



# St. Xavier's College – Autonomous Mumbai

## Syllabus For 5<sup>th</sup> Semester Courses in **BIOCHEMISTRY** (June 2013 onwards)

### Contents:

Theory & Practical Syllabus for Courses:

S.BCH.5.01 –Cells and Biomolecules

S.BCH.5.02 – Nutrition and Metabolic Pathways

Template of paper

## 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,  $\beta$ - $\alpha$ - $\beta$ loop,  $\beta$  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 (Phosphorylation/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,  $\omega$ -3 and  $\omega$ -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<sub>2</sub>S, 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,  $\beta$  oxidation of saturated fatty acids(even carbon) (5)
2. Energetics of  $\beta$  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 ( $\alpha/\beta$  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 )**

- Q1. Two experiments  
Q2 Journal

**Total marks: 40**  
30marks  
10 marks

**End Semester Practical Examination: (5.05 & 5.06 )**

- Q1. Three - Four experiments  
Q2. Viva/Quiz

**Total marks: 60**  
40-50 marks  
10 -20marks

**REFERENCES: (5.05 & 5.06)**

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2. Lubert Stryer. Biochemistry, 4<sup>th</sup> Edition
3. Satyanarayan. Biochemistry. 2<sup>nd</sup> Edition
4. Zubay. Biochemistry
5. Cooper. The Cell. 2<sup>nd</sup> Edition
6. Alberts et al. Cell Biology. 4<sup>th</sup> Edition
7. Biochemistry 2<sup>nd</sup> 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. Antia 1973. 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.