Education to Excel

SBRR MAHAJANA FIRST GRADE COLLEGE (Autonomous)

Jayalakshmipuram, Mysuru – 570 012 Karnataka, INDIA

Affiliated to University of Mysore

Re-accredited by NAAC with 'A' Grade, College with Potential for Excellence

UG ☑ **PG** ☐

Syllabi of I and II Semester

B.Sc. – Biochemistry

Choice Based Credit System - 2019

Credit Pattern for Courses

L: Lecture; T: Tutorial; P: Practicals

Sem	Type	Course	L + T + P = Tot.
I	DSC	Chemistry of Biomolecules	**4 : 0 : 02 = 6**
II	DSC	Bio-Organic chemistry and Biomolecules-I	**4 : 0 : 02 = 6**
III	DSC	Biomolecules – II and Enzymology	**4 : 0 : 02 = 6**
IV	DSC	Metabolism and Human Physiology	**4 : 0 : 02 = 6**
V	DSE	**No. of courses 1** DSE 1 - Nutrition DSE 2 – Molecular Basis of Infectious Diseases	**4 : 0 : 02 = 6**
	SEC	**No. of courses 1** SEC 1 - Biochemical Techniques SEC 2 – Protein Purification techniques	**2 : 0 : 0 = 2**
VI	DSE	**No. of courses 1** DSE 1 - Molecular Biology and Immunology DSE 2 – Plant Biochemistry	**4 : 0 : 02 = 6**
	SEC	**No. of courses 1** SEC 3 - Bioinformatics SEC 4 – Clinical Biochemistry	**2 : 0 : 0 = 2**

Credit means the unit by which the course work is measured. One hour session of Lecture or Tutorial per week for 16 weeks amounts to 1 credit. Two hours session of practical's per week for 16 weeks amounts to 1 credit per semester.

Biochemistry (DSC): CHEMISTRY OF BIOMOLECULES

Course duration: 16 weeks with 4 hours of instruction per week.

PART-A: BIO INORGANIC CHEMISTRY (25 hrs)

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 and 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 and 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 (23hrs)

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 and unique properties of water. Water as reactant.

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 Ostwalds'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, and 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 (16 hrs)

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 rearrangement) with two examples for each. Concepts of the following – carbanions, carbocations, free radicals, carbenes, nucleophiles and electophiles (Formation and Stability).

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References:

- Arun Bahl and B.S.Bahl, Tuli G D., Essentials of Physical Chemistry, S.Chand & company Ltd.
- Barrow G M (2007), Physical Chemistry, Tata McGraw-Hill, India.
- Beedu Sashidar Rao and Vijay Despane, Expermental Biochemistry, IK International Pvt. Ltd.
- Castellan W (2004), Physical Chemistry 4th Edn., Narosa, India.
- Chatwal G R. and Bhagi A K, Inorganic chemistry, Himalya Publishing house.
- Conn E E and Stumpf P K, Outlines of Biochemistry (1976), Wiley Eastern, New Delhi.
- Cotton F A and Wilkinson G, Basic Inorganic Chemistry.
- David T Plummer, An introduction to practical Biochemistry.
- Dayananda R.S, Biochemistry (Photochemistry).
- Douglas, Mc Daniel and Alexader, Concepts and Models in Inorganic Chemistry, JohnWiley.
- Indira L &.Chatwal G R , College Chemistry Vol II.
- J.L Jain, Fundamentals of Biochemistry, S.Chand & company Ltd.
- James E, Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Publication.
- John A Timbell, Principles of Biochemical Toxicology.
- John Wiley, Puri, Pathan and Sharma, PhysicalChemistry.
- Lee J D, A new Concise Inorganic Chemistry, E L. B. S.
- Lehninger A L, Principles of Biochemistry (1982), Worth Publishers, Inc, NewYork.
- Pattabhi Vand Gautham N(2002) Biophysical Chemistry. Narosa Publishing House, India.
- Sathyanarayana U, Biochemistry, Books and Allied (P) Ltd. Kolokatta.
- Stryer L, Biochemistry (1995), W.H Freeman Press, San Francisco, USA.
- Tewari K S and Vishnoi N K, Text book of Organic Chemistry, 3rd Edn.
- Voet D and Voet J G (2004), Biochemistry,3rd Edn., JohnWiley & Sons, Inc.USA.

Biochemistry (DSC) Practical 1

Course duration: 16 weeks with 4 hours of lab work per week

VOLUMETRIC ESTIMATIONS

1. Concept of good lab practices: Safety, Glassware handling,chemical handling and chemical waste management.
2. Use of analytical balance and weighting.
3. Calculation, preparation of normal, molar and percentage solutions.
4. Calibration of volumetric glasswares (Burette, pipette and measuring cylinder).
5. Preparation of standard Sodium carbonate solution, standardization of HCl(Methyl orange) and estimation of NaOH in the given solution. (methyl orange or phenolphthalein).
6. Preparation of standard Oxalic acid, Standardization of NaOH and estimation of H_2SO_4 in the given solution (phenolphthalein).
7. Preparation of standard Oxalic acid, Standardization of $KMnO_4$ and estimation of H_2O_2 in the given solution.
8. Preparation of standard $K_2Cr_2O_7$, Standardization of $Na_2S_2O_3$ and estimation of $CuSO_4$ in the given solution.
9. Preparation of $ZnSo_4$, Standardization of EDTA and estimation of total hardness of water using Eriochrome black-T indicator.
10. Preparation of standard potassium bipthalate, Standardization of NaOH and estimation of HCl in the given solution. (Phenolphthalein).
11. Preparation of standard oxalic acid solution, Standardization of NaOH solution and estimation of acidity in vinegar.
12. Preparation of standard potassium biphthalate solution,Standardization of sodium hydroxide solution and estimation of alkalinity of antacids.
13. Determination of rate constant of decomposition of H_2O_2 using $KMnO_4$.
14. Determination of density and viscosity of the given liquid using specific gravity bottle and Ostwald's viscometer.
15. Demonstration: Determination of miscibility temperature by water-phenol system.

Biochemistry (DSC): BIO ORGANIC CHEMISTRY AND BIOMOLECULES– I

Course duration: 16 weeks with 4 hours of instruction per week.

PART-A: BIO ORGANIC CHEMISTRY (50 hrs)

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 : Malic and Fumaric acid.
c) Ketoacids : Pyruvic, α-Ketoglutaric, Oxalo acetic acid.

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, Isolation, structure, occurrence and biological importance of **:**

a) Monoterpene –Menthol and Camphor.
b) Sesquiterpenes – Farnesol
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), ecdysone, testosterone, aldosterone and 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)

Carbohydrates:

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

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 and Osazone tests.

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References

- Arun Bahl and Bahl B S, Advanced Organic Chemistry, S. Chand Publications.
- Beedu Sashidar Rao and Vijay Despane, Expermental Biochemistry, IK International Pvt. Ltd.
- Conn E E and Stumpf P K, Outlines of Biochemistry (1976), Wiley Eastern, New Delhi.
- David T Plummer, An introduction to practical Biochemistry.
- Deb A C, TextBook of Biochemistry.
- Dr. Shuklal S P and Dr. Trivedi G L, Text book of Modern Organic Chemistry.
- Finar L, Organic Chemistry (Vol.I & II), E. L. B. S.
- Indira L &.Chatwal G R ,College Chemistry Vol II.
- Jain J L, Fundamentals of Biochemistry, S.Chand and company Ltd.
- Lehninger A L, Principles of Biochemistry (1982), Worth Publishers,Inc, NewYork.
- Morrison R. T and Boyd R. N, Organic Chemistry, Prentice Hall.
- Ramakrishnan and Vasudevan D M, Text Book of Medical Biochemistry.
- Sathyanarayana U, Biochemistry, Books and Allied (P) Ltd. Kolokatta.
- Stryer L Biochemistry (1995), W.H. Freeman Press, San Francisco, USA.
- Supratha Sen and Gupta, Organic Chemistry, Oxford University Publishers.
- Tewari K S and Vishnoi N K, Text book of Organic Chemistry, 3rd Edn.
- Text book of Biochemistry with Clinical Correlations (2011), 7th Edn.,Devlin, John Wiley and Sons,Inc.(New York)
- Voet D and Voet J G (2004), Biochemistry,3rd Edn., JohnWiley & Sons, Inc.USA.

Biochemistry (DSC) Practical 2

Course duration: 16 weeks with 4 hours of lab work per week

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 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.

Description of the paper

Sem	Type	Course	L + T + P = Tot.
1	DSC	Chemistry of Biomolecules	**4 : 0 : 02 = 6**
2	DSC	Bio Organic chemistry and Biomolecules-I	**4 : 0 : 02 = 6**
3	DSC	Biomolecules – II and Enzymology	**4 : 0 : 02 = 6**
4	DSC	Metabolism and Human Physiology	**4 : 0 : 02 = 6**
5	DSE	**No. of courses 1** DSE 1 - Nutrition DSE 2 – Molecular Basis of Infectious Diseases	**4 : 0 : 02 = 6**
	SEC	**No. of courses 1** SEC 1 - Biochemical Techniques SEC 2 – Protein Purification techniques	**2 : 0 : 0 = 2**
6	DSE	**No. of courses 1** DSE 1 - Molecular Biology and Immunology DSE 2 – Plant Biochemistry	**4 : 0 : 02 = 6**
	SEC	**No. of courses 1** SEC 3 - Bioinformatics SEC 4 – Clinical Biochemistry	**2 : 0 : 0 = 2**

Scheme of Valuation for Practicals
Biochemistry (DSC) Practical -1

C1 and C2 are to be conducted during 8th and 16th weeks respectively of the semester. C3 is the semester-end examination conducted for 3 hours. The student will be evaluated on the basis of skill, comprehension and recording the results.

The student has to compulsorily submit the practical record during C1 and C2. For C3, Students must submit completed practical records duly signed by batch teachers and certified by HOD.

- The student is evaluated for 10 marks in C1 and C2 as per the following scheme: Experiment: 10.

  The marks scored is then normalised for 5.

- The student is evaluated for 40 marks in C3 as per the following scheme:

Heading	Marks
Experiment	35
Record	05
Total	40

The student is evaluated for 40marks as per the following scheme.

A. Procedure writing - 09Marks
B. Minor experiment – 06Marks
C. Major experiment – 20Marks
D. Record - 05 Marks

A. Procedure writing - 09Marks (Procedure writing is given for any one of the following experiments)

1. Determination of rate constant of decomposition of H_2O_2 using $KMnO_4$ by volumetric analysis method.
2. Determination of density and viscosity of the given liquid using specific gravity bottle and Ostwald's viscometer.
3. Determination of miscibility temperature by water-phenol system.
4. Preparation of $ZnSo_4$. Standardization of EDTA and estimation of total hardness of water using Eriochrome black-T indicator.

Assessment (First 15min. is given for writing the procedure)

Principle: 2marks

Procedure:07marks

B. Minor experiment – 07marks

Two Problems for calculation of normal, molar and percentage solution is given. Molecular weight/equivalent weight is to be specified.

C. Major experiment – 20Marks (volumetric analysis)

One of the following experiment is to be given for conducting (principle, reaction, tabular column and calculation part is to be written)

1. Preparation of standard Sodium carbonate solution, standardization of HCl(Methyl orange) and estimation of NaOH in the given solution. (methyl orange or phenolphthalein).
2. Preparation of standard Oxalic acid, Standardization of NaOH and estimation of H_2SO_4 in the given solution (phenolphthalein).
3. Preparation of standard Oxalic acid, Standardization of $KMnO_4$ and estimation of H_2O_2 in the given solution.
4. Preparation of standard $K_2Cr_2O_7$, Standardization of $Na_2S_2O_3$ and estimation of $CuSO_4$ in the given solution.
5. Preparation of standard potassium bipthalate, Standardization of NaOH and estimation of HCl in the given solution. (Phenolphthalein).
6. Preparation of standard oxalic acid solution, Standardization of NaOH solution and estimation of acidity in vinegar.
7. Preparation of standard potassium biphthalate solution, Standardization of sodium hydroxide solution and estimation of alkalinity of antacids.

Assessment of experimental results:

Principle and Reaction: 03marks

Preparation of standard solution: 04marks

Preparation: 3marks
Calculation of normality: 1marks

Standardization: 6marks

Estimation: 7marks

Discrepancy	Standardization	Estimation
0-0.2ml	5m	6m
0.3-0.4ml	4m	5m
0.5-0.6ml	3m	4m
Above 0.6ml (any other value)	2m	3m
Calculation **Normality and Weight/litre**	1m	1m

Biochemistry (DSC) Practical -II

Part –A: Qualitative analysis of the organic compound.
Part –B: Qualitative analysis of Carbohydrate.
Part –C: Procedure writing for Organic Preparation.

Part –A: Qualitative analysis of the organic compound (16 marks)

1. Preliminary test - 1marks
2. Detection of elements - 3marks
3. Solubility tests - 3marks
4. Functional group tests (minimum two tests) - 4marks
5. Determination of physical constant - 2marks
6. Naming the compound and structure -2 marks
7. Preparation of solid derivative - 1marks

Part –B: Qualitative analysis of Carbohydrate (15 marks)

Candidates may be given carbohydrate sample for identification (Glucose, Fructose, Maltose and Lactose).

Assessment of Experimental results:

1. Identification of class of biomolecule (Molisch Test) :02
2. Reducing tests: any three :06
3. Distinguishing test between mono and disaccharide :02
4. Distinguishing test between aldoses and ketoses :01
5. Preparation of osazone and identification :03
6. Structure of monosaccharides :01
7. Structure of disaccharide**s** :02

Part –C: Procedure writing for Organic Preparation. (4 marks)

One of the following experiments is to be given for Procedure writing

1. Aspirin from salicylic acid.
2. Benzoic acid from benzaldehyde.
3. para-bromo acetanilide from acetanilide.
4. meta-dinitrobezene from nitrobenzene.

Question Paper Pattern
DSC Courses

Maximum Marks – 80 **Duration: 3 hours**

Instructions: Answer any TEN questions from Part A and any SIX questions from Part B.

Part -A **2 x 10 = 20**

1. a.
   b.
   c.
   d.
   e.
   f.
   g.
   h.
   i.
   j.
   k.
   l.

Part –B **6 x 10 = 60**

2. a.
   b
3. a.
   b.
4. a.
   b.
5. a.
   b.
6. a.
   b.
7. a.
   b.
8. a.
   b.
9. a.
   b.

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NOTE: Ten marks questions may be divided in to 6+4 or 5+5 or 3+3+4