Annexure - 1

UNIVERSITY OF MYSORE

GRADUATE COURSES – SEMESTER SCHEME

2015-2016

BIOCHEMISTRY

SYLLABUS

(FOR CANDIDATES ADMITTED FROM 2015-16 ONWARDS)

MYSORE UNIVERSITY

BACHELOR OF SCIENCE
DEGREE COURSE
B.Sc. BIOCHEMISTRY SYLLABUS

(2015 – 2016)

Course - B.Sc.

Eligibility - 10+2 with Physics, Chemistry and Biology subjects.

Programme Duration - 3 years (6 semesters)

Semester - Each semester comprises of 16 weeks.

Theory - Classroom teaching and learning.

Practicals - Experiments/demonstrations to develop practical skills prerequisite to obtain Bachelor's degree.

Internal Assessment (IA) - Continous assessment of student progress through seminars/ test/Viva-Voce/ assignments/ Visit to scientific institution.

(P.No.1- 27)

UNIVERSITY OF MYSORE
SEMESTER SCHEME SYLLABUS FOR B.Sc
SUBJECT : BIOCHEMISTRY
Scheme of instruction and examination

Title of the paper	Instruction/week		Examination						
			Duration		Marks				
	T	P	T	P	T	IA	P	IA	Total
I Semester									
BC1.1 Introduction to Biochemistry	3	3	3	3	60	10	20	10	100
II Semester									

BC2.1Bioorganic-I	3	3	3	3	60	10	20	10	100
III Semester									
BC3.1 Bioorganic-II and Biochemical techniques	3	3	3	3	60	10	20	10	100
IV Semester									
BC4.1Biomolecules	3	3	3	3	60	10	20	10	100
V Semester									
BC5.1 Enzymology, Clinical Biochemistry and Nutrition.	3		3	3	80	20			100
BC5.2 Metabolism and Human physiology	3		3	3	80	20			100
Practical 5 : BC 5.1 and BC 5.2		4	0	6			80	20	100
VI Semester									
BC6.1Molecular Biology and Genetic engineering	3		3	3	80	20			100
BC6.2 Microbiology and Immunology.	3		3	3	80	20			100
Practical 6 : BC6.1 and BC 6.2		4	0	6			80	20	100

T-Theory P-Practical IA-Internal Assessment

SEMESTER – I

CLASS DURATION- 03 HOURS PER WEEK

MARKS-Theory-60+Internal Assessment-10=70

48hrs

BC-1.1 INTRODUCTION TO BIOCHEMISTRY

BIO PHYSICAL CHEMISTRY

Overview of Biochemistry: 3hrs

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

Concentration units: 2hrs.

Avagadro's number, 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. Its effect on Biomolecules. Effect of non polar compounds on water.

Colligative properties: 3hrs.

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.

Physical properties of molecules: 3hrs

Adsorption : Definition, Freundlich and Langmuir's adsorption isotherm. Applications of adsorption.

Viscosity : Definition, Determination of viscosity of liquids and solutions by Ostwalds's viscometer (solutions of gum and protein to be taken as example).

Distribution law: Distribution law, partition coefficient. Applications of distribution law.

Ionic Equilibria 6 hrs.

Lewis concept of acids and bases. Ionic product of water. pH scale, buffers, Henderson Hasselbach equation, buffer capacity, preparation of acidic and basic buffer solutions. Theory of acid base indicators. Choice of indicators. pH titration curves and isoelectric pH of aminoacids. Electrodes (Hydrogen Electrode & Calomel electrode), Glass

electrode. Conductometric titrations [Strong acid against strong base, weak acid (amino acid) against NaOH]. Determination of Pka value of amino acid by using pH meter.

Photochemistry: 5 hrs.

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

BIO INORGANIC

Co-ordination compounds: 9hrs.

Transition metals, Properties (Colour, Oxidation States, Magnetic Properties). Co-ordinate bond, double and complex salts – differences with examples. Postulates of werner's theory. Types of ligands – Uni, bi and polydentate 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 – Types, structure and chemical nature.

Nitrogen: 2hrs.

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

Phosphorous: **2hr**

Importance of phosphorus compounds in biological system, phosphorous cycle.

Oxygen: 2hrs.

Importance of oxygen in Biological System. Formation and 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: **2 hrs**

Source, entry in to biological system and toxicity of Lead, Mercury, Cadmium and Arsenic.

Radiochemistry: **5hrs.**

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 measure in handling radio isotopes.

Reference textbooks:

1. Barrow, G. M. (2007) Physical Chemistry Tata McGraw-Hill, India.
2. Castellan, G. W.(2004) Physical Chemistry 4th Ed. Narosa, India.
3. Kotz, J. C., Treichel, P. M. & Townsend, J. R. (2009) General Chemistry Cengage Le arning India Pvt. Ltd.: New Delhi.
4. Mahan, B. H. (1998) University Chemistry 3rd Ed. Narosa, India.
5. J. D. Lee, A new Concise Inorganic Chemistry, E L. B. S.
6. F. A. Cotton & G. Wilkinson. Basic Inorganic Chemistry, John Wiley.
7. Douglas, McDaniel and Alexader : Concepts and Models in Inorganic Chemistry, John Wiley.
8. James E. Huheey, Ellen Keiter and Richard Keiter : Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Public

9. Pattabhi. V. and Gautham.N. (2002) Biophysics. Narosa Publishing House, India.

10. Puri, Pathan & Sharma - Physical Chemistry.

PRACTICAL – I

Practical Duration – 03 Hours per week

Examination – 03 Hours

Marks=30

Practical Proper-20 Internal Assessment – Record-05+Class Test-05=10

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

ii) Determination of miscibility temperature by water-phenol system.

SEMESTER – II

CLASS DURATION- 03 HOURS PER WEEK

MARKS-Theory-60+Internal Assessment-10=70

48hrs

BC-2.1 BIOORGANIC CHEMISTRY – I

Introduction to Organic Chemistry: 4 hrs.

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

Chemical Bonding: 6 hrs.

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, nucleophies and electophiles (Formation and Stability).

Aliphatic hydrocarbons: **4 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: **4 hrs.**

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

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 organomatellic compounds: **4 hrs.**

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

Alcohols: **6 hrs.**

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: 8 hrs.

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 system, Racemisation and resolution (Biochemical, chemical and physical methods). Geometrical isomerism.

Reference text books:

* Arun Bahl and B. S. Bahl : *Advanced Organic Chemistry,* S. Chand.

* L. Finar : *Organic Chemistry* (Vol. I & II), E. L. B. S.
* R. T. Morrison & R. N. Boyd : *Organic Chemistry*, Prentice Hall.

PRACTICAL – II

Practical Duration – 03 Hours per week

Examination – 03 Hours

Marks=30

Practical Proper-20 Internal Assessment – Record-05+Class Test-05=10

I Systematic qualitative analysis of the organic compounds:

Urea, Benzamide, Benzaldehyde, Aniline, Acetophenone, m-cresol, Nitrobenzene, Chlorobenzene, Naphthalene, p-Toluidine, Benzoic acid, Salicylic acid, Resorcinol, Benzyl alcohol and p-dichoro benzene.

II. Organic Preparations:

a) Aspirin from salicylic acid.

b) Benzoic acid from benzaldehyde.

c) para-bromo acetanilide from acetanilide.

d) meta-dinitrobezene from nitrobenzene.

SEMESTER – III

CLASS DURATION- 03 HOURS PER WEEK

MARKS-Theory-60+Internal Assessment-10=70

48hrs

BC-3.1 BIOORGANIC-II AND BIOCHEMICAL TECHNIQUES

BIO ORGANIC-II

HYDROXY ACIDS AND DICARBOXYLIC ACIS. 4hrs.

Structure & properties of

* Hydroxy Acids : Lactic acid, Citric acid and Isocitric acid
* Dicarboxylic acid: Maleic and Fumaric acid.
* Ketoacids: Pyruvic, α-Ketoglutaric, Oxalo acetic acid.

AMINES: 4 hrs.

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: 4hrs.

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

TERPENES: **4hrs.**

Definition, Isoprene rule, classification, isolation, structure and biological importance of menthol, camphor, farnesol, phytol, lanosterol, lycopene and dolichols.

STEROIDS: **4hrs.**

Basic ring structure in steroids. Structure and biological importance of cholesterol, Phytosterols, ergosterol,Cortisol, β-estradiol, testosterone and aldosterone. Bile acids [Mono, Di & Tri cholic acids].

ALKALOIDS: **5hrs.**

Definition, classification based on their structure and biological functions, Isolation of alkaloids, structure and physiological action of morphine, Nicotine & Atropine. Chemical Synthesis of nicotine and atropine.

VITAMINS: **5hrs.**

Classification-Water soluble & Fat soluble. Structural formulae of vitamins and co-enzyme (B_1, B_2, B_6 and Niacin). Vitamin C as redox reagent, Chemical synthesis of Vit-C. Structural formula of vitamin A, D, E and K.

BIOCHEMICAL TECHNIQUES. **18Hrs**

General Principles of chromatography – adsorption and partition. Rf values.

Paper chromatography –Principle and procedure of ascending, descending, Circular and 2D – chromatography.

TLC – Principle, procedure and applications.

Column chromatography – Principle, procedure and applications of Gel filtration, ion-Exchange, affinity chromatography, HPLC and GLC.

Electrophoresis - Principle of electrophoresis, Paper and gel electrophoresis (Agarose and SDS PAGE).

Centrifugation- Principle, procedure and applications of density gradient centrifugation,

differential centrifugation and ultracentrifugation.

Reference text Books:

* Biophysical Chemistry, Principles & Techniques –Himalaya Publ. House.
* Principles & Techniques of Practical Biochemistry – Wilson, Walker- Cambridge Univ. Press.
* G. Abbott - Chromatography.
* Friefelder D. WH Freeman and Company. Physical Biochemistry- Application to Biochemistry and Molecular Biology
* Arun Bahl and B. S. Bahl : *Advanced Organic Chemistry,* S. Chand.
* L. Finar : *Organic Chemistry* (Vol. I & II), E. L. B. S.

PRACTICAL –III

Practical Duration – 03 Hours per week

Examination – 03 Hours

Marks=30

Practical Proper-20 Internal Assessment – Record-05+Class Test-05=10

PART-A: Extraction of Biomolecules:

* Starch from potato.
* Casein from milk.
* Caffeine from tea leaves.
* Oil from oil seeds.
* Glycogen from liver.
* Cellulose from plant material.

PART-B (BIOCHEMICAL TECHNIQUES)

* Identification of amino acid by circular paper chromatography

* Ascending paper chromatography of amino acids.

* Separation of plant pigments by column chromatography using silica gel-G.

* Demonstration on polyacrylamide gel electrophoresis[PAGE] of proteins.

* Demonstration of separation of lipids by TLC.

* Demonstration of two dimensional chromatography of amino acids.

SEMESTER – IV

CLASS DURATION- 03 HOURS PER WEEK

MARKS-Theory-60+Internal Assessment-10=70

48hrs

BC 4.1 – BIOMOLECULES

CARBOHYDRATES: 14hrs

Definition, empirical formulae, classification, biological importance.

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 the series by chemical methods. Stereochemistry of monosaccharides, (+) and (-), D and L, epimers, anomers, and diastereoisomers.

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.

Disaccharides: Establishment of structures of Sucrose and Lactose, Biological Importance and structure of Isomaltose, Trehalose and Maltose.

Polysaccharides: Partial structure, occurrence and importance of Starch, Glycogen, Inulin, Cellulose, Chitin, and Pectin.

Glycosaminoglycans: Occurrence, importance and the structure of the repeating units of Heparin, Hyaluronic acid, Teichoic acid and Chondroitin sulphate Bacterial cell wall polysaccharide, peptidoglycans.

Qualitative tests – Molisch, Benedicts / Fehling's, Picric acid, Barfoed's, Bial's, Seliwanoff's, Osazone tests.

AMINO ACIDS: 14hrs.

Structure and classification of amino acids based on polarity. Reactions of the amino groups with HNO_2, LiAlH4. Ninhydrin, Phenyl isothiocyante, DANSYL Chloride, Flurodinitro benzene. Zwitterionic properties. Pka values. Reaction of carboxyl group – Hydrazine. Any method for the chemical synthesis of amino acids D & L notation.

Peptides

Peptide bond, structure and biological importance of Glutathione, Valinomycin. Leu-enkaphelin, Synthetic peptides- polyglutamic acid, polylysine. Chemical synthesis of di-peptides.

Proteins:

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.

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 of myoglobin and quaternary structure. of Hemoglobin, Denaturation and renaturation of proteins. Anfinsen's experiment.

LIPIDS:

14hrs

Classification and biological role, Fatty acids – Nomenclature of saturated and unsaturated fatty acids. Physiological properties of fatty acids.

Acylglycerols: Mono, di and triglycerols .Saponification, Saponification value, Iodine value, Acid value and significance.

Phosphoglycerides: Structure and biological importance of phosphatidyl choline, phosphatidyl ethanolamine, Phosphatidyl inositol, Plasmalogens, and Cardiolipin.

Sphingolipids: Structure and importance of Sphingomyelin.

Glycosphingo lipids: Structure and importance of Gangliosides and Cerebrosides.

Eicosanoids: Biological role of Prostaglandins, prostacyclins, Thromboxanes and leukotrienes. Structure of PGE_2, PGF_2 Alpha and TXA_2.

Plasma lipoproteins: Types – Chylomicrons, VLDL, LDL and HDL and their significance.

Biological Membrane: Composition of membrane, micelles and liposomes. Fluid Mosaic Model, functions of the plasma membrane. Endocytosis and phagocytosis. Membrane receptors and their functions.

NUCLEIC ACIDS:

6hrs.

Isolation of DNA and RNA. Composition of DNA. Nucleosides and Nucleotides. Chargaff's rule. Watson and Crick model of DNA. Melting of DNA (Tm).

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.

Reference text books:

1. A.L., Lehninger, PRINCIPLES OF BIOCHEMISTRY (1982), Worth Publishers, Inc. New York.
2. E.E. Conn and P.K. Stumpf. OUTLINES OF BIOCHEMISTRY (1976) Wiley Eastern, New Delhi.

3. L. Stryer BIOCHEMISTRY (1995) W.H. Freeman Press, San Francisco, USA.

* Voet, D. and Voet, J.G.(2004). Biochemistry, 3rd Edition, John Wiley & Sons, Inc.USA.
* Biochemistry U. Sathyanarayana Books and Allied (P) Ltd. Kolokatta

  ISBN 0-87893- 214-3.

* J.L Jain . Text book of biochemistry.

* Ramakrishnan - Medical Biochemistry.

* D.M. Vasudevan - Text Book of Biochemistry.

* A.C. Deb - Text Book of Biochemistry.

PRACTICAL – IV

Practical Duration – 03 Hours per week

Examination – 03 Hours

Marks=30

Practical Proper-20 **Internal Assessment – Record-05+Class Test-05=10**

Qualitative analysis of Biomolecules

* Carbohydrate – Glucose, Fructose, Lactose, Maltose and Sucrose.
* Proteins – Precipitation reactions of proteins, Colour reactions of proteins, Colour reactions of amino acids like tryptophan, tyrosine, cysteine, methionine, arginine, proline and histidine.
* Lipids– solubility, acrolein test, Salkowski test, Lieberman-Burchard test.
* Qualitative tests for nucleic acid.

SEMESTER V

PAPER-V

B C-5.1 ENZYMOLOGY, CLINICAL BIOCHEMISTRY AND NUTRITION

CLASS DURATION-03 HOURS PER WEEK

MARKS-Theory-80+Internal Assessment-20=100 48Hrs

ENZYMOLOGY

ENZYMES: 12hrs.

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 turn over 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 enzyme – Sigmoidal curve, positive and negative modulators, with phosphofruoctokinase as an example.

Iso enzymes – Detection, nature, importance. LDH as an example.

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

RNA as an enzyme. (Ribozymes).

Industrial and medical application of enzymes.

CLINICAL BIOCHEMISTRY 12hrs

Urine:

Normal composition of urine – Volume, pH, colour, specific gravity. Constituents- urea, uric acid, creatinine, pigment. Abnormal constituents – glucose, albumin, ketone bodies, variations in urea, creatinine, pigments and their clinical significance in brief.

Blood:

Normal constituents of blood and their variation in pathological conditions - urea, uric acid, creatinine, glucose, bilirubin, total protein, albumin/globulin ratio. Lipid profile – cholesterol, Triglycerides, lipoproteins - HDL and LDL.

Liver function tests:

Alkaline phosphatase, SGOT and SGPT.

Cardiac injury profile CPK and LDH.

Inborn errors of Metabolism:

Sickle cell anaemia, phenyl ketonuria, Neimann – Pick disease, Type III glycogen storage disease (Cori's disease).

NUTRITION

24hrs

Introduction

3hrs.

Concept of Nutrition, calorific value of foods and its determination (Bomb calorimeter) different components of energy expenditure, respiratory quotient, Basal Metabolic Rate (BMR), determination of BMR, factors affecting BMR. Specific dynamic action of foods.

Carbohydrates: **1hr.**

Dietary Sources, dietary fibres and protein sparing action.

Proteins:

3hrs.

Dietary sources, nutritional classification, Nutritional value of proteins – PER, NPU and Biological value of proteins (BV). Essential amino acids. Nitrogen balance, mutual supplementation of proteins, Malnutrition- Kwashiorkar and marasmus.

Fats: **1hrs.**

Dietary sources of fats, invisible fat, essential fatty acids and their biological importance.

Vitamins: **6hrs.**

Dietary sources, requirements, deficiency symptoms and biological role of water soluble vitamins Thiamine, Riboflavin, Niacin, Pantothenic acid, Pyridoxine, Biotin, Folic acid, Vit B_{12} and Vit-C.

Fat soluble vitamins : Vitamin A, D, E and K.

Hypervitaminosis.

Minerals: **3hrs.**

Mineral metabolism of Ca, P, Fe, Cu

Water Metabolism: **1hr.**

Distribution of water in body fluids, Regulation of water metabolism.

Antinutritional factors: **1hr.**

Sources and harmful effects of anti vitamins (eg avidin, dicoumarol), Natural toxicants (eg Lathyrus sativa) and adultrants (eg butter yellow, lead chromate, malachite green).

Digestion, absorption and transport of carbohydrates proteins and fats, GI tract, secretions, composition and function of – saliva, gastric, bile, pancreatic and intestinal juices. Appetite, gastrointestinal hormones. **5hrs.**

Reference text books:

1. R.K.Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell, HARPER'S BIOCHEMISTRY, 22nd edn.(1990), Prentice-Hall, International, USA.
2. P.K. Stumpf, OUTLINES OF BIOCHEMISTRY, 4th edn. (1994), Wiley Eastern, New Delhi, (Chapters 7 & 8).
3. Nelson and Cox, LEHNINGER's PRINCIPLES OF BIOCHEMISTRY, (2000), Kalyani Publishers, Ludhiana/Worth Publishers, Inc., New York.
4. L. Stryer BIOCHEMISTRY 4th Ed. (1995) W.H. Freeman Co., San Francisco, USA
5. G.L. Zubay BIOCHEMISTRY 4th Ed. (1998) W.C. Brown Publishers, USA.
6. Voet, D and Voet, J.G, (2009) Biochemistry, John Wiley and Sons, N.Y. USA.
7. Garret, R.H. and Grisham, C.M. (2005) Biochemistry, 3rd Edition. Thomson Learning INC.
8. MS Swaminathan - Nutritional Biochemistry.
9. Davidson S and Pasmor J.R Nutrition and dietetics.
10. B. Sreelakshmi. Food science.
11. Sakunthala Manay, Sadhakshara Swami. Food facts and principles.
12. T.M. Delvin (editor), Text book of biochemistry with clinical correlation, (1982), john wiley & Sons Inc. USA.

SEMESTER V

PAPER-VI

B C-5.2 METABOLISM AND HUMAN PHYSIOLOGY 48hrs

CLASS DURATION-03 HOURS PER WEEK

MARKS-Theory-80+Internal Assessment-20=100

METABOLISM **24Hrs**

Metabolism: Anabolism and catabolism, compartmentalization of metabolic pathways. **1Hr**

Bio Energetics: 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. 4Hrs

Biological oxidation: 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.

5Hrs

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

Gluconeogenesis. **8Hrs**

Metabolism of Lipid : 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.
4Hrs

Metabolism of Amino acids: General reaction of amino acid degradation – Transamination, deamination and decarboxylation. Ketogenic and glucogenic amino acids. Urea cycle and its significance.
2Hrs

HUMAN PHYSIOLOGY **24hrs**

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: 3hrs.

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

Bone : 3hrs.

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

Excretory system: 2hrs.

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

Body fluids: 5hrs.

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 its function. Blood brain Barrier. Blood buffers.

Endocrine system: 6hrs.

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 steroid hormone action. Mechanism of hormone action. concept of messengers. Eg: cAMP, DAG, IP3, G-protein.

Liver: **2hrs.**

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

Reference text books:

* Human Physiology, Vol. I & II, - C. C. Chatterjee – Medical Allied Agency – Calcutta.

* Concise Medical Physiology – Choudhary – New Central Book Agency – Calcutta.

* TextBook of Medical Physiology – Guyton – Prism Books Pvt. Ltd. – Bangalore.

* Harper's Biochemistry – Murray, Granner, Mayes, and Rodwell – Prentice Hall International Inc.

5. Textbook of medical physiology: A. C. Gyton, and J. E Hall . Saunders ElsevierPublications, , A division of Reed Elsevier India Pvt .Ltd . New Delhi ISBN 81-8147-084-2.

6. Human physiology: Chatterjee, Medical Allied Agency.

7. Principles of anatomy and physiology: 13th edition, Gerard J Totora, Bryan Derrickson.

8. Human physiology, international edition, ninth edition, Eric P Widmaier, Hershel Raff and Kevin T Strang.

9. L. Stryer BIOCHEMISTRY (1995) W.H. Freeman Press, San Francisco, USA.

10.A.L., Lehninger, PRINCIPLES OF BIOCHEMISTRY (1982), Worth Publishers, Inc. New York.

11. G.L. Zubay BIOCHEMISTRY 4th Ed. (1998) W.C. Brown Publishers, USA

FIFTH SEMESTER

Practical Duration – 04 Hours per week

Two practical examinations. Each examination is of 03 hours duration

PRACTICAL – V

Marks=50

Practical Proper-40 **Internal Assessment – Record-05+Class Test-05=10**

I Biochemical analysis of urine sample:

* Qualitative analysis of urine - detection of urea, uric acid and creatinine.

* Qualitative analysis of abnormal constituents in urine - glucose, albumin, bile pigments, bile salts and ketone bodies.

II Colorimetric estimation of

* Glucose by DNS method.
* Protein by Biuret method.
* Protein by Lowry's method.
* Uric acid.
* Urea by DAMO method.
* Creatinine by Jaffe's method.
* Phosphorous by Fiske and Subbarow's method.
* Iron by Wong's method.

PRACTICAL – VI

Marks=50

Practical Proper-40 **Internal Assesment – Record-05+Class Test-05=10**

Enzyme Assays:

* Isolation of Urease and demonstration of its activity.
* Isolation of Acid phosphatase and demonstration of its activity.
* Salivary amylase
    * Determination of specific activity of salivary amylase by DNS.
    * Determination of pH optimum of salivary amylase.
    * Determination of Km and Vmax of salivary amylase.

* Determination of initial velocity [time kinetics] of salivary amylase.

* Determination of optimum temperature of salivary amylase.
* Effect of sodium chloride on amylase.

SEMESTER VI
PAPER-VII

BC-6.1 MOLECULAR BIOLOGY AND GENETIC ENGINEERING

CLASS DURATION-03 HOURS PER WEEK

MARKS-Theory-80+Internal Assessment-20=100 48hrs

MOLECULAR BIOLOGY 30Hrs

Basic concepts of Genetic Information: 2hrs

Nucleic acids as genetic information carriers, experimental evidences e.g. bacterial genetic transformation, Hershey Chase experiment. Central dogma of molecular biology and it's modification.

Degradation of Nucleic acid: 4hrs.

Degradation of nucleic acids by Nucleases-DNase, RNase and phosphodiesterases.

Schematic pathway for degradation of purine nucleotides and pyrimidine nucleotides. Recycling of purine bases by salvage pathway using PRPP.

Replication of DNA: 4hrs.

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: 4hrs.

Role of RNA polymerase. Initiation, elongation and termination, Reverse transcription.

Genetic code: General features, Wobble hypothesis. 1hr.

Prokaryotic Protein biosynthesis: 4hrs.

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

Mutations: 4hrs.

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

Repair of DNA: DNA damage and their repair. Types of damages, repair by direct reversal of damage, excision repair, recombination repair, SOS repair. 3hrs

Concept of gene: 4hrs.

* Gene expression in prokaryotes - concept of Lac-Operon and Trp operon.

* Functional units in a typical eukaryotic gene-promoter, introns and exons.

GENETIC ENGINEERING

18hrs

Historical development, aim and scope of genetic engineering. 1hr.

Isolation of DNA, Cutting of DNA by restriction endonucleases –Types, staggered cut and blunt end.
2hrs

Outline of Techniques of genetic engineering. 9hrs.

Cutting genomic DNA, Separation of fragments by agarose gel electrophoresis. Vectors- plasmid ($_P$BR 322), Bacteriophage, viruses, cosmids, phagemid and plant vectors. Insertion of foreign DNA into Vectors- Use of linkers and adapters. Homopolymer tailing. Transfections of vectors into host cells. cDNA. Principle of polymerase chain reaction and applications.

Blotting techniques: 3hrs.

Principle and procedure of Southern, Northern and Western blotting. Dot blot. DNA finger printing.

Applications of Genetic engineering **3hrs**

* Transgenic plants, transgenic animals and gene therapy.

* Human genome project.

Reference text books:

* Nelson and Cox, Lehninger's Principles of Biochemistry (2000), Worth Publish., Inc. NewYork.
* L. Stryer. BIOCHEMISTRY, 4th Edn., (1995), W.H. Freeman Press, San Fransisco, USA.
* E.J. Gardner and D.P. Snustad. PRINCIPAL OF GENETICS (1984), John Wiley & Sons, Ney York.
* Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., 2008 Molecular Biology of the Gene 6th edition. Cold Spring Harbour Lab. Press, Pearson Pub.
* Freifelder - Molecular Biology.

SEMESTER VI

PAPER 6.2 MICROBIOLOGY AND IMMUNOLOGY

CLASS DURATION-03 HOURS PER WEEK

MARKS-Theory-80+Internal Assessment-20=100

48hrs

MICROBIOLOGY **19hrs**

Study of Micro-organisms: **2hr.**

Staining micro-organisms – principle and procedure of gram stain and acid fast stain.

Microbial nutrition: 5hrs.

Growth of micro-organisms, measurement of growth, factors influencing growth – Nutrition,carbon source, Nitrogen source, Temperature, pH and oxygen. Batch and continuous culture. Growth curve, phases of growth curve. Concept of synchronous cultures. Instrumentation in bioreactors.

Industrial Microbiology: 4hrs.

Production and importance – Alchoholic beverages (Beer and Wine), Fermented products of milk cheese, antibiotic production – penicillin, single cell protein – Spirulina. Fermentors – types and components.

Antibiotics: 3hrs.

Definition, Mechanism of action of penicillin streptomycin, and chloramphenicol, antibiotic resistance in brief.

Viruses: 2hrs.

Classification based on genetic material with examples.

Plant viruses – TMV, morphology, general characteristics and its replication.

Bacteriophages: 3hrs.

Morphology, general characteristics, life cycle (lysogeny and lytic cycle) of T-even bacteriophage.

IMMUNOLOGY **29hrs**

IMMUNITY: **6hrs.**

Role of immunologically important organs and cells - bone marrow, thymus, spleen and lymphocytes. Hematopoiesis. Formation and functions of T & B Lymphocytes. Helper T-cells and killer T-cells. Macrophages. Cellular and humoral immunity.

Types of immunity: Innate and Adaptive immunity. Passive and active

immunity. **4 hrs.**

Antigens: **3hrs.**

Definition, types, chemical nature and antigenicity. Epitopes, paratopes and Haptens, Adjuvants.

Antibodies: **4hrs**

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: **4hrs.**

Formation of Antigen-Antibody complex. Agglutination and precipitation. Principle, procedure and applications of Immuno diffusion, RIA, ELISA.

Immunization: **2hrs.**

Vaccination – vaccines and their preparations, Primary and secondary immune response.

Hypersensitivity: Immediate and Delayed hypersensitivity. Type I hypersensitivity reaction (Anaphylaxis).

2hrs

Immunological disorders: 2hrs.

Autoimmune disorder- systemic lupus erythomatus and rheumatoid arthritis.
Immunodeficiency diseases- AIDS .

Reference text books:

* M. Pelczar, E.C.S. Chan and M.R. Krieg, MICROBIOLOGY, McGraw Hill Inc., Singapore (1997).

* Powar, Daginawala – Himalaya Publishing House. General Microbiology, Vol. I & II.

* Stanier, Adelberg, Ingraham – The Macmillan Press – London. General Microbiology.

* Nandini Shetty . Introduction to Immunology.
* Janis Kuby. – W. H. Freeman and Co. Immunology.
* I.M. Riott, J. Brostoff, D. Male "Immunology" 3rd edn. W.H. Freeman and Pub. Company, USA.
* J. Kuby "Immunology" 3rd edn., Mosby Year Book Co., England

SIXTH SEMESTER

Note: - The students may be taken for the visit to scientific institution in the country relevant to Biochemistry and a report to be submitted. The report is valued for 5 marks and these marks to be considered for IA Practical – VIII instead of class test.

Practical Duration – 04 Hours per week

Two practical examinations. Each examination is of 03 hours duration

PRACTICAL – VII

Marks=50

Practical Proper-40 Internal Assessment – Record-05+Class Test-05=10

1. Determination of

* Moisture content of foods

* Adultrants in food

* Calcium in ragi

* Iron in drumsticks.

2. Estimation of vitamin-C in lemon and gooseberries.

* Gravimetric estimation of sulphate as barium sulphate.

* Estimation of amino acid by formal titration.

* Estimation of reducing sugars by Hedgedon and Jensen method.

* Determination of saponification value of oil or fat.

* Determination of iodine value of oil or fat.
* Determination of Molar extinction coefficient of a given solution.

* Determination of absorption maxima of proteins and nucleic acid.
* Ouchterlony immunodiffusion.

PRACTICAL – VIII

Marks=50

Internal Assessment – Record-05+Class Test-05=10

Practical Proper-40

* Conductometric titration of strong acid against strong base.

* Conductometric titration of weak acid (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.

* Gram staining.

* Demonstration of western blotting.

* Extraction and estimation of DNA from coconut endosperm.

9.Extraction and estimation of RNA from spinach leaves.

Visit to scientific institution in the country:

* Bangalore : IISC, JNCASR, NIMHANS, UAS-NCBS, Biocon.

* Bombay : TIFR, Cancer Research Institute, BARC, IIT.

* Hyderabad – CCMB, NIN, Raddy's lab, Indian drug research lab, International crop research institute for semi arid Tropics (ICRISAT).

* University of Poona

  National Institute of Virology, National Chemical Laboratory, National center for cell science.

* Goa: National Institute of occanography (NIO)

* Cochin – Sri Chitra Tirunal Institute of medical science.

* Kasargod : Coconut Research Institute.

* Trivendrom – Rajiv Gandhi institute of Biological science.

* Mangalore – Fisheries college

  Manipal Centre for Higher Education, Plant biotechnology lab – St. Allcious college.

* Hassan : Coffee estate, MCF.

* Ooty : Potato research station.

* Coonoor : TATA tea process centre, vaccine institute

* Madras : IIT

* Centre for leather and resin institute

* RSIC – Regional Sophisticated Instrumentation Centre.