SYLLABUS FOR M.Sc. BIOCHEMISTRY

ENTRANCE EXAMINATION FOR THE YEAR 2017-18

UNIT-I: BIO-INORGANIC CHEMISTRY AND BIO-PHYSICAL CHEMISTRY

Bio-inorganic chemistry

1. Coordination Compounds:

Tansition metals, properties (Colour, Oxidation states, Magnetic Properties). Coordinate bond, double and complex salts – differences with examples. Postulates of Werner's theory. Type of ligands, uni, bi and polydenate with examples. Coordination number. Porphyrin nucleus and classification. Important metallo porphyrins occurring in nature, structure and their biological importance (Hb, cytochrome, chlorophyll, Vit-B12). Bile pigments chemical nature and their role.

2. Radiochemistry:

Natural and artificial radioactivity. Characteristics of radioactive elements, units of radioactivity, disintegration constant, half life, alpha, beta and gamma radiations. Detection of radioactivity by GM counter. Application of radioisotopes – ^{3}H, ^{14}C, ^{131}I, ^{60}CO, ^{32}P. Biological effect of radioactivity. Safety measurements in handling radio isotopes.

3. Nitrogen:

Fixation of atmospheric nitrogen – symbiotic and non – symbiotic. Nitrogen cycle, environmental pollution by nitrogen compounds.

4. Phosphors:

Importance of phosphorus compounds in biological system, phosphorus cycle.

5. Oxygen:

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

6. Sulphur and Selenium:

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

7. Biochemistry Toxicology:

Toxicity of Lead, Mercury, Cadmium and Arsenic.

Bio-physical chemistry

1. Concentration Units:
Avagadro's number, Mole, Mole fraction, Molarity, Equivalent weight, Normality, and Molality.

2. Collegative properties:
Osmotic pressure and its measurement by Berkely-Hartley method. Laws of osmotic pressure, Hypo, Hyper and iostomic solution. effect of osmotic pressure on living cells. Donnan membrane equilibrium. Relative lowering of vapour pressure, Roult's law. Elevation of boiling point, depression of freezing point and their application in determination of molecular weight. Abnormal molecular weight, Van't Hoff's factor. Degree of association and dissociation.

3. Adsorption:
Freundlich's and Langmuirs adsorption isotherm. Application of adsorption.

4. Viscosity:
Definition, determination of viscosity of liquids and solutions by Ostwald's viscometer.

5. Distribution Law:
Distribution law, partition coefficient applications of distribution law.

6. Acid, bases, and buffers:
Lewis concept of acids and bases. Ionic product of water. pH scale, buffers, Henderson-Hasselbach equation, buffer capacity. Preparation of acid and basic buffer solutions. Theory of acid base indicators. Choice of indicators. pH titration curve and isoelectric pH of aminoacids.

7. Electrochemistry:
Specific, equivalent and molar conductance. Reference electrodes (hydrogen electrode and calomel electrode). Quinhydrone electrode. glass electrode, determination of equivalent conductance of a strong electrolyte. conductrometric titration (strong acid against strong base, weak acid (amino acid) against NaOH) determination of pKa values of weak acids by potentiometric titration. Determination of pH of a buffer by potentiometric method using quinhydrone electrode.

8. Photochemistry:
Law of photochemistry, Quantum efficiency, light absorption, Beer-Lamberts law, spectrophotometer, colorimeter. Fluorescence, phosphorescence, chemiluminescencs, bioluminescence (Elementary treatment). Applications of UV-chemiluminescence spectra. Principle of IR spectra and its applications.

UNIT-II: BIO-ORGANIC CHEMISTRY- I

1. Introduction to Organic chemistry:
Classification of organic compound, Unique characteristics. IUPAC nomenclature of organic compounds.

2. Investigation of organic compounds:
Detection and quantitative estimation of element – nitrogen (estimation by Kjeldhl's methods), sulphur, phosphorus and halogens.

3. Reaction Mechanism:
Concept of inductive effects and resonance. Classification of organic reactions. (substitution addition, elimination and rearrangement). Concepts of the following – carbo-cations, free radicals, carbenes, nucleophiles and electrophiles.

4. Aliphatic Hydrocarbons:
Dienes – types with examples, 1,3 butadiene, preparation, stability, mechanism of addition of HBr, Diels – Alder reaction. Mechanism of Markownikoff and anti Markownikoff addition of HBr to propane. Conformational analysis of ethane.

5. Cycloalkanes:
Reactivities and relative stabilities. Bayer's strain theory. Sactise- Mohr theory. Boat and chair forms of cycloalkanes . Axial and equatorial bonds.

6. Arenes:
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 toulelne, chlorobenzene, nitrobenzene, and phenol Polynuclear hydrocarbons - Resonance structure of Naphthalene, Anthracene, Phenanthrene and Diphenyl. Reaction-oxidation and nitration of sulphonation of naphthalene and oxidation of Anthracene.

7. Alkyl halides and Organ metallic Compounds:
SN1 and SN2 reaction mechanism. Concept of elimination reaction example – n butyl chloride. Application of organometallic compounds, organo-lead, organo-lithium, cisplatin.

8. Alcohols:
Classification. Monohydric alcohols – distinguishing reaction of 1^{o} , 2^{o} and 3^{o} alcohol. Dihydric alcohol – Glycol, preparation and uses. Trihydric alcohol- Glycerol, synthesis from propane, properties (reaction with concentrated H_2SO_4, HNO_3, Oxalic and HI Ethanols – Acidity of phenols, effects of substation on acidity.

9. Stereochemistry:
Stereoisomerism, types, Fischer-projection formulae, asymmetric carbon atom, molecular dissymmetry, chirality, optical isomerism example: Glyceraldehydes, Lactic acid and Tartaric

acid. Nomenclature of enantiomers.D and L system, R and S system, Racemisation and resolution.

UNIT-III: BIOORGANIC CHEMISTRY- II

1. Hydroxy acid and dicarboxylic acid:

Structure and properties of: a) Hydroxyl acids: Lactic acid, citric acid and isocitric acid. b) Dicarboxylic acid: Maleic and fumeric acid. c) Keto acids: Pyruvic,α-ketoglutaric , oxalo-acetic acid.

2. Amines:

Classification, properties, amino functional groups. Basicity of amines, acylation. Reaction with HNO_2 and Schiff's base formation. Distinguishing reactions of primary, secondary and tertiary amines.

3. Heterocyclic compounds:

Occurrence, structural formula and importance of Furan, Pyrrole, Thiophene, Pyridine, Pyran, Thiazole, Pyrimidine, Purine, Indole, Imidazole, Quinoline and Isoquinoline.

4. Terpenes:

Isoprene rule, classification, structure, occurance and importance of; a) Mono terpenes - Limonene, Menthol and Camphor. b) Sesqui terpenes - Santonin, Juvenile Hormone-I and Absciscin –II. c) Di terpenes – Phytol. d) Triterpenes – Lanosterol. e) Tetra terpenes – Lycopine. f) Poly terpenes – Dolichols.

5. Steriods:

Basic ring system in steroid. Structure and biological importance of Cholesterol, Ergosterol, Bile Acids (Mono, Di, and Tricholic acid) and Ecdysone.

6. Alkaloids:

Definition, classification based on their biological functions with example. Structure and physiological action of LSD, Morphin, Nicotine, Atropine and Aristolochic Acid.

7. Vitamins:

Classification, water soluble and fat soluble. Structural formula and coenzyme forms of Vitamin B1, B2, B6 and Niacin. Vitamin C as a redox reagent, properties and chemical synthesis. Structural formula of vitamin A,D,E and K.

UNIT-IV: BIOMOLECULES

1. Carbohydrates:

Carbohydrates-Classification, Biological importance Monosaccharides: Configuration, relationship of D-Aldoses. General properties of Aldoses and Ketoses-oxidation, reduction, reducing property, formation of gycolipides, acylation, methylation, condensation-phenyl hydrazine, addition-HCN. Iterconversion 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 Diasterioisomers. Glucose: Elucidation of open chain structure and ring structure of glucose. Conformation of glucose(only structure).Mutarotation. Structure of Galactose, mannose, ribose and fructose. Structure and biological importance of amino sugars, deoxy sugars, deoxy sugars, sugar acids, neuraminic and muramic acid. Disaccharides: Establishment of structure of sucrose and lactose. Biological importance and structure of isomaltose, trehalose and maltose. Polysaccharides: Partial structure, occurrence and importance of starch, glycogen, insulin, cellulose, chitin and pectin.
Glycosaminoglycans: Occurrence, importance and structure of the repeating units of heparin, hyaluronic acid, teichoic acid and choritin sulphate. Bacterial cell wall polysaccharides, peptidoglycans.
Qualitative tests: Molish, Benedict's, Fehling's, picric acid, Barfoed's, Bial's, Selivanoff's, osazone tests.

2. Amino acids:
Structure and classification of amino acids based on polarity. Reactions of the amino groups with HNO_2, $LiAlH_4$. Ninhydrin, phenyl isothio cyanate, DANSYL chloride, flurodinitro benzene, Zwitterionic properties, pKa values. Reaction of carboxy group hydrazine. Any method for the chemical synthesis of amino acids. D and L notation.

3. Peptides:
Peptide bond, structure and biological importance of Glutothione, Valinomycin, Leuenkaphelin, synthetic peptides-poly glutamic acid, polylysine. Chemical synthesis of dipeptides.

4. Proteins:
Isolation, methods of purification-dialysis salting out, pH precipitation and solvent precipitation.
Classification of proteins based on solubility, structure and function with examples, colour reactions of proteins: Biuret, Xanthoproteic, Million's. Primary structure of proteins, methods of determining N- and C- terminal amino acids, amino acid composition, sequencing by Edman's degradation method. Secondary structure- α-Helix, β-sheet, β-bend. Tertiary and quaternary structure. 3 D structure of Hemoglobin, Denaturation and renaturation of proteins. Anfinsen's experiment.

UNIT-V: LIPIDS, NUCLEIC ACIDS & BIOCHEMICAL TECHNIQUES

1. Lipids:
Classification and biological role, Fatty acids- Nomenclature of saturated and unsaturated fatty acids. Physical and chemical reactions, esterification, rancidity, essential fatty acids. Aclglycerols: Saponification, saponification value, iodine value, acid value and significance. Phosphoglycerides: Structure of lecithin, cephalins, phosphotidyl inositol, plasmalogens and cardiolipin, biological role of phosphoglycerides.
Sphingolipids: Structure and importance of sphingomyelin.
Glycosphingo lipids: Structure and importance of gangliosides and cerebrosides.
Prostaglandins: Structure of PGE2 and PGF2, Biological roles of Thromboxane, Leukotrienes and Prostaglandins.
Plasma lipoproteins: Types and functions.

Biological membrane: Composition of membrane, Fluid mosaic model, functions of the plasma membrane – endocytosis, phagocytosis, membrane receptors and their functions.

2. Nucleic acids:

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

(b) RNA: composition, types (mRNA, tRNA and rRNA). Secondary structure of tRNA – clover leaf model. Chemical reactions of RNA and DNA with acid and alkali. Color reactions of RNA and DNA.

3. Biochemical techniques:

General principles and procedures of chromatography – adsorption and partition. Techniques: Paper chromatography – Ascending, descending and circular. 2D chromatography, Rf values, column chromatography, principles and procedures of gel filtration, ion exchange chromatography, affinity chromatography. TLC and their applications. Principles and procedures of electrophoresis, paper and gel electrophoresis.

Centrifugation – Principle of differential centrifugation. Ultra centrifuge – construction and applications.

UNIT-VI: ENZYMOLOGY

1. Enzymes:

General characteristics, co-factors, co-enzymes and metal ions. Classification of enzymes based on IUB with examples. Unit of enzyme activity – 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 substrate concentration, pH, temperature.

Michaelis-Menten equation. Lineweaver-Burk (L-B) plot. Determination of Vmax and km from L-B plot and their significance.

Allosteric properties – Sigmoidal curve, positive and negative modulators with PFK as an example.

2. Isoenzymes and multienzyme complex:

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

Multi enzyme complex – pyruvate dehydrogenase complex – composition, subunits, assembly, enzymatic reactions functions.

RNA as an enzyme (Ribozymes)

UNIT-VII: METABOLISM

1. Metabolism:
Anabolism, catabolism, stages. Compartmentalization of metabolic pathways.

2. Bioenergetics:
Laws of thermodynamics, first and second law. Concept of enthalpy, entropy and free energy. Standardized free energy. Endergonic and exergonic reaction. Coupled reactions. High energy compounds – structure of ATP and its free energy change during hydrolysis, other high energy compounds.

3. Biological oxidation:
Ultra structure of mitochondria, Electron Transport Chain, Electron transport complexes. Complex I, II, III and IV. Uncouplers and inhibitors of respiration (Rotenone, Actinomycin D, Cyanide and 2, 4 DNP)
Oxidative phosphorylation, P/O ratio. Formation of ATP- Outline of Mitchell's hypothesis. Substrate-level phosphorylation with examples.

4. 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 lactate, alcohol and acetyl Co-A. Citric acid cycle and its energetic. Amphibolic integrating roles of TCA cycle. Anaplerosis. Pentose phosphate pathway and its significance. Cori cycle. Gluconeogenesis.

5. Lipid metabolism:
Oxidation of fatty acid: α, β and ω types. B-oxidation of even number saturated fatty acids. Energetic of β-oxidation. Biosynthesis of even number fatty acids, Ketone bodies formation. Outline of cholesterol biosynthesis.

6. Metabolism of Amino Acid:
General reaction of amino acid degradation- Transamination, deamination and decarboxylation. Ketogenic and glucogenic amino acids. Urea cycle and its significance.

UNIT-VIII: MOLECULAR BIOLOGY, GENETIC ENGINEERING & IMMUNOLOGY

Molecular Biology

1. Degradation of Nucleic Acid:
Degradation of nucleic acid by DNase and RNase and phosphodiesterase. Schematic pathway for degradation of purines and pyrimidines (salvage pathway). Central dogma of molecular Biology and its modification. DNA as a genetic material

2. Replication of DNA:
Semi conservative mechanism. Meselson and Stahl experiment. Mechanism of Replication of prokaryotic

3. Prokaryotic RNA Synthesis:
Role of RNA polymerase Initiation, elongation and termination. Reverse transcription.

4. Genetic code:
General features, Wobble hypothesis.

5. Prokaryotic Protein Biosynthesis:
Activation of Amino acids, Amino acyl tRNA synthesis. Initiation, elongation and terminationof protein synthesis.

6. Mutations:
Concept f mutation and mutagens: effect of HNO_2, alkylating agents, intercalating agent and UV-radiation. Concept of missense, nonsense, point mutation, frame shift mutation.

7. Concept of gene:
1) Gene expression in prokaryotes- concept of Lac operon. 2) Functional units in a typical eukaryotic gene-promotors, introns and exons.

Genetic Engineering

1. Historical aspects:
Historical development, aim and scope of genetic engineering

2. Isolation of Nucleic acids:
Isolation of DNA, cutting of DNA by restriction endonuclease: staggered and blunt end cuts.

3. Techniques:
Outline of Techniques of Genetic Engineering Cutting genomic DNA, Separation of fragments by agarose gel electrophoresis. Vector, plasmid: pBR^{322}, insertion of foreign DNA into Vectors. Transfection of vectors into host cells. cDNA principles of polymerase chain reaction and application.
Blotting Techniques Principles and procedures of Southern and Northern blotting, Western blotting

4. Applications of Genetic Engineering:
Transgenic plants, transgenic animals and gene therapy. Human genome project

Immunology

1. Immunity:
Cellular and humoral immunity, cellular basis of immunity. Role of immunologically important organs and cells bone marrow, thymus, spleen and lymphocytes. Formation and function of T & B Lymphocytes and macrophages, Helper T-cells and killer T-cells.

2. Antigens:
Definition, Haptenes, Epitopes, Antigens, Antigenicity.

3. Antibodies:
Definition types and structure of a typical immunoglobulin (IgG-Light chain, heavy chain, hyper-variable region, constant domains, Fab and Fc).

4. Anigen:
Anigen – Antibody reaction *in vitro*. Formation of Antigen-Antibody complex. Application of immune diffusion, RIA, ELISA.

5. Immunization:
Vaccination – vaccines and their preparations, Primary and secondary response.

6. Immunological disorders:
Allergy (hyper sensitivity reactions) – Types, AIDS-HIV virus structure, mode of transmission, mechanism-role of reverse trancriptase, clinical features, diagnosis, treatment.

UNIT-IX: HUMAN PHYSIOLOGY AND CLINICAL BIOCHEMISTRY

Human physiology

1. Neurotransmission:
Type of neurons generalized structure of multipolar neuron. Resting membrane potential. Action potential, transmission of a nerve impulse along an axon and across a synapse. Neurotransmitters, Inhibitors of neuro transmitters.

2. Muscle:
Types of muscles and their structure. Ultrastructure of skeletal muscle. Contractile and regulatory proteins of muscle, sliding filament model of skeletal muscle contraction.

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

4. Excretory system:
Structure of the Nephron, formation of urine-glomerular filteration, tubular reabsorption and secretions.

5. Body Fluids:
Blood volume, composition and function. RBC, WBC and platelets, their structure 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.

6. Acid base balance:
Maintenance of normal pH of the body fluids. Blood buffers. Role of lungs and kidney in acid-base balance.

7. Endocrine system:
Endocrine organs, classification of hormones, Hierarchy, interplay and dynamic balance andregulation of hormone secretions. General mechanism of steroid hormone action. Mechanism of hormone action concept of second messengers. Examples: cAMP, DAG, IP3, G-Protein.

8. Liver:
Structure of lobules functions – metabolic storage and detoxification.

Clinical Biochemistry

1. Urine:
Normal composition of urine – volume, pH, colour, specific gravity. Constituents ; urea , uric acid, creatinine, pigments, abnormal constituents – glucose, albumin, ketone bodies, variations in urea, creatinine, pigments and their clinical significances in brief.

2. 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.

3. Liver function Tests:
Alkaline phosphatase, SGOT and SGPT Cardiac injury profile CPK and LDH

4. Inborn errors of Metabolism:
Sickle cell anemia, phenyl ketonuria, Nieman-pick disease.

UNIT-X: NUTRITION AND MICROBIOLOGY

Nutrition

1. Introduction:
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 food. Expenditure of energy during rest and work.

2. Carbohydrates:
Dietary sources, dietary fibres and protein sparing action.3. Proteins 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.

3. Fats:
Dietary sources of fats, invisible fat, essential fattyacids and their biological importance.

4. Vitamins:
Dietary sources, requirements, deficiency symptoms and biological role of water soluble vitamins – Thiamine, Riboflavin, Niacin, Pantothenic acid, Pyridoxine, Biotin, Folic acid, Vit.B12 and Vitamin C. Fat soluble vitamins – Vitamin A,D,E and K. Hypervitaminosis

5. Minerals:
Mineral metabolism of Ca, P, Fe, Zn, Cu, I

6. Water metabolism:
Distribution of water in body fluids. Factors influencing water metabolism.

7. Antinutritional factors:
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.

Microbiology

1. Study of Microorganisms:
Staining microorganisms – Principle and procedure of gram stain, acid fast stain.

2. Microbial nutrition:
Growth of microorganisms, measurement of growth factors influencing growth-nutrition, carbon source, nitrogen source. Temperature, pH and oxygen. Growth curve, phases of growth curve.

3. Industrial Microbiology:
Production and importance – Alcoholic beverage (Beer and Wine), Fermented products of milk, cheese, antibiotic production – penicillin, single cell protein – spirulina.

4. Antibiotics:
Definition, Mechanism of action of penicillin, streptomycin and chloramphenicol, antibioticresistance in brief.

5. Viruses:
Classification based on genetic material with examples. Plant viruses – TMV. Morphology,General characteristics and its replication.

6. Bacteriophages:
Morphology and general characteristics life cycle (Lysogeny and lytic cycle) of T evenbacteriophages.

ELIGIBILITY CRITERIA

1. The candidate should have studied B.Sc. with Biochemistry/Chemistry as a major/ optional.

2. The candidate shall have obtained a minimum of 45% (40% in case of SC/ST and Category I candidates) of marks in cognate/optional subjects put together from all the years of the examination of the course.

3. In case a candidate has taken longer than prescribed duration to pass the qualifying course, a deduction of 3% from the percentage of the aggregate of marks of cognate/optional subjects for every additional year shall be applied and the candidate should have obtained the minimum marks prescribed even after such deduction to become eligible for admission.

4. The candidate seeking admission to M.Sc. Biochemistry shall have to appear for Entrance examination.

5. The date of the Entrance Examination will be given in the prospectus, will be notified in the department notice board and also in the University web site.

6. The Entrance Examination shall be of 1 hr duration with 50 multiple choice questions of 1 mark each for a maximum of 50 marks.

7. The syllabus for the Entrance examination will be uploaded in the University web site.

8. The results of the Entrance examination will be announced in the Department Notice board and also in the University web site.

9. There shall be no provision for revaluation with respect to Entrance examination.

10. Entrance examination fee has to be paid through Demand Draft.

11. Fees paid for the Entrance examination is not refundable.

12. Marks list will be prepared by taking 50% of B.Sc. cognate/optional subject and 50% marks obtained from the Entrance examination.

13. The candidate list – selection list/waiting list will be announced in the department notice

board and also in the University web site.

14. Separate intimation will not be sent to the candidates.

15. Students from Foreign National degree will apply through equivalence committee.