



# St. Xavier's College (Autonomous) Mumbai

## Syllabus For 5<sup>th</sup> Semester Courses in **BIOCHEMISTRY** (June 2018 onwards)

### Contents:

Syllabus (theory and practicals) for Courses:

SBCH0501	Molecules of Biological Significance
SBCH0502	Nutrition and Metabolism
SBCH05PR	Practicals

Template for theory and practical question paper  
Evaluation and Assessment Grid

### Percent revision:

2015-16: No revision  
2016-17: No revision  
2017-18: 25% (0501) and 21.66% (0502)  
2018-19: 40-50% revision to practicals  
2019-20: No revision  
2020-21: No revision

## BIOCHEMISTRY

**T.Y.B.Sc.**

**Course No.: SBCH0501**

**Title: Molecules of Biological Significance**

### Learning Objectives:

The objectives of the course are to:

1. Increase student awareness of the role of primary compounds in the maintenance of cellular structure and function in plants and animals.
2. Introduce the students to the medical and non-medical applications of secondary metabolites
3. Consolidate the understanding of protein structure, folding and the role of enzymes and coenzymes in carrying out essential biochemical reactions.

**No. of lectures: 60**

### UNIT I: Primary compounds and Secondary metabolites (15 lectures)

1. **Carbohydrates:** (6)
  - a. Starch, Cellulose, Chitin, Pectin
  - b. Proteoglycans: Hyaluronic acid, Chondroitin sulphate, Heparin, NANA
  - c. Glycoproteins and Glycolipids in animal cell membrane
  - d. Gangliosides - Blood group antigens
2. **Lipids:** (2)
  - a. Cholesterol (biochemical role, role in a cell membrane, disorders, obesity-diabetes link)
  - b. Lipopolysaccharides - in Gram negative cells
3. **Nucleic acids:** (Guided self-study) (1)

Structure of nucleotides and polynucleotides

  - a. Nucleic Acid forms – A, B, Z
  - b. RNA- mRNA, rRNA, tRNA, snRNA, micro RNA, hnRNA
4. **Secondary Metabolites in Plants** (6)
  - a. Alkaloids-true, proto, pseudo; Phenolics- simple phenyl propanoids, Coumarins, Benzoic acid derivatives, Flavonoids, Stilbenes, Lignin
  - b. Terpenoids.  
(For all - Classes, Chemistry/source, Medical /non medical applications with an example)

### UNIT II: Vitamins and Micronutrients (15 lectures)

1. **Vitamins:** (3)
  - a. Water soluble – Thiamine, Riboflavin, Niacin, Pyridoxine, Biotin, Lipoic acid, Folic acid, Vitamin C  
(Chemistry- Group involved in its activity, Biochemical role, Disorders)
  - b. Fat soluble vitamins ( A,D,E,K) (6)

Vitamin A: Chemistry, Wald's visual cycle, Role in vision, deficiency disorders (Night blindness, Keratomalacia)  
Vitamin D: Chemistry, Role in calcium absorption and mobilization, Deficiency disorders (Rickets, Osteomalacia)  
Vitamin E, Vitamin K: Chemistry, Physiological role  
(E: antioxidant, K: Blood clotting)

- 2. Minerals:** (6)  
Ca, Mg, Na, K, Fe, Zn, Se  
(Absorption, Distribution, Metabolism, Physiological role, Disorders)

**UNIT III: Amino acids and Proteins** (15 lectures)

**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 structure - Alpha helix and Beta pleated sheets, Ramchandran plot (2)
  - c. Super secondary structure: Structural patterns (motifs for DNA and RNA binding, protein-protein interactions) (2)
  - d. Tertiary structure - eg. Myoglobin; Concept of a Domain (1)
  - e. Quaternary structure - eg. Hemoglobin; Concept of subunits (2)
3. Protein Denaturation and Renaturation – Ribonuclease (1)
4. Functional classification of Protein (1)

**UNIT IV: Enzymes** (15 lectures)

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 (3)  
(Induced fit, Lock and Key); Units of Enzyme activity, Factors affecting enzyme activity
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)

## References

1. Basic Concepts in Biochemistry: A Student's Survival Guide. 2<sup>nd</sup> Ed. Hiram F. Gilbert. McGraw-Hill.
2. Biochemistry. 7<sup>th</sup> Ed. JM Berg, JI Tymoczko, L Stryer, GJ Gatto, Jr. WH Freeman and Company, New York.
3. Lehninger Principles of Biochemistry. 7<sup>th</sup> Ed. DL Nelson, M Cox. Macmillan International Higher Education.
4. Biochemistry. 4<sup>th</sup> Ed. D. Voet and JG Voet. Wiley.
5. Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins. 3<sup>rd</sup> Ed. N Price and L Stevenson. Oxford University Press.
6. Enzymes. 2<sup>nd</sup> Ed. M Dixon and EC Webb. Academic Press.
7. Textbook of Biochemistry with Clinical Correlations. 7<sup>th</sup> Ed. TM Devlin. Wiley.
8. A Textbook of Physiological Chemistry for Students of Medicine. 17<sup>th</sup> Ed. HA Harper.
9. Plant Biochemistry (2008) C. Bowsher, M. Steer, A. Tobin, Garland Science, Taylor and Francis group.
10. Pharmacognosy: Phytochemistry Medicinal Plants. 2<sup>nd</sup> Ed. J. Bruneton, Lavoisier Publishing.
11. Plant Biochemistry. 3<sup>rd</sup> Ed. H-W Heldt, Elsevier Academic Press.

## BIOCHEMISTRY

**T.Y.B.Sc.**

**Course No.: SBCH0502**

**Title: Nutrition and Metabolism**

### **Learning Objectives:**

The learning objectives of the course are to understand:

1. Metabolism of carbohydrates and lipids and their significance in living systems.
2. The link between nutrition, metabolism and energy.
3. Nutritive aspects of food.

**No. of lectures: 60**

### **UNIT I: Nutrition**

**(15 lectures)**

1. **Introduction to Nutrition**, Factors affecting, National and International organizations, Dietary guidelines for Indians (NIN) (1)
2. **Overview of digestion, absorption, and excretion** (1)
3. **Nutritive value of food** (2)  
Balanced diet; Food pyramid, Eat Well plate (Self study)  
Carbohydrates and Dietary fibres (beneficial and adverse effects of dietary fiber)  
Proteins (Essential and non-essential amino acids, complete and incomplete proteins; Nitrogen balance, Measurement of protein quality –Biological Value, Protein Efficiency Ratio, Net Protein Utilization, Protein Digestibility Corrected Amino Acid Score)  
Fats (saturated fats, MUFA and PUFA,  $\omega$ -3 and  $\omega$ -6 fatty acids, trans-fats)  
Food quality - processing and storage (2)  
Water and electrolyte balance
4. **Nutrition in Weight Management, Nutrition for Exercise and Sports** (1)
5. **Nutrition in Disease Management:** (4)  
Nutritional disorders: Type II diabetes mellitus, Obesity, Cardiovascular Disease, Kwashiorker, Marasmus, Malnutrition,  
Eating disorders: Anorexia nervosa, Bulimia nervosa, Binge eating disorder, Fad diets
6. **Energy content of food:** Measurement of energy content (Guided self study) (2)  
*in vitro*(Bomb calorimeter), *in vivo* (indirect calorimetry); RQ of food  
Energy expenditure : BMR, Physical activity, Thermic effect of food  
Numericals based on the above concepts
7. **Body composition** (2)  
Body fat percentage, Essential body fat, body fat distribution and body type, influencing factors Measurement of body composition (Direct: Skin fold measurement, BIA, etc., Indirect indicators: Body Mass Index, Waist Hip Ratio)

### **UNIT II: Carbohydrate metabolism**

**(15 lectures)**

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 lectures)

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, 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 lectures)

1. Lipolysis, Knoop's experiment,  $\beta$ -oxidation of saturated fatty acids (even carbon) (5)
2. Energetics of  $\beta$ -oxidation of saturated fatty acids (C<sub>4</sub> to C<sub>20</sub>) (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)

## References

1. Basic Concepts in Biochemistry: A Student's Survival Guide. 2<sup>nd</sup> Ed. Hiram F. Gilbert. McGraw-Hill.
2. Biochemistry. 7<sup>th</sup> Ed. JM Berg, JI Tymoczko, L Stryer, GJ Gatto, Jr. WH Freeman and Company, New York.
3. Lehninger Principles of Biochemistry. 7<sup>th</sup> Ed. DL Nelson, M Cox. Macmillan International Higher Education.
4. Biochemistry. 4<sup>th</sup> Ed. D. Voet and JG Voet. Wiley.
5. Krause's Food & Nutrition Therapy. 12<sup>th</sup> Ed. LK Mahan & S Escott-Stump. Saunders, USA.
6. Nutrition. 6<sup>th</sup> Ed. P Insel, D Ross, K McMahon, M Bernstein. Jones & Bartlett.
7. Human Nutrition & Dietetics. 10<sup>th</sup> Ed. JS Garrow, WPT James & A Ralph. Churchill Livingstone Press, London.
8. Nutritive value of Indian foods. 1990. CGopalan. National Institute of Nutrition, India.
9. Dietary Guidelines for Indians. 2011. National Institute of Nutrition, India.
10. Textbook of Biochemistry with Clinical Correlations. 7<sup>th</sup> Ed. TM Devlin. Wiley.

**Practical: SBCH05PR**

1. Preparation of solutions: Normal and molar solutions, solutions prepared as mg% or %
2. Carbohydrates
  - a. Qualitative identification of Starch, Dextrin, Sucrose, Lactose, Maltose, Fructose, Glucose
  - b. Extraction and isolation of starch from potato/ sweet potato/ maize
  - c. Estimation of lactose by Cole's ferricyanide method
  - d. Estimation of reducing sugar by DNSA / Folin Wu method
  - e. Demonstration experiment: GOD-POD assay (kit-based)
3. Proteins
  - a. Qualitative identification of Casein, Gelatin, Albumin, Peptone
  - b. Isolation of casein from milk
  - c. Estimation of proteins colorimetrically by Folin-Lowry method
4. Lipids
  - a. Determination of acid value of oil (fresh and rancid)
5. Vitamins
  - a. Estimation of Vitamin C by DCPIP/ Iodometry
6. Minerals
  - a. Estimation of Phosphorus
  - b. Estimation of Iron
  - c. Estimation of Calcium
7. Glycine titration curve



## **Template of Theory Question paper**

### **SBCH0501 and SBCH0502**

#### **CIA I – 20 marks, 45 mins.**

Objective/Short questions, not more than 3 marks each

#### **CIA II – 20 marks**

Test (45 mins.)/ Survey/ Assignment/ Presentation/ Poster/ Essay/ Review

#### **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 22-30 marks

**Question 2:** Unit II: maximum marks per sub-question - 12 marks

15 marks to be answered out of 22-30 marks

**Question 3:** Unit III: maximum marks per sub-question - 12 marks

15 marks to be answered out of 22-30 marks

**Question 4:** Unit III: maximum marks per sub-question - 12 marks

15 marks to be answered out of 22-30 marks

## **Template of Practical Question paper**

### **Course: SBCH05PR**

#### **CIA & End Semester Practical Examination**

**Total marks: 100**

#### **CIA: (0501 & 0502)**

**Total marks: 40**

Q1. One/ Two experiments

20 marks

Q2. Spots/ Viva

10 marks

Q3. Journal

10 marks

#### **End Semester Practical Examination: (0501 & 0502 )**

**Total marks: 60**

Q1. Two - four experiments

50 marks

Q2. Viva/Quiz

10 marks

**DEPARTMENT OF LIFE SCIENCES AND BIOCHEMISTRY**

**T.Y.B.Sc. Biochemistry Exam Grid Semester 5**

<b>T.Y.B.Sc. Biochemistry Exam Grid Semester 5</b>					
<b>Course</b>	<b>Exam</b>	<b>Knowledge</b>	<b>Understanding</b>	<b>Application/Analysis</b>	<b>Total</b>
<b>0501</b>	CIA I	8	8	4	20
	CIA II	8	8	4	20
	End semester	20	20	20	60
<b>Course</b>	<b>Exam</b>	<b>Knowledge</b>	<b>Understanding</b>	<b>Application/Analysis</b>	<b>Total</b>
<b>0502</b>	CIA I	8	8	4	20
	CIA II	8	8	4	20
	End semester	20	20	20	60