Syllabus
For 6th Semester Courses in BIOCHEMISTRY
(June 2013 onwards)

Contents:
Syllabus (theory and practicals) for Courses:
S.BCH.6.01 Biomolecules and Bioanalytical Chemistry
S.BCH.6.02 Metabolism, Clinical Biochemistry and Pharmacology

Template for theory question paper
BIOCHEMISTRY

T.Y.B.Sc. Course No. S.BCH.6.01

Title: Biomolecules and Bioanalytical Chemistry

Learning Objectives:
On completion of the course, the student must be able to:
1. Understand the concepts of pH and buffers, appreciate their importance in biology and able to solve numerical problems.
2. Understand the basic concepts of centrifugation, chromatography and electrophoresis.
3. Understand the applications of techniques mentioned above in biology.

Number of lectures: 60

UNIT I: pH and Buffers (15 lectures)

1. pH and Buffers: Concept of pH, Ion product of water; pKa and pKb
   a. Derivation of: Hendersen Hasselbalch equation; An equation for Kw,Ka & Kb.
   b. Buffers, Buffer capacity, Physiological buffers (bicarbonate, phosphate, protein, Hb); Respiratory and Metabolic acidosis and alkalosis; lungs in pH regulation, Kidneys in pH regulation (Buffering by bicarbonates and ammonia; renal correction of acidosis and alkalosis)
   c. Ionization of Glycine, Aspartic acid and Lysine; Titration curve of these amino acids, Derivation of an equation for pI
   d. Determination of pH: Using Indicator, Colorimetric determination, potentiometric determination (Electrode potential, half cell, silver/silver chloride electrode, calomel electrode, glass electrode, combination electrode, pH meter)
   e. Numericals on all of the above concept

UNIT II: Biophysical Chemistry and Centrifugation (15 lectures)

1. Biophysical Chemistry
   a. Phases, Systems and components; Gas Laws (Boyle’s, Guy Lussac’s, Avagadro’s laws and their biological significance [Self study]
   b. Diffusion: Definition, Factors affecting diffusion and its Biological significance
   c. Brownian movement and its biological application
   d. Viscosity of liquids: Definition, Factors affecting viscosity, Biological significance/applications
   e. Surface Tension: Definition, Factors affecting surface tension, Biological application
   f. Dipoles and dielectric constant
   g. Osmosis and Osmotic pressure, Definition, Factors affecting Osmosis, Biological applications
   h. Adsorption: Types, Characteristics and Biological significance
   i. Colloids–Classification, Properties: Emulsions & Suspensions; Micelles; Liposomes

2. Centrifugation
   a. Centrifugal force and Relative centrifugal force; Nomogram; Types of centrifuges (Clinical, High speed, Ultracentrifuge) and rotors (Swing out, Angle)
b. Types of centrifugation – Preparative and Analytical; Differential and Density gradient (Rate zonal, Isopycnic) [to be covered with respect to subcellular fractionation] (2)
c. Sedimentation velocity, sedimentation equilibrium, sedimentation rate, sedimentation coefficient Svedberg (1)
d. Applications of centrifuges & ultracentrifuges (1)
e. Numericals on the above concepts. (1)

UNIT III: Chromatography (15 lectures)

1. Principle, Working and Applications of:
   a. Partition : Paper and gas chromatography (13)
   b. Adsorption: Thin layer and column chromatography
   c. Ion Exchange chromatography
   d. Gel Filtration
   e. Affinity

2. Principle and applications of HPLC (1)

3. Numericals on the above concepts (1)

UNIT IV: Electrophoresis and Spectroscopy (15 lectures)

1. Electrophoresis (8)
   Principle and set up
   Factors affecting the rate of migration of a particle in an electric field
   Supporting media: Paper, Cellulose acetate, Agar, Agarose and Polyacrylamide
   Types of electrophoresis: Zone and Moving boundary; High and low voltage;
   Vertical (slab) and Horizontal PAGE: Native - discontinuous, Role of SDS; Applications

2. Spectroscopy (7)
   Introduction of concepts: Electromagnetic spectrum, Measurements using light/radiation intensity, UV/Visible spectroscopy and Complementary colour
   Beer’s and Lambert’s laws, derivation and limitations of the Beer-Lambert law
   Concept of Lambda max, Molar extinction coefficient
   Construction and working of a simple single beam colorimeter and spectrophotometer
   Application of the law in the measurement of Proteins and Sugars
   Numericals on the above concepts

References:
1. Biochemistry, 4th Ed. - Lehninger, Nelson and Cox
2. Biochemistry, 4th Ed. - Stryer
3. Biochemistry - Mathew van Holde
4. Biochemistry - U. Satyanarayana
5. Biochemistry - Zubay
6. Analytical Chemistry - Christian
7. Analytical Chemistry - Skoog
8. Tools of Biochemistry - T. Cooper
10. Biophysics and Biophysical Chemistry for Medical and Biology students - Debjyoti Das
11. Essentials of Biophysics - P. Narayanan
BIOCHEMISTRY
Course No. S.BCH.6.02

T.Y.B.Sc.

Title: Metabolism, Clinical Biochemistry and Pharmacology

Learning Objectives:
On completion of the course, the student must be able to:

1. Understand the basic tenets of protein metabolism and turnover of amino acids.
2. Understand the intricate mechanism of signaling pathways and their dependence on various cues.
3. Understand the fundamentals of disorders of metabolism and their impact on health.
4. Understand the fundamentals of bioinformatics and its applications in biological sciences.
5. Understand the fundamentals of pharmacology and understand the mechanism of absorption, metabolism and excretion of drugs in human system.

Number of lectures: 60

UNIT I: Nucleic Acid and Protein Metabolism
(15 lectures)

1. Protein synthesis: Translation (self study) (6)
   a. Protein sorting: signal sequences, protein transport - gated, transmembrane, vesicular, protein translocation into mitochondria
   b. Protein degradation - lysosome, proteosome - role of ubiquitin
2. Metabolic fates of amino acids (ketogenic and glucogenic) (5)
   Transamination – Mechanism of transamination with Pyridoxal phosphate, SGOT & SGPT significance
   Deamination – Oxidative (glutamate dehydrogenase, D&L aminoacid oxidases) Non oxidative- (Asp, Ser, Cys)
   Decarboxylation (His, 5-OH Trp, Glu, Tyr), Mechanism of decarboxylation with Pyridoxal phosphate
3. Transport of Ammonia – Glutamine, Alanine (1)
4. Urea cycle (2)
5. Integration of Carbohydrate, Protein and Lipid metabolism (1)

UNIT II: Integration of Metabolism and Biosignalling
(15 lectures)

1. Biosignalling: Signal Molecules (6)
   a. Hormones-Classification (Aminoacid derived, Peptide, Steroid, Eicosanoid), Synthesis, transport, secretion and physiological role of Thyroid hormones and insulin; Physiological role of glucocorticoids (Cortisol, Cortisone); Physiological role of Nitric oxide, Growth factors (PDGF, EGF), Neurotransmitters (Acetylcholine,glutamate)
   b. Signal Transduction: Signal transduction with Cell surface receptor - e.g. G protein coupled receptors – i) cAMP pathway in glycogen metabolism; ii) cGMP in photoreception iii) Hydrolysis of PIP2
   c. Signal transduction with Intracellular receptor: Steroid Hormone receptor and mode of action (5)
   d. Endocrine regulation of fuel metabolism – Role of Insulin, Glucagon, Glucocorticoids, Epinephrine in regulation of metabolism (4)
UNIT III: Clinical Biochemistry and Bioinformatics (15 lectures)

1. Metabolic disorders /dysfunction (3)
   a. Carbohydrate metabolism: G6PD deficiency; Diabetes mellitus; Arsenic poisoning
   b. Lipid metabolism: Familial hypercholesterolemia; Atherosclerosis
   c. Protein and amino acid metabolism: Phenylketonuria; Tyrosinemia, Albinism
   d. Nucleic acid metabolism: Gout

2. Diagnostic enzymology (6)
   a. Basis of diagnostic enzymology: Basal levels of enzymes in blood; Effect of disease on the basal level of circulating enzymes; Factors affecting the usefulness of enzyme measurements in clinical studies
   b. Approaches to the study of diagnostic enzymology:
      i. A selected enzyme e.g. LDH
      ii. A selected organ e.g. Liver
      iii. A selected condition e.g. The Myocardial Infarction

3. Bioinformatics (6)

UNIT IV: Pharmacology (15 lectures)

1. Introduction to Pharmacology (5)
   b. Nature, sources and nomenclature of drugs
   c. Basic concept of – drug specificity, drug receptor (details of this will be covered elsewhere), Antagonism, Desensitization & tachyphylaxis, SAR (structure-activity relation) and drug resistance [using ONLY one example each]

2. Pharmacokinetics [ADME] (10)
   a. Absorption of drug – factors affecting absorption of drug
      i. Drug administration (Topical, Enemata, Enteral, Parenteral)
      ii. Physico-chemical properties of drugs (solubility, diffusion coefficient, ionization)
   b. Distribution of drug – Body fluid compartments & concept of volume of distribution
   c. Metabolism of drug –
      i. Concept of first-pass (presystemic) metabolism and BA (bioavailability)
      ii. Site(s) of drug metabolism and importance of CytP450 microsomal enzymes
      iii. Phase I reactions (oxidation, reduction, hydrolysis) –ONLY one e.g. each
      iv. Phase II reactions (conjugation with respect to glucuronyl, methyl & acetyl groups)

References:
1. Biochemistry, 4th Ed. - Lehninger, Nelson and Cox
2. Biochemistry, 4th Ed. - Stryer
3. Biochemistry - Mathew van Holde
4. Biochemistry - U. Satyanarayana
5. Biochemistry - Zubay
6. Cell Biology - Alberts
7. Cell Biology - Cooper
8. Textbook of Biochemistry with Clinical Correlations - Thomas Devli
T.Y.B.Sc. Practical Syllabus
Course no.: S.BCH.6.01 & S.BCH.6.02

1. Determine the nutritive value of food – carbohydrate, protein, lipid content of a food item
   Chromatography –
   i. Ascending/Descending/Circular paper chromatography of amino acids/sugars
   ii. Thin layer chromatography - separation of lipids / plant pigments
   iii. Column chromatography – Adsorption / Molecular sieve / Ion exchange

2. Enzymes – extraction, activity, fractionation, inhibitor studies
   i. Extraction of enzyme
   ii. Fractionation of the enzyme with Ammonium Sulphate (50% and 100%)
   iii. Determination of Activity and Specific activity of the enzyme
   iv. Effect of an activator/inhibitor on the Km of an enzyme.
   v. Immobilization of an enzyme

3. Clinical Biochemistry Pharmacology and
   i. Glucose Tolerance test (GOD-POD)
   ii. Estimation of Acetyl salicylate [monograph and estimation]
   iii. Sucrose [monograph]

4. Electrophoresis (demonstrations)
   i. Agarose gel electrophoresis of proteins/ nucleic acids
   ii. PAGE : Native/ SDS

5. Urine analysis: Qualitative tests for the following
   i. Specific gravity
   ii. Sugars, Proteins, Bile salts, Bile pigments, Neutral Substance - Urea (Heller’s ring test)
Template of Theory Question paper
S.LSC. Courses 6.01 & 6.02

CIA I – 20 marks, 45 mins.
Objective/Short questions, not more than 3 marks each

CIA II – 20 marks, 45 mins.
Objective/Short questions, not more than 3 marks each

End Semester exam – 60 marks, 2 hours

Question 1: Unit I: maximum marks per sub-question - 12 marks
15 marks to be answered out of 22-23 marks

Question 2: Unit II: maximum marks per sub-question - 12 marks
15 marks to be answered out of 22-23 marks

Question 3: Unit III: maximum marks per sub-question - 12 marks
15 marks to be answered out of 22-23 marks

Question 4: Unit III: maximum marks per sub-question - 12 marks
15 marks to be answered out of 22-23 marks

Template of Practical Question paper
S.LSC. Courses 6.01 & 6.02

CIA: (6.01 & 6.02) Total marks: 40

Q1. Group Project ( Experiment design, planning and execution) 20 marks

Q2. Group presentation & individual report 20 marks

End Semester Practical Examination: (6.01 & 6.02) Total marks: 60

Q1. Two - four experiments 40 marks

Q2. Viva/Quiz 10 marks

Q3. Journal 10 marks