St. Xavier's College (Autonomous),

Mumbai

Syllabus of the courses offered by the Department of Life Science and Biochemistry (2016-17)

St. Xavier's College – Autonomous Mumbai

Syllabus For 5th Semester Courses in BIOCHEMISTRY (June 2013 onwards)

Contents:

BIOCHEMISTRY

T.Y.B.Sc. **COURSE S.BCH. 5.01**

Title: CELLS AND BIOMOLECULES **60 Lectures**

Learning Objectives :

The objectives of the course are to:

i) increase student awareness of the role of biomolecules in maintenance of cellular structure & function, metabolism, homeostasis

ii) understand of the complexity of membranes and their significance in cellular activities

iii) consolidate the understanding of protein structure and enzymes

Unit I: Cell Structure **15**

1. Overview of a Prokaryotic (*E.coli*) and Eukaryotic cell (yeast, plant and animal) (4)
2. Membrane of a mammalian cell: Structure and composition – Lipids, Proteins, Carbohydrates; Fluid mosaic model; Donnan Membrane equilibrium; Membrane potential (5)
3. Membrane Transport (3)
4. Endomembrane systems: Endoplasmic reticulum and Golgi (3)

Unit II: Biomolecules and their Significance **15**

1. Carbohydrates : Starch, Cellulose, Chitin, Pectin, Proteoglycans -Hyaluronic acid, Chondroitin sulphate, Heparin; NANA (2).
2. Glycoproteins; Glycolipids in animal cell membrane – Gangliosides - Blood group antigens (1)
3. Lipids in the cell membrane- phospholipids and cholesterol, lipid rafts; Lipopolysaccharides - in Gram negative cells; (3)
4. Nucleic acids: DNA forms – A,B,Z ; Types of RNA- mRNA ,rRNA, tRNA, snRNA, micro RNA, Hn RNA (3)
5. Vitamins - Fat soluble and Water soluble vitamins – (Biochemical role) (6)

Unit III: Amino acids and Proteins **15**

1. Structure and classification of Amino acids (1)
2. Protein Structure:

a. Primary Structure of Proteins - peptide bond, phi & psi angles, determination of amino acid sequence using Sanger's reagent, Edman's degradation, Proteolytic cleavage and ordering of peptide fragments; Numericals on the above. (5)

b. Secondary- Alpha helix and Beta pleated sheets (2)

c. Super secondary structure: Structural patterns:- motif [Helix-loop-helix, β-α-βloop, β barrel] (2)

d. Tertiary- eg. Myoglobin; Concept of a Domain (1)

e. Quaternary – eg. Hemoglobin; concept of subunits (2)

3. Protein Denaturation and Renaturation – Ribonuclease (1)
4. Functional classification of Protein (1)

Unit IV: Enzymes **15**

1. Concept of Holoenzyme, Apoenzyme; Isozyme (Hexokinase and Glucokinase, LDH); Enzyme activity and Specific activity; Constitutive and Induced enzymes; Ribozyme (3)
2. Enzyme classification (2)
3. Active site, Activation energy, Reaction rate, Enzyme – substrate interaction (Induced fit, Lock and Key); Units of Enzyme activity, Factors affecting enzyme activity (3)
4. Rate order of reactions; Derivation of Michaelis Menten equation – single substrate; Michaelis Menten plot and Lineweaver Burke plot (2)
5. Enzyme inhibition-: Reversible (Competitive, Noncompetitive egs. Dicoumarol, Sulfa drugs) Irreversible (Iodoacetamide); (2)
6. Regulatory enzymes – Allosteric enzymes (eg- ATP/ADP as modulators of PFK-1); Regulation by Covalent modification (Phoshorylation/dephosphorylation of Glycogen phosphorylase) (2)
7. Problems based on the above concepts (1)

CIA : I & II– Test with Objective type questions/ MCQs/ Short questions /Problems/Assignments

BIOCHEMISTRY

T.Y.B.Sc. **COURSE S.BCH. 5.02**

Title: NUTRITION AND METABOLISM **60 Lectures**

Learning Objectives:
The learning objectives of the course are to understand metabolism and its significance in living systems. The approach involves an understanding of the nutritive aspects of food, an introduction to the synthesis of a carbohydrate by a primary producer and a study of the metabolism of & energy obtainable from physiologically significant molecules in the human system.

Unit I: Nutrition **15**

1. Introduction to Nutrition, Factors affecting Nutrition, National and International organizations ; Overview of digestion, absorption, and excretion (2)
2. Energy content of food : Measurement of energy content – *in vitro*(Bomb calorimeter), *in vivo* (indirect calorimetry); RQ of food (2)
3. Body composition – Factors affecting and measurement of body composition (Body Mass Index, Waist Hip Ratio, Skin fold measurement etc.) (1)
4. Energy expenditure : BMR, Physical activity, Thermic effect of food (2)
5. Nutritive significance of food: Balanced diet; Nutritive significance of Carbohydrates and fiber (beneficial and adverse effects of dietary fiber), Proteins (Nitrogen balance, Measurement of protein quality –Biological Value, Protein Efficiency Ratio, Net Protein Utilization), Fats (Trans fat, ω-3 and ω-3 fatty acids), vitamins, minerals, water (3)
6. Nutritional disorders: Kwashiorkor and Marasmus, Iron deficiency anemia; Obesity, Diabetes Mellitus, Cardio Vascular Disorders- Atherosclerosis. (3)
7. Numericals based on the above concepts (2)

Unit II: Carbohydrate metabolism **15**

1. Glycolysis, Gluconeogenesis, Glycogenesis, Glycogenolysis, Cori cycle, HMP shunt (10)
2. Oxidation of Pyruvate, TCA cycle, Amphibolic nature of TCA, Anaplerotic reactions (5)

Unit III: Bioenergetics and Photosynthesis **15**

1. Malate - Aspartate and Glycerol phosphate shuttles (2)
2. Mitochondrial Electron Transport Chain: Electron carriers- Chemistry, Sequence, Experiments that proved the sequence; Q cycle; Inhibitors of electron transport (Rotenone, Amytal, Piericidin A, Antimycin , BAL, CN, H_2S, CO, Azide (4)
3. Oxidative phosphorylation(OP): Mitchell's hypothesis and proton motive force, ATP synthase , Boyer's binding change mechanism for ATP synthesis, Inhibitor of OP – Dinitrophenol (3)
4. Energetics of Glucose /Fructose / Maltose oxidation (2)
5. Photosynthesis : Photophosphorylation - Linear and Cyclic; Calvin Cycle (4)

Unit IV: Lipid metabolism **15**

1. Lipolysis, Knoops experiment, β oxidation of saturated fatty acids(even carbon) (5)
2. Energetics of β oxidation of saturated fatty acids (C4 to C20) (2)
3. Formation and utilization of Ketone bodies, ketone bodies in starvation, diabetes mellitus, pregnancy and alcoholism (3)
4. Lipogenesis, Citrate transport, Synthesis of Palmitic acid (3)
5. Lipoprotein(formation and fate) (2)

CIA : I & II– Test with Objective type questions/ MCQs/ Short questions /Problems/ Assignments

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T.Y.B.Sc BIOCHEMISTRY
S.BCH. 5.01 & S.BCH.5.02 PRACTICALS

1. Preparation of reagents: Normal & Molar solutions ; Solutions prepared as mg% or %.

2. Carbohydrates:

A. Qualitative identification of Starch, Dextrin, Sucrose, Glucose, Fructose, Lactose, Maltose
   1. Extraction and Isolation of Starch from potato/maize/sweet potato
   2. Estimation of lactose from milk by the Cole's Ferricyanide method.
   3. Estimation of a reducing sugar by the DNSA method / Folin Wu

B. Demonstration experiments: Formation of Galactose crystal and GOD-POD assay

3. Proteins:
   a. Qualitative identification of Casein, Albumin, Gelatin and Peptone
   b. Isolation of Casein from milk.
   c. Estimation of proteins colorimetrically by i) Biuret method ii) Folin Lowry method
4. Enzymes:
   a. Determination of the Optimum pH, and Km of an enzyme (α/β Amylase / Acid Phosphatase)
5. Nucleic Acids: Extraction of DNA from plant/animal/microbial source . Qualitative test for DNA / test for purity (A_{260}/A_{280})
6. Lipids :
   a. Determination of Acid value of oil (fresh and rancid)
   b. Demonstration of the lipid profile (enzymatically)
7. Vitamins: Estimation of Vitamin C

Template of a Practical Question paper
S.BCH.5.PR

CIA: (5.05 & 5.06) **Total marks: 40**

Q1. Two experiments 30marks

Q2 Journal 10 marks

End Semester Practical Examination: (5.05 & 5.06) **Total marks: 60**

Q1. Three - Four experiments 40-50 marks

Q2. Viva/Quiz 10 -20marks

REFERENCES: (5.05 & 5.06)

1. Nelson and Cox. Lehninger's Principle of Biochemistry. 4th Edition
2. Lubert Stryer. Biochemistry, 4th Edition
3. Satyanarayan. Biochemistry. 2nd Edition
4. Zubay. Biochemistry
5. Cooper. The Cell. 2nd Edition
6. Alberts et al. Cell Biology. 4th Edition
7. Biochemistry 2nd Ed – Mathew van Holde
8. Textbook of Biochemistry *with clinical correlations* –Thomas Devlin
9. Diagnostic Enzymology - David Hawcroft
10. The Physical Biology of the Cell - Kondev et al
11. Mahan & Escott-Stump 2004. Krause's Food, Nutrition & Diet therapy 11th Edition
12. Garrow, James & Ralph 2000. Human Nutrition & Dietetics. 10th Edition
13. F.P. Antia1973. Clinical dietetics & Nutrition 2nd Edition
14. C. Gopalan 1990 Nutritive value of Indian foods. National Institute of Nutrition
15. Paul Insel, Don Ross, Kimberley McMahon, Melissa Bernstein 2007. Nutrition. 4th Edition
16. Journals (for Nutrition):
    a) Indian Food Industry AFST Journal(s) 2007
    b) The Hindu Survey of Indian Agriculture 2007
    c) American Journal of Clinical Nutrition
    d) Journal of Nutrition
    e) International Journal of Diabetes in Developed Countries.

St. Xavier's College – Autonomous Mumbai

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

Contents:

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 (2)
   a. Derivation of: Hendersen Hasselbalch equation; An equation for Kw,Ka & Kb. (2)
   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) (5)
   c. Ionization of Glycine, Aspartic acid and Lysine; Titration curve of these amino acids, Derivation of an equation for pI (2)
   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) (2)
   e. Numericals on all of the above concept

UNIT II: Biophysical Chemistry and Centrifugation (15 lectures)

1. Biophysical Chemistry (8)
   a. Phases, Systems and components; Gas Laws (Boyle's, Guy Lussac's, Avagadro's laws and their biological significance [Self study] (1)
   b. Diffusion: Definition, Factors affecting diffusion and its Biological significance
   c. Brownian movement and its biological application (1)
   d. Viscosity of liquids: Definition, Factors affecting viscosity, Biological significance/applications (1)
   e. Surface Tension: Definition, Factors affecting surface tension, Biological application (1)
   f. Dipoles and dielectric constant (1)
   g. Osmosis and Osmotic pressure, Definition, Factors affecting Osmosis, Biological applications (1)
   h. Adsorption: Types, Characteristics and Biological significance (1)
   i. Colloids –Classification, Properties; Emulsions & Suspensions; Micelles; Liposomes (1)

2. Centrifugation (7)
   a. Centrifugal force and Relative centrifugal force; Nomogram; Types of centrifuges (Clinical, High speed, Ultracentrifuge) and rotors (Swing out, Angle) (2)

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: (13)
   a. Partition : Paper and gas chromatography
   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 concept s: 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
9. Analytical Biochemistry - William and Wilson/ Wilson and Walker
10. Biophysics and Biophysical Chemistry for Medical and Biology students - Debjyoti Das
11. Essentials of Biophysics - P. Narayanan

BIOCHEMISTRY

T.Y.B.Sc. **Course No. S.BCH.6.02**

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 glucocoricoids (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 PIP_2
   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: Phenyketonuria; 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)

a. Definition/ concept of – Pharmacology, pharmacognosy, Pharmacy, Pharmacodynamics, Pharmacokinetics, Therapeutics, Toxicology, Chemotherapy, Pharmaceutical Standard Reference Materials (Materia Medica, Pharmacopoeia, National Formulary, BPI, AMA Drug Evaluations).
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 $CytP_{450}$ 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 BiochemistryPharmacology 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 : Qualitaive 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