

St. Xavier's College (Autonomous),
Mumbai



Syllabus of the courses offered by the
Department of Life Science and Biochemistry
(2019-20)



St. Xavier's College – Autonomous Mumbai

Syllabus For 5th Semester Courses in **BIOCHEMISTRY** (June 2018 onwards)

Contents:

Syllabus (theory and practicals) for Courses:

SBCH501	Molecules of Biological Significance
SBCH502	Nutrition and Metabolism

Template for theory and practical question paper

BIOCHEMISTRY

T.Y.B.Sc.

Course No.: SBCH 501

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. NA 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-in Blood clotting

2. Minerals: (6)

Ca, Mg, Na, K, Fe, Zn, Se

(Absorption, Distribution, Metabolism, Physiological role, Disorder)

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- Alpha helix and Beta pleated sheets, Ramchandran plot (2)
 - c. Super secondary structure: Structural patterns:- (motif for DNA and RNA binding, protein-protein interactions) (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 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 (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)

References

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

BIOCHEMISTRY

T.Y.B.Sc.

Course No.: SBCH502

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, ω -3 and ω -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, H₂S, 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, 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)

References

1. Basic Concepts in Biochemistry: A Student's Survival Guide. 2nd Ed. Hiram F. Gilbert. McGraw-Hill.
2. Biochemistry. 7th Ed. JM Berg, JI Tymoczko, L Stryer, GJ Gatto, Jr. WH Freeman and Company, New York.
3. Lehninger Principles of Biochemistry. 7th Ed. DL Nelson, M Cox. Macmillan International Higher Education.
4. Biochemistry. 4th Ed. D. Voet and JG Voet. Wiley.
5. Krause's Food & Nutrition Therapy. 12th Ed. LK Mahan & S Escott-Stump. Saunders, USA.
6. Nutrition. 6th Ed. PInsel, D Ross, K McMahon, M Bernstein. Jones & Bartlett.
7. Human Nutrition & Dietetics. 10th 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. 7th Ed. TM Devlin. Wiley.

Practical: SBCH5PR

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 DCIP/ Iodometry
6. Minerals
 - a. Estimation of Phosphorous
 - b. Estimation of Iron
 - c. Estimation of Calcium
7. Glycine titration curve

**Template of Theory Question paper
SBCH501 and SBCH502**

CIA I – 20 marks, 45 mins.

Objective/Short questions, not more than 3 marks each

CIA II – 20 marks, 45 mins.

Test/ 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: SBCH5PR**

CIA & End Semester Practical Examination

Total marks: 100

CIA: (501 & 502)

Total marks: 40

Q1. One/ Two experiments

20 marks

Q2. Spots/ Viva

10 marks

Q3. Journal

10 marks

End Semester Practical Examination: (501 & 502)

Total marks: 60

Q1. Two - four experiments

50 marks

Q2. Viva/Quiz

10 marks



St. Xavier's College – Autonomous Mumbai

Syllabus For 6th Semester Courses in **BIOCHEMISTRY** (June 2018 onwards)

Contents:

Syllabus (theory and practicals) for Courses:

SBCH601	Biomolecules and Bio-analytical Chemistry
SBCH602	Metabolism, Clinical Biochemistry and Pharmacology

Template for theory and practical question paper

BIOCHEMISTRY

T.Y.B.Sc.

Course No.: SBCH601

Title: Biophysical and Bio-analytical Chemistry

Learning Objectives:

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

1. Concepts of pH and buffers, appreciate their importance in biology and solve numerical problems.
2. Principle, concept and applications of centrifugation, chromatography and electrophoresis.

Number of lectures: 60

UNIT I: (15 lectures)

1. **pH and Buffers** (11)
 - a. Concept of pH, Ionic product of water; pKa and pKb
 - b. Derivation of Hendersen-Hasselbalch equation; relation between Kw, Ka & Kb.
 - c. Buffers, Buffer capacity, Physiological buffers (bicarbonate, phosphate, protein, Hb)
 - d. 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)
 - e. Ionization of Glycine, Aspartic acid and Lysine; Titration curve of these amino acids,
 - f. Derivation of an equation for pI
 - g. Determination of pH: using Indicators, Colorimetric determination, Potentiometric determination (Electrode potential, half cell, silver/silver chloride electrode, calomel electrode, glass electrode, combination electrode, pH meter)
 - h. Numericals on the above concepts.
2. **Protein Purification** (4)
 - a. Cell lysis techniques – purpose, methods, choice (Mechanical – Bead mill/Sonication/ French press;
 - b. Physical – Thermolysis (Freeze-thaw), Osmotic shock;
 - c. Chemical–Alkaline lysis/ Detergents/ Organic solvents;
 - d. Enzymatic – Lysozyme/ Cellulase/ Chitinase)
 - e. Post- cell lysis: Separation and purification techniques (overview only – list/ flowchart)
 - f. Ammonium sulphate fractionation (salting in, salting out, A.S Fractionation nomogram, problems), Protein crystalization, molecular filtration.

UNIT II: Biophysical Chemistry & 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 [Guided Self study] (1)
 - b. Definition, influencing factors, biological significance and applications of: Diffusion, Osmosis, Brownian motion, Viscosity, Surface tension, Adsorption (6)
 - c. Dipoles and dielectric constant (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 and applications of centrifugation: Preparative and Analytical; Differential and Density gradient (Rate zonal, Isopycnic) [to be covered with respect to subcellular fractionation] (3)
 - c. Sedimentation: Velocity, Equilibrium, Rate, Coefficient (Svedberg unit) (1)
 - d. 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 (Size Exclusion) chromatography
 - e. Affinity chromatography
2. Principle and applications of HPLC (1)
3. Numericals on the above concepts (1)

UNIT IV: Electrophoresis and Spectroscopy (15 lectures)

1. **Electrophoresis** (8)
- a. Principle and set up
 - b. Factors affecting the rate of migration of a particle in an electric field
 - c. Supporting media: Paper, Cellulose acetate, Agar, Agarose and Polyacrylamide
 - d. Types of electrophoresis: Zone and Moving boundary; High and low voltage; Vertical (slab) and Horizontal
 - e. PAGE: Native -discontinuous, Role of SDS; Applications
2. **Spectroscopy** (7)
- a. Introduction of concepts: Electromagnetic spectrum, Measurements using light/radiation intensity, UV/Visible spectroscopy and Complementary colour
 - b. Beer's and Lambert's laws, derivation and limitations of the Beer-Lambert law, Application of the law in the estimation of proteins and sugars
 - c. Concept of Lambda max, Molar extinction coefficient
 - d. Construction and working of a simple single beam colorimeter and spectrophotometer
 - e. Principle and applications of NMR and Mass spectrophotometry
 - f. Numericals on the above concepts

References:

1. Analytical Chemistry. 7th Ed. GD Christian, PK Dasgupta, KA Schug. Wiley.
2. Fundamentals of Analytical Chemistry. 9th Ed. DA Skoog, DM West, FJ Holler, SR Crouch. Cengage Learning.
3. Tools of Biochemistry -T. Cooper
4. Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed. K Wilson, J Walker. Cambridge University Press.
5. Biophysics and Biophysical Chemistry. 6th Ed. D Das. Academic Publishers.
6. Essentials of Biophysics. 2nd Ed. P. Narayanan. Anshan Publishers.
7. Biochemistry. 7th Ed. JM Berg, JI Tymoczko, L Stryer, GJ Gatto, Jr. WH Freeman and Company, New York.
8. Lehninger Principles of Biochemistry. 7th Ed. DL Nelson, M Cox. Macmillan International Higher Education.
9. Biochemistry. 4th Ed. D. Voet and JG Voet. Wiley.
10. Biochemistry. 4th Ed. C K Mathews, KE van Holde, Ahern.
11. Biochemistry. 4th Ed. G Zubay. Brown (William C) Co., USA.
12. Biochemistry. 3rd Ed. U Satyanarayan, U Chakrapani. Books and Allied (P) Ltd., Kolkata, India.

BIOCHEMISTRY

T.Y.B.Sc.

Course No.: SBCH602

Title: Metabolism, Clinical Biochemistry and Pharmacology

Learning Objectives:

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

1. Basic tenets of nucleic acid and protein metabolism, turnover of amino acids.
2. Intricate mechanism of signalling pathways and their dependence on various cues.
3. Fundamentals of disorders of metabolism and their impact on health.
4. Basic bioinformatics and the applications of computational biology.
5. Fundamentals of pharmacology: drug-receptor interactions, ADME.

Number of lectures: 60

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

1. Nucleic Acid Metabolism (guided self study) (1)

- a. De novo synthesis of purines and pyrimidines
- b. Purine and pyrimidine recycling by salvage pathway

2. Protein Metabolism (14)

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

UNIT II: Signal Molecules (15 lectures)

1. Hormones (6)
 - a. Classification (Aminoacid derived, Peptide, Steroid, Eicosanoid)
 - b. Synthesis, transport, secretion and physiological role of Thyroid hormones and insulin
 - c. Physiological role of glucocorticoids (Cortisol, Cortisone)
2. Other signal molecules:
Nitric oxide, Growth factors (PDGF, EGF), Neurotransmitters (Acetylcholine, glutamate)
3. Signal Transduction with Cell surface receptor -G protein coupled receptors
 - a. cAMP pathway in glycogen metabolism
 - b. cGMP in photoreception

- c. Hydrolysis of PIP₂
- 4. Signal transduction with Intracellular receptor: Steroid Hormone receptor and mode of action (5)
- 5. 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)
 - a. Overview, Purpose, Applications
 - b. Biological data and Databases
 - c. Sequence analysis (Formats, Alignment, Scoring)
 - d. Structural analysis (Molecular visualization softwares)
 - e. Phylogenetic analysis (Cladograms and Phylograms)

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 and 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 and acetyl groups)
- d. Excretion of drug – Renal, Biliary and Fecal, other
3. Drug-drug and drug-food interactions

References:

1. Biochemistry. 7th Ed. JM Berg, JI Tymoczko, L Stryer, GJ Gatto, Jr. WH Freeman and Company, New York.
2. Lehninger Principles of Biochemistry. 7th Ed. DL Nelson, M Cox. Macmillan International Higher Education.
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4. Textbook of Biochemistry with Clinical Correlations. TM Devlin. 7th Ed. Wiley.
5. Goodman Gillman's Pharmacological Basis of Therapeutics. 10th Ed. JG Hardman, LE Limbird (editors), McGraw Hill, New York.
6. Basic and Clinical Pharmacology. 9th International Ed. BG Katzung. McGraw Hill.
7. Pharmacology and Pharmacotherapeutics. 24th Ed. RS Satoskar, NN Rege, SD Bhandarkar. Elsevier.
8. Bioinformatics: Sequence and Genome Analysis - DW Mount. 2004 (2nd Ed.), Cold Spring Harbor Laboratory Press, New York.
9. Bioinformatics and Functional Genomics – J Pevsner. 2015. (3rd Ed.) Wiley.
10. Bioinformatics: Methods and Applications – Genomics, Proteomics and Drug Discovery. (3rd Ed.)
SC Rastogi, N Mendiratta, P Rastogi. PHI Learning Pvt. Ltd., New Delhi

Practicals: SBCH6PR

1. Chromatography
 - a. Ascending/ descending/ circular paper chromatography of amino acids/ sugars
 - b. Thin layer chromatography (TLC) – separation of lipids/ plant pigments
 - c. Column chromatography – Adsorption / molecular sieve/ ion exchange
2. Enzymology
 - a. Extraction of enzyme.
 - b. Optimum pH
 - c. Kinetics: K_m , V_{max} (Michaelis-Menten, Lineweaver – Burk)
 - d. Fractionation with ammonium sulphate (50% and 100%), Dialysis
 - e. Determination of activity and specific activity
 - f. Effect of activator and inhibitor on K_m
 - g. Enzyme immobilization
3. Pharmacology
 - a. Estimation of acetyl salicylate
4. Electrophoresis
 - a. PAGE: Native/SDS
5. Urine analysis (qualitative tests for the following)
 - a. sugars, proteins, bile salts, bile pigments, ketone bodies
6. Group research projects

**Template of Theory Question paper
SBCH601 and SBCH602**

CIA I – 20 marks, 45 mins.

Objective/Short questions, not more than 3 marks each

CIA II – 20 marks, 45 mins.

Test/ 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: SBCH6PR**

CIA & End Semester Practical Examination

Total marks: 100

CIA: (601 & 602)

Total marks: 40

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

20 marks

Q2. Group presentation & individual report

20 marks

End Semester Practical Examination: (601 & 602)

Total marks: 60

Q1. Two - four experiments

40 marks

Q2. Viva/Quiz

10 marks

Q3. Journal

10 marks