Biochemistry Syllabus

(Effective from June 2011)

Choice Based Credit System for Under Graduate students of Gujarat University

1. Objectives of Credit system:
   to provide mobility and flexibility for students within and outside the parent department
2. To provide broad based education
3. To help students learn at their own pace
4. To provide students scope for acquiring extra credits
5. To impart more job oriented skills to students
6. To make any course multi disciplinary in approach

What is credit system?

Weightage to a course is given in relation to hours assigned for the course. Generally one hour per week is one credit. However, there could be some flexibility because of practical, field visits and tutorials. Following table shows distribution of credits:

First year	**Semester I**	**Semester II**
4 credits	Biochemistry 101	Biochemistry 103
3 credits	Biochemistry 102 (Practical)	Biochemistry 104 (practical)
2 credits	Biochemistry Elective 101	Biochemistry Elective 102
		Biotechnology Elective102
Total 18 credits		

Second year	**Semester III**	**Semester IV**
4 credits	Biochemistry 201	Biochemistry 204
4 credits	Biochemistry 202	Biochemistry 205
3 credits	Biochemistry 203 (Practical)	Biochemistry 206 (practical)
2.5 credits	Biochem sub. Elective 201	Biochem sub. Elective 202
Total 25 credits		

Second year	**Semester V**	**Semester VI**
4 credits	Biochemistry 301	Biochemistry 307
4 credits	Biochemistry 302	Biochemistry 308
4 credits	Biochemistry 303	Biochemistry 309
4 credits	Biochemistry 304	Biochemistry 310
5 credits	Biochemistry 305 (Practical)	Biochem 3011 (Practical)
2 credits	Biochem sub. Elective 301	Biochem sub. Elective 303
2 credits	Biochem sub. Elective 302	Biochem sub. Elective 304
Total 25 credits		

In addition, in each year students will have foundation course for 2 credits. Students who opt for biotechnology will have to take compulsory subjective electives from semester I to VI as per syllabus.

Course pattern: The course consists of three major components. They are core course, elective course and subject elective course.

Core Course
A core course is the course offered by the parent department, totally related to the major subject, components like Practicals, Projects, Group Discussion, Viva, Field Visit, Library record form part of the core course. All the students of the course must take the core courses.

Subject elective
The optional course is also offered by the parent department. The objective is to provide choice and flexibility within the department. The student can choose his/her optional. The optional is related to the major subject. The difference between core course and optional course is that there is choice for the student. The department is at liberty to offer optional course every semester or in any two semesters. It must be offered at least in two semesters. The staff too may experiment with diverse courses.

Elective Course
Elective Course is an interdepartmental course offered by a department for the students belonging to other departments. The objective is to provide mobility and flexibility outside the parent department. This is introduced to make every course multi-disciplinary in nature. It is to be chosen from a list of courses offered by various departments. The list is given at the end of the syllabus copies. Two Elective Courses must be taken by students.

First Year	Semester I		Semester II	
4 credits	*101: Biomolecules*		*103: Biomolecules Adv.*	
	Unit 1:	Nature and Scope of Biochemistry Origin of life	Unit 1:	Complex carbohydrates
	Unit 2:	Carbohydrate chemistry	Unit 2:	Proteins
	Unit 3:	Amino acids	Unit 3:	Complex lipids and sterols
	Unit 4:	Lipid chemistry	Unit 4:	Nucleic acids
3 credits	*102: Practical*		*104: Practical*	
2 credits	*Biochem Elec:*		*Biochem Elec:*	
	101:Elective: Nutrition & dietetics		*103:* Environmental studies	
	102:Elective: Food adulteration			

Semester I

101: Biomolecules *(4 credits)*

Unit 1: Nature and Scope of Biochemistry

What is biochemistry, development of biochemistry, What is biochemical approach, scope of biochemistry, applications of biochemistry, Biochemical literature (how to conduct a literature search and how to read a research article).

Origin of life

Living matter, early history, Chemical evolution, Origin of living systems (molecules to first cell), RNA world, development of metabolic pathways, central dogma of life, mutation and evolution.

Unit 2: Carbohydrate Chemistry

Introduction, natural occurrence, Physiological importance
Classification: aldose and ketoses, Mono, oligo and polysaccharides, Structure of monosaccharide

Physical properties of carbohydrates: Isomerism, Asymmetric carbon atom, Stereoisomerism, Optical isomerism and measurement of optical activity, enantiomers, diasterioisomers, epimers, anomers, anomeric carbon atom.

Configuration in sugars, Reference carbohydrate, Fischer's projection formula and representation of various sugars, Haworth's representation of cyclic structure. Furanose and pyranose structures and representation of various sugars, Mutarotation, Conformation in sugars: boat and chair forms.

Chemical properties of carbohydrate due to aldehyde and keto groups: Oxidation of sugars, Reduction of sugars, Lobry de Bruyn-von Ekenstein reaction, reducing action of sugars in alkaline medium, Action of mineral acids, Action of hydroxylamine, Action of hydrogen cyanide, Action of hydrazine

Chemical properties of carbohydrate due to hydroxyl groups: Formation of esters, ethers and glycosides, Importance of glycosides.

Colour reactions of carbohydrates: Molisch's test, iodine test, Fehlings test, Benedict's test, Barfoed's test, Seliwanoff test, Bial's test, Anthrone test, Dinitrosalicycylic acid test, diphenylamine test, Phloroglucinol test, Benzimidine test, Mucic acid test, Carbazole test. Transformation of sugars: Step up and step down synthesis, aldo and keto conversions, Sugars to uronic acids, Sugars to vitamin C.

Unit 3: Amino acids

Introduction, structure and classification of: standard amino acids, introduction to rare amino acids, non-protein amino acids, essential Vs Non essential amino acids.

Colour reactions of amino acids: Ninhydrin reaction, Hopkins-Coles reaction, Ehrlich's reaction, Nitropruside reaction, Sakaguchi's reaction, Xanthoproteic reaction, Million's reaction, Sullivan's reaction, Pauli's reaction, Folin-Phenol reaction,

Physical properties of amino acids: Stereoisomerism, stereo-specificity, optical activity, acid base properties, ampholytic nature, titration curve.

Chemical reactions of amino acids due to carboxyl group: formation of esters, reduction of carbonyl group by LiAlH4, decarboxylation, amide formation, Chemical reactions of amino acids due to amino groups: methylation of amino acids, Sanger's reaction, Edman's reaction, Nitrous acid reaction, Sorenson's formal titration, Siegfried's carbamino reaction, Dansyl chloride reaction, oxidative deamination by oxides and ninhydrin

Unit 4: Lipid Biochemistry

Introduction, classification of lipids, classification of fatty acids, saturated, unsaturated, hydroxyl, cyclic, branched chain, PUFA, Structure, properties, function and importance of saturated, unsaturated, hydroxyl, cyclic, branched chain, PUFA.

Physical properties, isomerism, geometrical (cis-trans) isomers, positional isomers, melting point, boiling point, solubility, absorption spectra.

Chemical properties: salt formation, detergent, esterification, hydrogenation, halogenations, oxidation, Triglycerides: chemical properties, chemical composition, hydrolysis, saponification, hydrogenation, detergents (action and importance).

Chemical constants of fat: saponification value, iodine number, reichert Meissl number, acetyl number, acid number, Rancidity of fats: Hydrolytic, oxidative and lipolytic. Prevention of rancidity, Waxes: natural waxes, properties, importance

Ref:

1. Berg JM, and Tymoczko TJ Stryer L,: Biochemistry (6th ed), (2008).WH Freeman Publishers
2. Conn EE, Stumpf PK, Bruening G and Doi RH: Outlines of Biochemistry (2007).
3. David Ucko: Living chemistry: an introduction to general, organic and biological chemistry, (1986).
4. Deb AC: Fundamentals of Biochemistry (2000).
5. Donald Voet and Voet J: Biochemistry (4th ed), (2011). John Wiley and Co.

6. Jeoffrey Zubay: Origin of life on the earth and in the cosmos (2nd ed) (2000). Academic Press
7. Jeoffrey Zubay: Principles of Biochemistry, McGraw Hill Publications, (1996).
8. Murray RK, Rodwell VW: Harpers review of Biochemistry (25th ed), (2000).
9. Nelson DL and Cox MM: Lehninger's Principles of Biochemistry (5th ed). (2008).
10. Rama Rao AV: A text book of Biochemistry (10th ed) (2006).
11. Rodney Boyer: Concepts in Biochemistry (3rd ed), (2006). John Wiley and Co.
12. West and Todd: Text book of Biochemistry (4th ed) (1970). The Macmillan Co. New York.
13. White A, Handler P and Smith EL: Principles of Biochemistry (6th ed) (1978). MacGraw-Hill Publications.

102: Practicals *(3 credits)*

Duration: 2hr **Marks: 100** **Total 45 hrs**

Note:

- *Students should know the principles, theory, protocol and calculations for each experiment.*
- *They should know about reagent preparations.*

1. Basic Practicals:
    a. Biochemical reagent preparations for various solutions with respect to different Normality, Molarity etc.
    b. Use of microscope and microscopic examination of osazones.
    c. Preparation of distilled water and water analysis (pH, Hardness, Alkalinity, Nitrite, Chloride)

2. Experiments involving titrimetric procedures:
    a. Estimation of amino acid by formal titration.
    b. Estimation of ascorbic acid by 2,6 dichlorophenol indophenol.
    c. Estimation of sugar from biological fluid by Cole's method.
    d. Determination of Acid number of edible oil.
    e. Determination of saponification number of edible oil.
    f. Estimation of unsaturated fat by iodine value of oil.

3. Qualitative analysis:
    a. Qualitative tests for monosaccharides, disaccharides and polysaccharides.
    b. Qualitative tests for sugar mixtures which includes reducing and non-reducing sugars and monosaccharides with mono, di or polysaccharides.

Ref:

1. A Manual of Laboratory Techniques, MIN, ICMR Publications
2. Jayaraman, J: Laboratory manual in Biochemistry
3. Malhotra VK: Handbook of practical biochemistry
4. Mukherjee L: Medical Laboratory Technology, Vol 1,2,3.
5. Plummer: An Introduction to Practical Biochemistry, (1987), McGraw HillPublications.
6. Ranjana Chawla: Clinical Chemistry
7. Sadasivan and Manickam: Biochemical methods.
8. Eaton AD, Clesceri LS, Greenberg, AE: Standard methods for the examination of water and waste water (13^{th} ed), (1995).
9. Varley H: Practical Clinical Biochemistry, (1966).

Semester I

Biochem Elective: 101: Nutrition and Dietetics *(2 credits)*

Unit 1: General nutrition

i. Introduction and definition of food and nutrition, basic food groups
ii. Energy yielding, body building and protective foods
iii. Classification of food
iv. Description of proximate principles.

Unit 2:

ii. Role of various vitamins and minerals
i. Balanced diet for various groups.
ii. Assessment of nutritional status.
iii. Diet surveys for individuals and family

Unit 3: Menu planning and dietetics

i. Diet during physiological stress
ii. Diet in obesity and under weight
iii. Diet in fever
iv. Diet in malnutrition

Unit 4:

ii. Diet in liver diseases
i. Diet in diabetes
ii. Diet and anaemia
iii. Diet in cancer

Ref:

1. B Shrilakhshmi: Dietetics (5th ed) (2006).
2. R. Rajalakhshmi: Applied Nutrition.
3. MS Banaji, Rao and Reddy: Human Nutrition (2nd ed) (2004)
4. ME Shils, JA Olson and M Shike: Modern Nutrition in health and disease (10th ed) (2006)
5. B Shrilakhmi: Food science(3rd ed) (2005)
6. Kathleen Mahan,Stump SE: Krause's Food, nutrition and diet therapy (11th ed), (2004).
7. B Shrilakhmi: Nutrition Science (2006)
8. C Gopalan, R Sastri and SC Balasubramanian: Nutritive value of Indian Foods (2007)

Semester I

Biochem Elective: 102: Food Adulteration *(2 credits)*

Unit 1: Food adulterants

What is food adulteration? Food quality, safety and authenticity, why is it done? Who dies it? How is it done? Types of food adulterants. Which food items are adulterated? How can one detect?

Unit 2: prevention of adulteration

How can one prevent it? People's awareness, laws (food standards), education, effect on health of various adulterants which are commonly used

Unit 3: Evaluation of food Quality

Quality management system, ISO 22000, HACCP, Codex standards, PFA act, food laws and standards

Ref:

1. Sreelakhshmi: Food science
2. Bamaji M: Text book of human nutrition (3rd ed)
3. Rajalakshmi: Applied nutrition (2nd ed)

Semester II

103: Biomolecules Adv. *(4 credits)*

Unit 1: Complex carbohydrates

Oligosaccharides: Occurrence, structure, chemical name, functions and importance of: maltose, sucrose, lactose, cellobiose, trehalose, raffinose.

Polysaccharides: Occurrence, structure, chemical name, functions and importance of: starch, glycogen, cellulose, hemicelluloses, dextrin, chitin, inulin, dextran, pectin, agar, algininc acid, mannans.

Carbohydrate derivatives of biological importance: amino sugars, deoxy sugars, sugar phosphates, blood group polysaccharides, cell wall polysaccharides, teichoic caid, muramic acid, sialic acid, mucopeptides.

Glycosaminoglycans: Occurrence, structure and functions oaf hyaluronic acid, heparin, chondroitin sulphates, A, B and C, Glycoproteins and preoteoglycans.

Unit 2: Proteins

Peptides, structure, formation and characteristics of peptide bonds.
Proteins: Classification based on solubility, shape and composition. Functions of proteins.
Properties: isoelectric pH of proteins, hydration, behaviours in solution, solubility, salting in and salting out or proteins, precipitation of proteins by acid reagents, heavy metals, heat, extreme pH changes, denaturation and renaturation of proteins.

Chemical properties of proteins: colour reactions.
Structure of proteins: primary, secondary, tertiary and quaternary structures.

Determination of sequences of amino acids in proteins.
Biological functions of : fibrous proteins, keratins, collagen, elastin. Globular proteins, haemoglobin, myoglobin. Other proteins, glycoproteins, lipoproteins, nucleoproteins, metaloproteins.

Unit 3: Complex lipids and sterols

Glycerophospholipids: Classification, properties and functions of lecithin, lysolecithin, cephalins, plasmalogens, phosphatidyl serine, phosphatidyl inositol.Sphingolipids: Classification, properties and functions of cerebrosides, gangliosides.Sulpholipids, gangliosides, proteolipids, and prostaglandins, Structure and properties of sterols. Colour reactions of cholesterol.

Unit 4: Nucleic acids

Introduction to nucleic acids. Composition of DNA and RNA. Nitrogenous bases: structure and properties of normal and rare. Sugars. Nomenclature for writing the structure of nucleic acids. Nucleosides and nucleotides, linkages, different types, naturally occurring, functions.

DNA: important features of double helix structure.
RNA: different types, structures, functions and differences and similarities with DNA.

Ref:

1. Berg JM, and Tymoczko TJ Stryer L,: Biochemistry (6th ed), (2008).WH Freeman Publishers
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12. West and Todd: Text book of Biochemistry (4th ed) (1970). The Macmillan Co. New York.
13. White A, Handler P and Smith EL: Principles of Biochemistry (6th ed) (1978). MacGraw-Hill Publications.

104: Practicals *(3 credits)*

Duration: 2hr **Marks: 100** **Total 45 hrs**

1. Experiments involving oxidometry
    a. Use of potassium permanganate in the estimation of i) Iron ii) oxalate iii) hydrogen peroxide iv) nitrite v) chromate.
    b. Estimation of calcium from biological fluids.
    c. Use of potassium dichromate in the standardization of sodium thiosulphate and estimation of copper by iodometry.
2. Qualitative analysis of colour reactions of amino acids.
3. Qualitative analysis of proteins like gelatin, egg albumin and its identification.
4. Precipitation test for proteins.
5. Analysis for physical and chemical properties of lipids e.g. solubility, cholesterol reaction, saturation and un saturation of lipids.
6. Qualitative tests for food stuffs.
    a. Milk
    b. Bread
    c. Potato
7. Use of single cell colorimeter, its construction and operation
8. Estimation of protein by Biuret method.

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10. Varley H: Practical Clinical Biochemistry, (1966).

Semester II

Biochem Elective: 103*: Environmental Studies** ***(2 credits)