BANGALORE UNIVERSITY

Syllabus
for

B. Sc. Biochemistry
(CBCS)

I to VI Semesters
(With effect from 2014-15)

Department of Biochemistry,
Central College Campus
Bangalore -560 001

June 2014

FOREWARD

The University proposed to introduce credit based B. Sc. Programme from the academic year 2014-15. The guidelines which was prepared by the task force committee constituted by the University for this purpose was provided. The enclosed syllabus has been prepared based on these guidelines. A core committee was formed to accomplish this task, which included the senior teachers from affiliated colleges which are offering Biochemistry as cognate subject and also the teachers from the University department. Three meetings were held to prepare and finalize the theory and practical syllabus for I to VI semester of B. Sc. Biochemistry course. The meetings were held on 07.05.2014, 03.06.2014 and 13.06.2014. The teachers of the core committee played a pivotal role in preparing the syllabi. The final draft syllabus was circulated to the members of BOS in Biochemistry (UG). The final BOS approved syllabus is enclosed herewith. The Chairman records his thanks to the teachers involved in the preparation of this syllabus.

Proceedings of the BOS in Biochemistry (UG)

The final draft syllabus prepared by the department with the help of the core committee was circulated to members of the Board of Studies in Biochemistry (UG) by E. mail and a hard copy was also mailed. The members have indicated their approval and some of the suggestions and comments made by the have been incorporated in the final syllabus enclosed herewith.

Sd.

Chairman, Dept. of Biochemistry

Members of the Core Committee which prepared the B.Sc. Biochemistry syllabus

1. Prof. N.H. Manjunath, Chairman, DOS in Biochemistry, Bangalore University, Central College Campus, Bangalore -560 001.

2. Dr. V. R. Devaraj, Associate Professor, Dept. of Biochemistry, Bangalore University, Central College Campus, Bangalore -560 001.

3. Prof. V. Veeraraghavan, Prof. of Biochemistry, Reva Institute of Science & Management, Kattiganahalli, Yelahanka, Bangalore – 560 064.

4. Dr. N. Manjula, Associate Professor, Dept. of Chemistry and Biochemistry, Vijaya College, Bangalore -60 004.

5. Dr. C.K. Mythily, Associate Professor, Dept. of Chemistry, Maharani's Science College for Women, Bangalore.

6. Dr. Mahesh Arvind, Associate Professor, Dept. of Chemistry and Biochemistry, Vijaya College, Bangalore -60 004.

7. Smt. Renuka Srihari, Associate Professor, Dept. of Biochemistry, Maharani Lakshmi Ammanni College for Women, I.I.Sc. Post, Malleswaram, Bangalore – 560 012.

8. Dr. R. Nagesh Babu, Assistant Professor, Dept. of Chemistry, Maharani's Science College for Women, Bangalore.

9. Mr. S. Kantharaju, Assistant Professor, Dept. of Chemistry, SJR. College, Ananda Rao Circle, Bangalore – 560 009.

SCHEME OF EXAMINATION

Title of the paper	Contact hrs/Wk	Exam. hours	I A	Marks	Total Marks	Credits
First Semester						
Biochemistry-I	4	3	30	70	100	2
Biochemistry practical-I	3	3	15	35	50	1
Second Semester						
Biochemistry-II	4	3	30	70	100	2
Biochemistry practical-II	3	3	15	35	50	1
Third Semester						
Biochemistry-III	4	3	30	70	100	2
Biochemistry practical-III	3	3	15	35	50	1
Fourth Semester						
Biochemistry-IV	4	3	30	70	100	2
Biochemistry practical-IV	3	3	15	35	50	1
Fifth Semester						
Biochemistry-V	3	3	30	70	100	2
Biochemistry-VI	3	3	30	70	100	2
Biochemistry practicals-V	3	3	15	35	50	1
Biochemistry practicals-VI	3	3	15	35	50	1
Sixth Semester						
Biochemistry-VII	3	3	30	70	100	2
Biochemistry-VIII	3	3	30	70	100	2
Biochemistry practical-VII	3	3	15	35	50	1
Biochemistry practical-VIII	3	3	15	35	50	1

Pattern of Internal assessment of Practical and Practical Examination

1. Internal assessment Marks:

Attendance: 5 Marks

More than 91% attendance	:	5 Marks
86 – 90% attendance	:	4 Marks
81 – 85% attendance	:	3 Marks
75 – 80% attendance	:	2 Marks

Tests: 10 Marks (two internal tests to be conducted for)

2. Scheme of Practical Examination:

Duration	:	3 hours
Total Marks	:	35
Marks for practical record	:	5
Marks for procedure writing	:	5
Marks for Viva – Voce	:	5
Marks for performing experiment	:	20

Practical Record:

Recording 8 or more different experiments	:	5 Marks
Recording 6-7 different experiments	:	4 Marks
Recording 4-5 different experiments	:	3 Marks
Recording 3 different experiments	:	2 Marks
Recording Less than 3 experiments	:	0 Marks

II Procedure writing : 5 Marks

B.Sc. Biochemistry First Semester

Biochemistry – I 52 hrs

Unit-I 13 hrs

1. Measurement

SI Units – International System of Units – Basic Units, Derived Units. Simple problems relating to derived units (conversions) – Prefixes, subsidiary units – Non SI units and their SI equivalents. Significant figures – and computarion Dimensional analysis for volume, density pressure, surface tension and viscosity.

Exponential notation – expression of a large number in an exponential form; purposes, positive and negative powers of 10. Graphical representation of data – Types of graphs, Advantages of showing data in graphical forum.

Errors in quantitative analysis – types ,sources minimization of errors.

Precision and accuracy.

Relationship between significant figures and precision 6 hrs

2. Atomic structure

Electromagnetic radiation – (wave length, frequency, velocity, wave number) electromagnetic spectrum, Nature of wave particle.

Quantum numbers & their significance (Principal quantum number, Azimuthal quantum number(1) , Magnetic quantum number (m) and Spin quantum number [s])

Shapes of Atomic orbitals – s, p and d orbitals.

Pauli Exclusion Principle, Aufbau Principle, Hund's rule of maximum multiplicity-cause of stability of half filled and completely filled energy levels.

Electronic configuration of elements up to At No.54, (n+l rule , $2n^2$,order of energy levels to be followed)

Oxidation numbers – concept, difference between valency and oxidation number, and computation. calculation of equivalent weights of oxidising and reducing agents.

7 hrs

Unit-II 13 hrs

3. Chemical bonding

Ionic bond - factors favouring formation – lattice energy – energetics of Ionic bond formation (NaCl as example) Born – Haber cycle – for Nacl. Calculation of Lattice energy Characteristics of ionic compounds. Covalent bond- definition, pictorial representation of covalent bond formation in H_2, HCl, NH_3, CO_2 and N_2. Valence bond theory – postulates, Sigma and pi bonds Hybridization of orbitals and directoral characteristics –sp,sp^2 , sp^3(egs- methane, ethene and acetylene) Resonance forms of H_2 and Benzene. VSPER theory-Shapes of H_2O, NH_3, H_3O^+, SF_4 , ClF_3 and ICl^-_2. Molecular Orbital Theory – postulates, Atomic orbitals and molecular orbitals; conditions for the formation of molecular orbitals. LCAO – Bonding and antibonding molecular orbitals; comparison between bonding and antibonding molecular orbitals. Shapes of molecular orbitals (by s-s, s-p, p-p overlap) – pictures to be given. Molecular orbital diagrams for the formation of H_2, He and O_2. Polarisation concept, Fajan's rule, bond length, bond angle and bond energy, dipole moment. Coordinate bond – Donor, acceptor, representation of the formation of co-ordinate bond in H_3O+, NH_4^+. Chelates – ligands, chelates in biological systems (mention chlorophyll, vitamin B_{12}, haeme, catalase as examples) Hydrogen bond – inter and intramolecular hydrogen bond- anomalous properties of HF, H_2O,NH_3 and nitro phenols Van-der Waals forces – definition. 8 hrs

4. Nuclear chemistry and Radioactivity

Characteristics of radioelements -Nucleus- – structure , nuclear forces - N/P ratio, mass defect, binding energy; packing fraction, instability of nuclei. Radioactivity –Types of radioactive decay, Properties of α, β, γ radiations. Group displacement law. Decay law - decay constant, Half life period and average life of a radioactive element. Detection of radioactivity – GM counter and scintillation counters. Tracer technique – pplications of P^{32} , C^{14} , I^{131} & Co^{60}. Safety measures 7 hrs

Unit-III 13 hrs

5. Solutions and Colligative properties

Concentration units – molarity, molality, normality, mole fraction – simple problems.

Types of solutions – homogenous and heterogeneous, factors influencing solubility– nature of solvent, solute, temperature, pressure and practice size. Solubility curves– plots showing solubility of sodium chloride, potassium nitrate, lead nitrate and sodium sulphate against temperature. Henry's law – statement, Applications. Colligative properties– Definition, Relative lowering of vapour pressure. Raoults' law of relative lowering of vapour pressure, Osmosis- preparation of copper ferrocyanide semi permeable membrane,

Osmotic pressure – measurement by Berkely – Hartley method. Theory of dilute solutions – Laws of osmotic pressure - Van't Hoff Boyle's law, Van't Hoff Charles' law and Avogardro's law. Hypo-, hyper- and isotonic solutions. Donnan membrane equilibrium and its applications. Elevation in boiling point, ebullioscopic constant. Depression in freezing point, cryoscopic constant. Limitations of colligative properties. Abnormal molecular weights and the van't Hoff factor – degree of association, Degree of dissociation

6 hrs

5. Electrochemistry

Strong and weak electrolytes – definition and examples. Activity and activity coefficient – concepts. Activity and mean activity of the electrolyte. Mean ionic activity. Ionic strength- classification of electrolytes as 1:1, 2:2, 2:1 electrolytes with examples. Electrochemical cells: conventions of representing galvanic cells , half cell reactions and cell reaction Reversible electrodes and cells – definition. Types-Cation reversible electrode, anion reversible electrode, redox electrode. (Examples and electrode reactions to be given) Single electrode potential – Nernst equation,Factors affecting single electrode potential. Standard Electrode Potential (definition). Reference electrodes – primary reference (Standard hydrogen electrode), secondary reference electrodes (Calomel, quinhydrone and glass electrodes). Electrochemical series- to predict the ease of oxidation, displacement reaction to calculate standard emf of cell Ion selective electrodes- concept, types and applications.

7 hrs

Unit – IV 13 hrs

6. Acids,Bases and Buffers

Modern concepts of acids and bases-Arrhenius, Lowry- Bronsted and Lewis concepts. Limitations of each concept. Strong and weak acids -ionisation constant K_a and pK_a of weak acids, comparison of acid strength on this basis, Ionic product of water ,common ion effect, solubility product and ionic product of sparingly soluble salts and conditions for precipitation. and in qualitative analysis –in prediction of selective precipitation of second and forth group basic radicals, precipitation of third group basic radicals. Hydrolysis of salts– pH of salt

solutions. Hydrogen ion concentration- pH, pH of some biological fluids and its importance. Buffers-definition, types, buffer action and buffer capacity. pH of buffers-Henderson–Hasselbalch equation-derivation, preparation of buffers, problems.

7 hrs

7. Liquids

Properties of liquids –vapour pressure, viscosity and surface tension. Relationship between vapour pressure and boiling point, freezing point-heat of fusion. Viscosity-Definition, units, experimental determination using Ostwalds viscometer. Viscosity and shape/size of molecules. Surface tension:- Definition, units, experimental determination using stalagmometer. Surfacants – effect of sufactants on surface tension. Viscosity and Surface tension in everyday life.

4 hrs

Biochemistry Practical - I

3 hrs / wk

1. Calibration of glass wares - pipettes, burettes and volumetric flasks (demonstration)
2. Preparation of standard sodium oxalate and estimation of potassium permanganate.
3. Preparation of standard potassium bipthalate and estimation of alkali
4. Preparation of standard potassium dichromate solution and estimation of $Na_2S_2O_3$.
5. Estimation of hardness of water using EDTA (Standard EDTA to be provided)
6. Estimation of nitrogen in ammonium salts using sodium hydroxide and standard oxalic acid
7. Estimation of chloride by Mohr's method
8. Estimation of Fe^{2+} using standard potassium dichromate and diphenyl amine indicator
9. Estimation of borax using standard sodium carbonate.
10. Estimation of carbonate and bicarbonate in a given mixture.

B.Sc. Biochemistry Second Semester

Biochemistry – II **52 hrs**

Unit –I **13 hrs**

1. Solids

Types-Crystalline and Amorphous. Size and Shapes. Definition of Space Lattice and Unit cell. Symmetry elements in crystals. Laws of Crystallography ,Weiss and Miller Indices with simple numericals. Crystal systems with examples. Defects in crystalline solids – Schotky & Frenkel defects. X – ray diffraction of crystals-Braag's equation. 5 hrs

2. Phase Rule

Definitions of Phase & Components,Criterion of phase equilibrium,Gibb's phase rule (no derivation) . Application of phase rule to one component system –water system, Two component system-water-potassium iodide (freezing mixtures). Solutions of liquids in liquids– ideal solutions and Raoult's and Henry's law .Non-ideal solutions-vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions- azeotropes –HCl - H_2O and water-ethanol system.. Distillation of solutions-Lever rule. Partial miscibility of liquids (Water – Phenol). Critical Solution Temperature (lower and upper).Effect of impurity on CST. Immiscibility of liquids. Principle of steam distillation. Nernst distribution law- statement, deviations from distribution law due to association and dissociation of the solute in one of the solvents. Applications of distribution law– solvent extraction. 6 hrs

3. Chemical Equilibrium

Reversible reactions with examples.Law of mass action, Chemical equilibrium – definition and characterstics.Relationship between K_c , K_p Homogenous and heterogeneous systems with examples. Le Chatlier principle . Equilibrium constant and free energy change. Biological applications-ATP and its role in bio-energetics and binding of oxygen by myoglobin and haemoglobin. Redox equilibria with example Fe^{2+} Fe^{3+} System. 3 hrs

Unit-II **13 hrs**

4. Reaction Kinetics

Experimental methods of studying kinetics of reactions, rate of reactions, Factors influencing rate of reaction – temperature, pressure, concentration and catalyst, rate law or Rate equation, Molecularity and order of a reaction, velocity constant or rate constant and half life period expressions for zero, first and second order reactions (a=b and a≠b).Theories of reaction rates – Effect of temperature on rate of reaction, Arrhenius equation, elementary treatment of transition state theory. 5 hrs

5. Catalysis

Characteristics of catalysts, Types of catalysis – Homogeneous and heterogeneous with both biological and non-biological examples. Theories of catalysis – intermediate compound formation theory and adsorption theory (No mechanism required). 2 hrs

6. Introduction to organic chemistry

IUPAC nomenclature bi and poly functional compounds. Inductive effect, resonance and hyper conjugation. Reactive intermediates – free radicals, carbocations and carbanions.

5 hrs

Unit-III **13 hrs**

7. Hydrocarbons

Mechanism of adition of HCl to propene, Morkownikoff's rule. Peroxide effect, Alkenes – ozonolysis, oxidation. Alkynes – formation of acetylides and their importance. Dienes– types with examples. Conjugate dienes, 1,3-butadiene – stability, mechanism of addition of HBr . Conformational analysis of ethane and n – butane. 4 hrs

8. Cycloalkanes

Reactivity and relative stabilities. Baeyer strain theory, Sachse – Mohr theory, boat and chair forms of cyclohexane, axial and equatorial bonds. 2 hrs

9. Arenes

Modern concept of structure of benzene, mechanism of electrophylic substitution in benzene (nitration, Friedal– Craft's alkylation and acylation). Electronic interpretation of the orienting influence of substituents in the electrophylic substitution of toluene, chlorobenzene and nitrobenzene. Aromaticity– Huckel rule (4n+2 rule), structure of naphthalene, anthracene, phenanthrene and diphenyl. Oxidation reactions of naphthalene. 6 hrs

Unit – IV **13 hrs**

10. Alkylhalides and organometallic reactions

SN^1 and SN^2 reaction mechanisms taking 1^o, 2^o & 3^o alkylhalides s examples. Mechanistic concepts of elimination reactions involving tertiarybutylchloride and *n*– butylchloride. Organometallic compounds – examples, preparation and synthetic applications of Gignard reagents. 4 hrs

11. Alcohols

Classification, monohydric alcohols: examples, general and distinguishing reactions. Dihydric alcohols: glycols, Trihydric alcohols: glycerol – synthesis from propene, properties and uses. 3 hrs

12. Phenols

Classification, electronic interpretation of acidity of phenols, mechanism of Kolbe, Reimer–Tiemann and bromination reactions. 2 hrs

13. Carbonyl compounds

General properties, addition of alcohols to aldehydes and ketones. Keto-enol tautomerism. Mechanisms: adition of HCN toacetaldehyde, Claisen and aldol condensations. Quinones: *o*- and *p*-benzoquinones- structure and properties. 5 hrs

Biochemistry Practical- II

3 hrs / wk

List of experiments:

1. Determination of density and viscosity of the given organic liquid using Ostwald's viscometer
2. Determination of composition of a binary liquid mixture by viscosity method.
3. Determination of density and surface tension of the given liquid using Stalagmometer
4. Partition Coefficient of iodine between carbon tetrachloride and water
5. Partition Coefficient of benzoic acid between toluene and water.
6. Kinetics of iodination of acetone by colorimetric method
7. Reaction kinetics of acid catalysed hydrolysis of ethyl acetate
8. Determination of molar mass of a non-electrolyte by ebullioscopic method
9. Effect of surfactants on surface tension of water.
10. Adsorption of oxalic acid on activated charcoal.

B.Sc. Biochemistry – Third Semester
Biochemistry –III

52 hrs

Unit – I **13 hrs**

1. Bio-inorganic and Environmental Chemistry:
Metal ions in biological systems; Transition metal ions and oxidation states; Types of ligands; Role of iron in Myoglobin, Haemoglobin and cytochromes; Copper in Hemocyanin, Magnesium in chlorophyll, Cobalt in vitamin B-12 and Molybdenum in nitrogenase; Metaloenzymes; Geometrical and optical isomerism in coordination complexes. 7 hrs

2. Environmental Toxicology:
Biochemical toxicology- toxicity and detoxification of Pb, Hg, Cd. LD and ED values of major toxicants. Water pollution: Treatment of sewage and industrial effluents (tanning and electroplating); Pesticides hazards – DDT, Malathion, lindane and 2,4-D. Brief Introduction to Bioremediation and Phytoremediation with applications. 6 hrs

Unit -II **13 hrs**

3. Carboxylic Acids :
Classification; hydroxy acids: preparation and properties of lactic acid; structures of tartaric, malic, citric and iso citric acids; dicarboxylic acids: saturated dicarboxylic acids- effect of heat on the first five members; ketoacids: structures , properties and reactions of pyruvic acid, α-ketoglutaric acid and oxaloacetic acid. 3 hrs

4. Amines:
Classification; isomerism; distinguishing reactions of 1°, 2° and 3° amines; some biologically important amines (DOPA, Histamine). 2 hrs

5. Alkaloids:
Introduction and general characteristics; general method of extraction; structure and medicinal uses of nicotine, atropine and LSD. 2 hrs

6. Terpenes: Structure and Biological roles of the following: menthol, santonin, juvenile hormone I, abscisin II, gibberilic acid and lanosterol. Steroids: basic ring system; structures of cholesterol, steroid hormones(testosterone and oestrogen); structures andbiological importance of β-carotene. 2 hrs

7. Heterocyclic Compounds: Structural and nomenclature of furan, pyran, thiophene, thizole, pyrrole, imidazole, pyridine, pyrimidine, purine, isoalloxazine and indole; biological compounds containing the above skeletons. reactions of imidazole and pyridine; Aromaticity of furan, thiophene, pyrrole and pyridine. 2 hrs

8. Drugs: Classification of drugs; synthesis and uses of sulphanilamide and pentothal. Antibiotics: Definition; types; sources; structures and antimicrobial spectrum of action of penicillin, chloroamphenicol, streptomycin and tetracyclines. 2 hrs

Unit - III **13 hrs**

9. Colloids:

Types of colloidal systems, electrical properties of colloids. Emulsions and emulsifiers; Gels; Applications of emulsions in lipid chemistry. 2 hrs

10. Photochemistry:

Laws of Photochemistry; Chemiluminescence; Bioluminescence; Photocatalysis and photochemical reactions. 2 hrs

11. Stereochemistry:

Stereoisomerism: types, stereochemical terminology; optical isomerism: Molecular dissymmetry; chirality: glyceraldehyde, lactic acid, tartaric acid; Nomenclature of enantiomers – the RS system and DL notation; diasterioism, epimers, mutarotation, racemization and resolution; Fischer's projection formulae; Geometrical isomerism: *cis-trans* isomerism in alkenes and ring compounds; structure and properties of maleic and fumaric acids; (E)-(Z) system of specifying geometrical isomers; significance of chirality in biological system.

9 hrs

Unit - IV

13 hrs

12. Introduction To Biochemistry:

Aim and scope, historical account of development of biochemistry, mention of the landmark developments, contributions of Paracelsus, van Helmholtz, Karl Sheele, Lavosier, Wohler, Emil Fisher, Louis Pasteur, Embden, Meyerhoff, Hans Kreb, Michaelis Menton, Watson & Crick, Chargaff and H. G. Khorana; biochemical composition of living organism: elemental and chemical compositions; properties of water which makes it as solvent of life. 5 hrs

13. Identification and Separation Techniques:

Spectroscopic methods- principle and applications of UV- Visible, IR, ESR and NMR spectroscopy. Separation techniques: principle, types and applications of centrifugation, chromatography and electrophoretic techniques. 8 hrs

Biochemistry Practical- III

3 hrs / wk

1. Systematic Qualitative Analysis of organic compound (8 practicals)

   The following compounds may be given for systematic qualitative analysis

1. Resorcinol	2. Urea	3. Glucose	4. Aniline
5. Benzoic Acid	6. Salicylic acid	7. Phenol	8. m-Cresol
9. Benzyl alcohol	10. Benzaldehyde	11. Acetophenone	12. Ethyl benzoate
13. Toluene	14. Chlorobenzene	15. Benzamide	16. Nitrobenzene

2. Determination of BOD
3. Determination of COD
4. Separation of compounds by TLC
5. Determination of λ max

B.Sc. Biochemistry – Fourth Semester

Biochemistry – IV

52 hrs

Unit – I 13 hrs

1. Tissues:
Classification, epithelial, connective tissues, role of collagen and elastin in bone composition, growth and remodeling, factors affecting growth. 3 hrs

2. Blood and Body fluids:
Composition of body fluids; blood; Properties, composition and functions; Erythropoiesis, blood coagulation - outline of extrinsic and intrinsic pathway; Composition and functions of CSF and Lymph. 5 hrs

3. Respiratory system:
Anatomy of Respiratory tract, Mechanism of respiration, Transport of gases and artificial respiration. Acid base balance by lungs and kidneys. Bohr's effect, transport of gases, chloride shift. 5 hrs

Unit – II 13 hrs

4. Digestive system:
Outline of digestive system ; composition and functions of major digestive secretions. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids. 5 hrs

5. Excretory system:
Structure and functions of nephron; glomorular filtration, tubular absorption and secretion; Concentration of urine, GFR, kidney function tests, composition of urine, renal failure, nephrites. 4 hrs

6. Endocrinology:
Introduction - Endocrine glands - chemistry of hormones and hormonal action. Functions of the hormones of hypothalamus, pituitary glands, adrenal cortex, thyroid, parathyroid and pancreas (Insulin, Glucagon and Somatostatin) Diabetes mellitus & Hyperinsulinoma; Local hormones and its biological action (PGE_2, PGI_2, TXA_4 and LTA_4). 4 hrs

Unit – III 13 hrs

7. Cardiovascular system:
Blood vessels- anatomy and physiology; ECG, Blood pressure. Regulation of heart rate, hemorrhages. 3 hrs

8. Nervous system:
Structure and classification of neurons, membrane potential, resting membrane potential and action potential; Mechanism of synaptic transmission, EEG; Neurotransmitters– classification, neurotransmitters receptors. 5 hrs

9. Muscular system:
Muscle types; ultra structure of skeletal and cardiac muscle fibers; Muscle proteins – contractile and non contractile. Definition of sarcomeres and mechanism of contraction. Energetics of muscle contraction. Regulation of skeletal muscle contraction. Muscular dystrophies. 5 hrs

Unit – IV 13 hrs

11. Nutrition:

Energy content of foods, Balanced diet- Definition, characteristic feature of balanced diet, proximate analysis of foods for carbohydrate, proteins, fats, fiber material and water content. Bomb calorimeter- diagram and description, Determination of calorific value of foods (Carbohydrate, fat and protein); respiratory quotient of food stuffs and significance of RQ. BMR determination by direct and indirect method; BOD; SDA- definition; SDA for carbohydrate, fat and mixed diet and its significance. RDA for different physical activities: pregnant women, lactating woman, infants and children. 6 hrs

12. Macronutrients

Carbohydrate, proteins, lipid and fiber; Essential aminoacids, semi essential and non essential aminoacids; complete and incomplete proteins, protein efficiency ratio; Nitrogen balance- Positive and negative nitrogen balance.; Fortification - Definition and Biomedical importance; Protein Energy malnutririon: Marasmus & Kwashiorkar- causative factors , treatment and prevention. 4 hrs

13. Micronutrients:

Nutritional importance of vitamin, classification, source, daily requirements and functions; Deficiency symptoms- hypervitaminosis of fat soluble vitamins. Nutritional importance of Minerals- Definition, classification, source, daily requirement and deficiency symptoms. 3 hrs

Biochemistry Practical- IV

3 hrs / wk

List of experiments

1. Paper chromatography of amino acid by circular method
2. Preparation of m- dinitrobenzene from nitrobenzene
3. Preparation of p- nitroacetanilide from acetanilide
4. Preparation of p- bromoacetanilide from acetanilide
5. Preparation of buffers (phospate and citrate buffer)
6. Determination of titrable acidity of urine
7. Estimation of bilirubin by sulpanalic acid method
8. Estimation of haemoglobin by Wong's method
9. Qualitative analysis of non protein nitrogenous substance in urine
10. Determination of A/G ratio in serum by biuriet method

B.Sc. Biochemistry – Fifth Semester

Biochemistry - V

52hrs

Unit – I 13 hrs

1. Carbohydrates:

Biological importance ; Monosaccharides : Elucidation of structure of glucose (open chain and ring structure); Epimers and Anomers-defination and example ; Brief review on configurational and conformational aspects of carbohydrates; Derived monosaccharides: structures and biological importance of **:** Amino sugars: glucoseamine and galactosamine and their N-acetylated forms, Sugar phosphates: D-ribose-5-P,β-D-ribose-5-P,glucose-6-P and fructose -1,6-diphosphate, Sugar acids: types with examples; Disaccharides: Structure of isomaltose, cellobiose and trehalose; brief discussion on reducing property; Polysacchraides: classification with examples ;structure,properties and importance of homo and hetero polysaccharides-Blood group and bacterial polysaccharides; glycosaminoglycans, cardioglycosides, Glycoproteins-structure and functions, Lectins-characteristics and biological importance.

Unit – II 13 hrs

2. Lipids:

Biological importance; Classification. Fatty acids: definition,classification,examples and structures, properties of fatty acids: melting point,solubility, cis-trans isomerism, reaction with NaOH, alcohol, catalytic hydrogenation, Acylglycerols: mono, di, triacylglycerols (general,structure). Hydrolysis of acylglycerols:Saponification,saponifaction number; Acid hydrolysis of triglycerides, unsaturation in acyl glycerols and iodine number; Rancidity : definition,oxidative and hydrolytic rancidity; Phosphoglycerides:structure and biological roles of phosphatidylcholine, phospatidyl ethanolamine, phosphaatidylserine,phospatidyl inositol;Sphinogolipds:structure of 4- sphingenine, ceramids and sphingomyelin, biological importance to be mentioned.Glycosphingolipids: Biological importance and general structure of cerebrosides and gangliosides; Prostaglandins: definition and example,structure of PGE2 and PGF2 and biological role ofprostaglandins in general; Thoromoboxanes and leukotrienes; Waxes: definition,types,biological importance; Lipoproteins: Types and functions, clinical significance; Membrane:common features of membranes ,behavior of amphipathic lipids in water; formation of micells, bilayers and vesicels; Biological membranes - fluid mosaic model, functions and composition; Steroids: definition, functions of cholic acid.

Unit – III 13 hrs

3. Proteins:

Structure and classification of α-amino acids based on the polarity of R group; amino acids as amphoytes – zwitterion structure of amino acids, Isoelectric pH, titration curve of alanine; reactions of amino acids with ninhydrin ,FDNB, Edman's reagent and decarboxylation of amino acids; peptides: structure and conformation, biological importance of peptides; Proteins: classification based on composition shape and function with examples; color reactions:ninhydrin, xanthoproteic, Lowry, Sakaguchi's and Biuret reaction; Overview of structural organization of proteins: Primary structure-importance of restoration of primary structure by taking sickle cell anemia as example, Secondary structure-Types –α-helix, β-pleated structure, triple helix – example and characteristic features of each type; Tertiary structure and Quaternary structure-factors stabilizing both; Denaturation-Denaturating agents and mechanism of operation, renaturation of ribonuclease-Anfinsen's experiment.

Unit – IV **13 hrs**

4. Bioenergetics and Biological Oxidation:

Laws of thermodynamics ; Definition of bioenergetics, stages of energy transformation-photosynthesis, respiration and utilization of energy; free energy concepts: free energy change: exergonic and endergonic reactions, meaning of ΔG,ΔG°,ΔG°□;Biochemical standard state and ΔG°□,ΔG and Keq(relationship). High energy compound: Definition and examples; energy coupling-explain the concept by taking suitable example; Biological oxidation:Comparison of biological oxidation with combustion using glucose as an example; Calculation of thermodynamic efficiency of biological oxidation for a mole of glucose; Redox potential of some biologically important half reactions(Ex:components of electron transport system); Calculation of energy yields from biological Red-ox reaction(problems to be solved); Electron transport chain: components sequence and their arrangement,4 complexes and their functions to be mentioned;Structure and reaction associated with ubiquinone, coenzyme Q,NAD, FMN and FAD. Scheme and sites of energy conservation;Cytochromes and NHI proteins; Oxidative phosphorylation: definition,salient features of chemiosmotic theory, P:O ratio.

Biochemistry Practical- V

3 hrs / wk

List of experiments:

1. Qualitative analysis of carbohydrates.
2. Qualitative analysis of amino acids and proteins.
3. Qualitative analysis of lipids.
4. Preparation of solid derivatives of monosaccharide – osazones.
5. Determination of total Carbohydrate content in cereal by anthrone method.
6. Estimation of amino acids by formal titration.
7. Estimation of ascorbic acid from biological samples by titrimetric method.
8. Determination of iodine value of a lipid.
9. Determination of saponification value of a lipid.
10. Estimation of Calcium from milk.

B.Sc. Biochemistry – Fifth Semester

Biochemistry - VI

52hrs

Unit - I 13 hrs

1. Enzymes:

Nomenclature (E.C. No. upto 2nd digit) and classification of enzymes, Holoenzyme, apoenzyme, prosthetic group.Substrate enzyme interaction – lock and key model, induced fit model. Active site and its characteristics. Enzyme specificity and theories. Enzyme assay– methods, enzyme units. Chemical nature of enzymes, catalysis and energy of activation. Enzyme kinetics of single substrate reactions- Michaelis theory, steady state theory. Michaelis-Menten equation (No derivation), Significance of Km and V max and their determination using Line Weaver– Burk plots. Effect of pH and temperature. Monomeric and oligomeric enzymes; cooperativity in catalysis, sigmoidal kinetics, allosteric effectors. Enzyme Inhibition: Types - reversible, irreversible, competitive, non-competitive, uncompetetive and mixed inhibitors. Partial inhibition, substrate inhibition and allosteric inhibition. Cofactors- metal cofactors, coenzymes (definition and role of NAD, TPP and PLP).

Unit - II 13 hrs

2. Nucleic acids:

Nucleosides and nucleotides, configuration and conformation, Composition of RNA and DNA, Physico- chemical properties of nucleic acids - effect of alkali, acid and heat (denaturation and renaturation), features of phosphodiester bond, endonucleases. Complementary base pairing, secondary structure of RNA, features of DNA double helix (Watson-Crick model), Nucleoproteins – histone and nonhistone. Isolation of nucleic acids and sequencing.

Unit – III 13 hrs

3. Genetic material:

Experimental proofs; Genome organization- from nucleotide to chromatin; the versatility of RNA. Basic features of DNA replication in vivo: semi - conservative replication, bidirectional replication-visualization of replication forks by autoradiography, unique origins of replication, DNA polymerases and DNA synthesis in vitro: Discovery of DNA polymerases, multiple DNA polymerases; the complex replication apparatus: semi- discontinuous synthesis, replication initiation, elongation and termination- Enzymology, outline of DNA replication in eukaryotes. 9 hrs

4. Mutation:

Mutagens – chemical and physical, Molecular basis of mutation: spontaneous and induced mutations. Types of mutation, reversion and suppression, DNA repair mechanisms- repair systems, direct (photoactivation), excision repair – base excision and nucleotide excision repair. 4 hrs

Unit - IV 13 hrs

5. Transcription:

Transfer of genetic information: the central dogma, RNA polymerases, different types of RNA polymerases, promoters, regulatory elements, constitutive and inducible promoter, operators. Initiation (role sigma factor), elongation and termination (rho dependent and independent); regulation of gene expression in prokaryotes: positive and negative control using lac operon as an example, attenuation: trp opero. Overview of eukaryotic transcription, post transcriptional processing: capping, splicing and polyadenylation. 8 hrs

6. Translation:

Genetic code– features; Translation machinery– ribosomes, composition and assembly. Translation - overview, mechanism, isoaccepting tRNA, wobble hypothesis, outline of translation in eukaryotes. Inhibitors of translation. 5 hrs

Biochemistry Practical-VI

3 hrs / wk

List of experiments:

1. Determination of total activity of α/β amylase
   a) Standard curve for maltose
   b) Determination of rate of amylase activity
2. Determination of optimum temperature for α/β amylase
3. Determination of optimum pH for α/β amylase
4. Determination of total activity of acid phosphatase
   a) Standard curve for p-nitro phenol
   b) Determination of rate of acid phosphatase activity
5. Determination of optimum temperature for acid phosphatase
6. Determination of optimum pH acid phosphatase
7. Determination of total activity Urease
   a) Standard curve for ammonium sulfate
   b) Determination of rate of Urease activity
8. Determination of optimum temperature for Urease
9. Determination of optimum pH Urease
10. Estimation of DNA by Diphenylamine method

B.Sc. Biochemistry – Sixth Semester

Biochemistry-VII 52hrs

Unit – I 13 hrs

1. Introduction to metabolism and Carbohydrate metabolism:
Definition, phases of metabolism, Anabolism and Catabolism- definition, schematic representation of metabolism. Glycolysis; definition, individual reactions with energetic. Irreversible reactions/ATP dependent reactions. Substrate level phosphorylation reactions of glycolysis. Net reaction of glycolysis. Entry of lactose, sucrose and glycogen into glycolysis. Fate of pyruvate- formation of Acetyl-CoA, Ethanol and Lactate. Stoichiometry and energetics of Glycolysis. Regulation of Glycolysis. TCA cycle- Individual reactions. Net reaction of TCA cycle. Number of ATP molecules production. Functions of TCA cycle- Amphibolic roles (Anapleorosis). Regulation of TCA cycle, energetics of TCA cycle. Pentose phosphate pathways (PPP/ HMP)- Significance , reactions. Gluconeogenesis- Definition and significance, flow chart for gluconeogenesis. CORI cycle-explanation, diagram, purpose. Substrate level phosphorylation (SLP) from TCA cycle. Glycogen metabolism- Glycogenolysis- definition, reactions. Glycogenesis- definition, reaction, Cori-diseases. Regulation of blood glucose level; role of Insulin and Glucagon.

Unit - II 13 hrs

2. Lipid metabolism:
β-oxidation of saturated fatty acids; individual reactions, enzymes, coenzymes. Energetics of β-oxidation of palmitic acid and stearic acid (one to be worked in the class room and remaining two may be given as home assignment), role of carnitine, Oxidation fatty acids-with odd number of carbon atoms, fate of propionyl coA, oxidation of unsaturated fatty acids. Fatty acid synthetases; structure and functions. Biosynthesis of fatty acids-general flow chart, fatty acid oxidation v/s fatty acid synthesis.Cholesterol- structure and functions. cholesterol biosynthesis-(chemical reactions up to the formation of mevalonate, remaining reactions may be given as flow scheme). Regulation of cholesterol biosynthesis. Atherosclerosis-cause, blood cholesterol levels (mentioning). Ketone bodies-cause for the production. Ketogenesis-reactions, utilization, over production (ketosis).

Unit – III 13 hrs

3. Amino acid metabolism:
General reactions- transamination- definition, reactions catalyzed by SGOT and SGPT, importance of transamination; Deamination - definition, oxidative and non-oxidative, examples for oxidative deamination- L-glutamate and non-oxidative- serine, aspartic acid and glutamine. Decarboxylation - definition, decaboxylation of glutamic acid, Histidine. Urea cycle- individual reactions, importance of urea cycle, hyperammonemia, regulation of urea cycle. Interrelationship between urea cycle and TCA cycle. Biosynthesis of glycine from serine and choline. Biosynthesis of alanine from transamination reaction. Biosynthesis of cysteine from L- serine. Epinephrine and Nor-epinephrine- importance and biosynthesis from tyrosine. Histamine; biological importance and synthesis. PKU and AKU characteristic features, metabolic reasons. 8 hrs

4. Nucleic acid metabolism: Biosynthesis of purine and pyrimidine nucleotides- sources of nitrogen and carbon atoms of purine and pyrimidine ring. Precursors of purine and pyrimidine

biosynthesis. Reactions involved in the biosynthesis. Conversion of nucleotides to deoxynucleotides. Orotic acid uria- general features. Gout; general features. 5 hrs

Unit - IV **13 hrs**

5. Photosynthesis:

Photosynthetic pigments and Photosynthetic unit. Light reactions – photosystem- I and II and their interactions. Synthesis of NADPH, photolysis of water, synthesis of ATP in cyclic and non-cyclic photophosphorylation. Dark reactions - chemical reactions upto the synthesis of fructose-6-phosphate. Trans- ketolation and aldolation reactions (shall be given in the form of flow chart). Interdependence of light and dark reactions. C_3 and C_4 plants- definition and C_4 pathway (HSK pathway). Bacterial photosynthesis. 10 hrs

6. Biological Nitrogen Fixation:

Nitrogen cycle, components of nitrogenase complex, stoichiometry of nitrogen fixation, nif genes. 3 hrs

Biochemistry Practical-VII

3 hrs / wk

List of experiments:

1. Estimation of protein by FC method
2. Estimation of Iron using ammonium thiocyanate by Colorimetric method
3. Colorimetric Estimation of Inorganic Phosphate by Fiske Subbarow method
4. Colorimetric Estimation of Creatine and Creatinine by Jaffe's metod
5. Colorimetric Estimation of Lactose in milk by D.N.S method
6. Estimation of amino acid (alanine/glycine) using ninhydrin by colorimetric method
7. Estimation of serum cholesterol by Zak's method
8. Extraction of DNA from onions
9. Conductometric titration of amino acid against NaOH.
10. Conductometric titration of amino acid against HCl

B.Sc. Biochemistry – Sixth Semester

Biochemistry -VIII **52 hrs**

Unit - I **13 hrs**

1. Industrial Microbiology:

Principles and methods of sterilization; physical chemical, filtration, UV- radiation, ultrasonic methods with example. Isolation of pure cultures; enrichment, dilution-plating, streak- and spread-plate and micromanipulations. Preservation of microorganism, sub-culturing, lyophyliztion.

Microbial growth kinetics; growth curve, kinetics in batch, continuous and fed-batch culture. Measurement of growth (cell count), immobilization of microbes.

Use of microorganisms in fermentation, strain improvement strategies. Fermentation Technology; design of fermentors, types, media inoculation. Fermentation types; single, batch, submerged and solid state. Production of ethanol, Glycerol, Citric acid, Penicillin and biofuels by microbial fermentation. Single cell proteins (SCP) definition and production.

Unit - II **13 hrs**

2. Molecular and Immunological techniques:

Blotting techniques: principle and applications of Western, Southern and Northern blotting; Molecular biology techniques: PCR- types, principle, applications; Hybridization techniques-types and applications. Fluorescent In situ Hybridisation (FISH), microarrays, Immunochemical techniques: principle and applications of Precipitation, agglutination, Immunodiffusion; Immunoelectrophoresis, RIA and ELISA. Autoradiography; principle and applications.

Unit - III

13 hrs

3. Immunology:

Organs and cells of Immune system - Primary and secondary Lymphoid organs, Characteristic and features of monocytes, granulocytes, mast cells and dendrite cells. Immunity– Definition, Types, Innate immunity – Mechanism of immune response anatomic, physiological, phagocytic and inflammatory barriers. Adaptive immunity cell mediated and humoral immunity –Mechanism of immune response. Complement system **–** Definition**,** functions, classical, alternate and lectin pathways. Antigens **-** Chemical nature of antigens, hapten, antigenicity, immunogenicity, epitope.

Immunoglobulins - History, Isotypes, structures and functions IgG, IgM, IgE. Methods of raising antibodies –adjuvants, immune sera, IgG fraction. Monoclonal antibodie – definition and production. Major histocompatibility complex proteins (MHC): Definition. Types, physiological role, Antigen processing and presentation. Vaccines**-** classification, methods of production of live, attenuated and toxoids, modern vaccines – recombinant and peptide vaccines Hyper sensitivity reactions- definition, types and examples, Type-I HS reaction and its mechanism.

Unit – IV **13 hrs**

4. Recombinant DNA Technology and Genetic Engineering:

Tools of Recombinant Technolog – Genetic engineering; definition, gene cloning-definition, use of DNA polymerase, restriction endonuclease, ligase and other DNA modifying enzymes in cloning. Cloning vectors- definition, characteristic features of plasmid vectors (pUC18, pBR322), features and advantages of cosmids, phage and yeast artificial chromosome. Outline of the methods of producing recombinant DNA. Cloning hosts - features of an ideal host (*E.coli*). Transformation - types, selection of transformants by colony hybridization, insertional inactivation and blotting. Gene libraries and cDNA libraries- outline of their construction and uses.

Biochemistry Practical-VIII

3 hrs / wk

List of experiments:

1. Determination of energy of activation for hydrolysis of Methyl acetate.
2. Determination of pKa value of acetic acid by pH metric titration.
3. Determination of pKa value of amino acid (glycine) by pH metric titration.
4. Preparation of microbial culture media and sterilization.
5. Gram staining and endospore staining.
6. Isolation of microorganisms from fermented foods (Demonstration)
7. Alcoholic fermentation of fruit juice. (Demonstration)
8. Identification of antigen by Ouchterlony Immunodiffussion technique.
9. Immunoelectrophoresis of serum or any biological sample.
10. Restriction digestion of DNA and separation by agar-gel-electrophoresis.

List of References for all the Semesters

A. For Theory component:

1. Chemistry- An Introduction to General, Organic and Biological Chemistry, VII Ed., (1999), Karen C. Timberlake, Benjamin/Cummings
2. Introduction to Biophysical Chemistry, Bruce Martin.
3. Physical Chemistry of Macromolecules, C. Tanford.
4. Stereochemistry of Carbon Compounds, Eliel(1977) Tata-McGrawHill.
5. Organic Mechanisms, Peter Sykes (1977), Longman
6. Inorganic Biochemistry, G.L. Eichhorn (1973) Elsevier.
7. Guide Book to Mechanisms in Organic Chemistry, Peter Sykes, 6th Ed., (1986), Longman
8. Introduction to Ecotoxicology, Ed. D.W. Connell, (2000) Blackwell Scientific
9. Molecular Pharmacology, ed. T. Kenakin, (1997), Blackwell Science Inc.
10. Molecular Cell Biology Baltimore et al., (1995) Scientific American Publication.
11. Analytical Biochemistry; D.J.Holme and H. Pick,(1983) Longman.
12. Instrumental Analysis in the Biological Sciences, M.H.Goxdon, R. Macrae (1987), Blackie & Sons.

13. Molecular Biology; Current Innovations and Future Trends; Griffin and Griffin, (1995), Horizon Scientific Press.
14. Molecular Biology and Biotechnology; Walker J.M. and Gingold E.B. [Eds.] (1992) Royal Society of Chemistry , London.
15. Practical Biochemistry; Principles and Techniques; K. Wilson and J. Walker (1995), Cambridge University
16. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
17. Biochemistry; Voet , D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.
18. Molecular Biology of the Cell, Alberts et al., (1989) 2nd Edn.Garland Publications
19. Principles of Biochemistry; Lehninger et al., [Eds.] (1997) 2nd Edn. Worth Publishers.
20. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
21. Text Book of Biochemistry with Clinical correlations; Thomas Devlin [Ed.] (1997), Wiley-Liss.
22. Principles of Enzymology for Food Sciences; Whitaker, Marcel Dekker (1972) Academic Press.
23. Basic and Clinical Immunology; Stites et al., [Ed.] (1982) Lange.
24. Roitt's Essential Immunology; Ivan, M. Roitt & Peter J Delves (2001) Blackwell Science
25. Principles of Nutrition by M.S Swaminathan
26. Principles of Nutrition by Dr.C. Gopalan.
27. Human Nutrition and Dietetics by Davidson and Passmore; 8th edition (1986)
28. Modern Nutrition and Health disease by M.E. Skillis and V.R. Young
29. Human Physiology by CC. Chatterjee, 11th edition (1985)
30. Essentials of Medical physiology by K Sambulingam, 3rd edition, 2005

B. For practicals:

1. Text book of Clinical Chemistry- Teitz
2. Clinical chemistry in Diagnosis and Treatment by P.D Mayne/ Arnold. New Delhi
3. Medical Laboratory technology- Kanai L. Mukherjee, Tata Mc Graw Hill Publication and Co. Ltd; Vol I, II, III
4. Practical Clinical Biochemistry- Harold Varley CBS, New Delhi
5. Medical Laboratory Science, theory and practice. J. Ochei & A. Kolhakar, Tata Mc Graw Hill.
6. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill
7. Lab manual of Biochemistry, Immunology and BioTechnology, Artinigam and Archana Ayyagiri -- Tata Mc Graw Hill.

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