoimmune disorder- systemic lupus erythomatus and rheumatoid arthritis.

Immunodeficiency diseases- AIDS.

PRACTICALS

BIOPHYSICAL AND BIOCHEMICAL EXPERIMENTS

Practical Duration – 04 Hours per week

Examination – 03 Hours

Marks=30

Practical Proper-20 marks and Internal Assessment-10 marks

- Conductometric titration of strong acid against strong base.
- Conductometric titration of amino acid against strong base.
- Preparation of acidic and basic buffers and determination of pH using pH meter.
- Determination of pKa value of amino acid by using pH meter.
- Determination of pKa value of acetic acid by using potentiometer.
- Determination of molar extinction coefficient.
- Determination of UV spectra of proteins and nucleic acid.
- Extraction of DNA from natural source.
- Estimation of DNA by diphenylamine method.
- Demonstration of estimation of RNA by orcinol method.

SEMESTER – VI

DSE-2: PLANT BIOCHEMISTRY (THEORY)

CLASS DURATION- 04 HOURS PER WEEK

MARKS= Theory 50 marks + Internal Assessment 20 marks, Total= 70 marks

64 hrs

Introduction to plant cell structure: 5 hrs

Plasma membrane, vacuole and tonoplast membrane, cell wall, plastids and peroxisomes.

Photosynthesis & carbon assimilation: 14hrs

Structure of PSI and PSII complexes, light reaction, cyclic and non cyclic photophosphorylation, Calvin cycle and regulation; C4 cycle and Crassulacean acid metabolism (CAM), photorespiration.

Nitrogen metabolism: 15 hrs

Biological Nitrogen fixation by free living and in symbiotic association, structure and function of enzyme Nitrogenase. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by Glutamine synthetase-glutamine oxoglutarate amino transferase (GS-GOGAT) pathway. Seed storage proteins in legumes and cereals.

Regulation of plant growth: 8 hrs

Introduction to plant hormones and their effect on plant growth and development, Regulation of plant morphogenetic processes by light.

Secondary metabolites: 12 hrs

Representatives alkaloid group and their amino acid precursors, function of alkaloids, examples of major phenolic groups; simple phenylpropanoids, coumarins, benzoic acid derivatives, flavonoids, tannins and lignin, biological role of plant phenolics, classification of terpenoids and representative examples from each class, biological functions of terpenoids.

Plant tissue culture: 10 hrs

Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somoclonal variation.

PRACTICALS

Plant Biochemistry

Practical Duration – 04 Hours per week

Examination – 03 Hours

Marks=30

Practical Proper-20 marks and Internal Assessment-10 marks

Extraction and assay of Urease from Jack bean

Estimation of carotene/ascorbic acid/phenols/tannins in fruits and vegetables

Separation of photosynthetic pigments by TLC

Separation of photosynthetic pigments by TLC

Culture of plant plants (explants).

SEMESTER – VI

SEC-3: Bioinformatics

CLASS DURATION- 02 HOURS PER WEEK

MARKS= Theory 35 marks + Internal Assessment 15 marks,

Total= 50marks

32 hrs

Unit 1:

Introduction to bioinformatics **4 hrs**

Computer fundamentals - programming languages in bioinformatics, role of supercomputers
in biology. Historical background. Scope of bioinformatics - genomics, proteomics, computer aided drug design (structure based and ligand based approaches) and Systems
Biology. Applications of bioinformatics.

Unit 2

Biological databases and data retrieval **8 hrs**

Introduction to biological databases - primary, secondary and composite databases, NCBI,
nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot,
TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem, Drug Bank, ZINC, CSD). Structure viewers (Ras Mol, J mol),
file formats.

Exercises

Sequence retrieval (protein and gene) from NCBI.
Structure download (protein and DNA) from PDB.
Molecular file formats - FASTA, GenBank, Genpept, GCG, CLUSTAL, Swiss-Prot, FIR.
Molecular viewer by visualization software.

Unit 3 :

Sequence alignment **3 hrs**

Similarity, identity and homology. Alignment – local and global alignment, pairwise and

multiple sequence alignments, alignment algorithms, amino acid substitution matrices (PAM
and BLOSUM), BLAST and CLUSTALW.

Exercises

BLAST suite of tools for pairwise alignment.

Multiple sequence alignment using CLUSTALW.

Unit 4

Phylogenetic analysis **3hrs**

Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic
trees - maximum parsimony, maximum likelihood and distance methods.

Exercise

Generating phylogenetic tree using PHYLIP.

Unit 5

Protein structure prediction and analysis **8 hrs**

Levels of protein structure. Protein tertiary structure prediction methods - homology modeling, fold recognition and *ab-initio* methods. Significance of Ramachandran map.

Exercises

Primary sequence analyses (Protparam).

Secondary structure prediction (GOR, nnPredict).

Tertiary structure prediction (SWISSMODEL).

Protein structure evaluation - Ramachandran map (PROCHECK).

Unit 6

Genomics **6 hrs**

Introduction to genomics, comparative and functional genomics, gene structure in prokaryotes and eukaryotes, gene prediction methods and tools.

Exercise

Gene prediction using GENSCAN and GLIMMER.

SEMESTER – VI

SEC-4: CLINICAL BIOCHEMISTRY

CLASS DURATION- 02 HOURS PER WEEK

MARKS= Theory 35 marks + Internal Assessment 15 marks, Total= 50 marks

32 hrs

Introduction: 1 hr

Clinical biochemistry: Definition, scope, collection & preservation of biological fluids.

Urine: 6 hrs

Normal composition of urine – Volume, pH, colour and specific gravity.

Chemical analysis and normal values of the constituents- urea, uric acid, creatinine, pigments and their clinical significance.

Abnormal constituents - glucose, albumin, ketone bodies and bile pigments and their pathological significance.

Blood: 10 hrs

Normal constituents of blood and their variation in pathological conditions- urea, uric acid, creatinine, glucose, bilirubin, total protein, albumin/globulin ratio.

Blood- RBC, WBC and platelets: structure and functions. Total WBC count, differential count, erythrocyte count, platelet count, glycated haemoglobin, Hb%, blood grouping & ESR. C-reactive protein and subpopulation of blood cells.

Lipid profile: cholesterol, triglycerides, lipoproteins: chylomicrons, VLDL, LDL and HDL. Hypo and lipoproteinemia, atherosclerosis.

Clinical enzymes: 3 hrs

Alkaline phosphatase, serum transaminases (SGPT & SGOT),

Cardiac injury profile- CPK and LDH.

Liver disorders: 6 hrs

Cirrhosis, hepatitis, fatty liver and jaundice (pre, post and hepatic). Estimation of conjugated

and total bilirubin in serum (Diazo method). Detection of bilirubin and bile salts in urine (Fouchet's test and Hay's test).

Inborn errors of Metabolism: 6 hrs

Glycogen storage disease (Von-Gierke's disease), fructosuria, galactosemia, phenylketonuria, alkpatonuria, albinism, Lesch-Nyhan syndrome, Niemann-Pick disease.

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UNIVERSITY OF MYSORE

BIOCHEMISTRY (UG), CBCS, 2018-19 ONWARDS, SCHEME OF INSTRUCTION

Year	Semester	Course	Title of the Paper	Credits	Total credits	Total Hours		Total Hours/ Week
				L:T:P		Th	Pr	
I BSc	I	DSC	CHEMISTRY OF BIOMOLECULES	4:0:2	06	64	64	8
	II	DSC	BIO-ORGANIC CHEMISTRY AND BIOMOLECULES– I	4:0:2	06	64	64	8
II BSc	III	DSC	BIOMOLECULES –II AND ENZYMOLOGY	4:0:2	06	64	64	8
	IV	DSC	METABOLISM AND HUMAN PHYSIOLOGY	4:0:2	06	64	64	8
III BSc	V	DSE	NO. OF COURSE 1 DSE 1- NUTRITION DSE 2- MOLECULAR BASIS OF INFECTIOUS DISEASES	4:0:2	06	64	64	8
		SEC	NO. OF COURSE 1 SEC 1- BIOCHEMICAL TECHNIQUES SEC 2- PROTEIN PURIFICATION TECHNIQUES	2:0:0	02	32	00	2
	VI	DSE	NO. OF COURSE 1 DSE 1- MOLECULAR BIOLOGY AND IMMUNOLOGY DSE 2- PLANT BIOCHEMISTRY	4:0:2	06	64	64	8
		SEC	NO. OF COURSE 1 SEC 3- BIOINFORMATICS SEC 4- CLINICAL BIOCHEMISTRY	2:0:0	02	32	00	2

UNIVERSITY OF MYSORE
CBCS SYLLABUS 2018-19 ONWARDS
SCHEME OF EXAMINATION

Year	Sem	Course	Title of the Paper	Credits	C-3			Maximum Marks						Exam Duration	
				L:T:P	Th	Pr	IA	C3	IA	C-1		C-2		Th	Pr
										Th	Pr	Th	Pr		
I BSc	I	DSC	CHEMISTRY OF BIOMOLECULES	4:0:2	60	20	20	80	20	05	05	05	05	3H	3H
	II	DSC	BIO-ORGANIC CHEMISTRY AND BIOMOLECULES– I	4:0:2	60	20	20	80	20	05	05	05	05	3H	3H
II BSc	III	DSC	BIOMOLECULES –II AND ENZYMOLOGY	4:0:2	60	20	20	80	20	05	05	05	05	3H	3H
	IV	DSC	METABOLISM AND HUMAN PHYSIOLOGY	4:0:2	60	20	20	80	20	05	05	05	05	3H	3H
III BSc	V	DSE	NO. OF COURSE 1 DSE 1- NUTRITION DSE 2- MOLECULAR BASIS OF INFECTIOUS DISEASES	4:0:2	60	20	20	80	20	05	05	05	05	3H	3H
		SEC	NO. OF COURSE 1 SEC 1- BIOCHEMICAL TECHNIQUES SEC 2- PROTEIN PURIFICATION TECHNIQUES	2:0:0	40	-	10	40	10	10	-	10	-	2H	-
	VI	DSE	NO. OF COURSE 1 DSE 1- MOLECULAR BIOLOGY AND IMMUNOLOGY DSE 2- PLANT BIOCHEMISTRY	4:0:2	60	20	20	80	20	05	05	05	05	3H	3H
		SEC	NO. OF COURSE 1 SEC 3- BIOINFORMATICS SEC 4- CLINICAL BIOCHEMISTRY	2:0:0	40	-	10	40	10	10	-	10	-	2H	-