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:

<table>
<thead>
<tr>
<th>First year</th>
<th>Semester I</th>
<th>Semester II</th>
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</thead>
<tbody>
<tr>
<td>4 credits</td>
<td>Biochemistry 101</td>
<td>Biochemistry 103</td>
</tr>
<tr>
<td>3 credits</td>
<td>Biochemistry 102 (Practical)</td>
<td>Biochemistry 104 (practical)</td>
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<tr>
<td>2 credits</td>
<td>Biochemistry Elective 101</td>
<td>Biochemistry Elective 102</td>
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<tr>
<td></td>
<td></td>
<td>Biotechnology Elective 102</td>
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<tr>
<td>Total 18 credits</td>
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<table>
<thead>
<tr>
<th>Second year</th>
<th>Semester III</th>
<th>Semester IV</th>
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<tbody>
<tr>
<td>4 credits</td>
<td>Biochemistry 201</td>
<td>Biochemistry 204</td>
</tr>
<tr>
<td>4 credits</td>
<td>Biochemistry 202</td>
<td>Biochemistry 205</td>
</tr>
<tr>
<td>3 credits</td>
<td>Biochemistry 203 (Practical)</td>
<td>Biochemistry 206 (practical)</td>
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<tr>
<td>2.5 credits</td>
<td>Biochem sub. Elective 201</td>
<td>Biochem sub. Elective 202</td>
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<tr>
<td>Total 25 credits</td>
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<table>
<thead>
<tr>
<th>Second year</th>
<th>Semester V</th>
<th>Semester VI</th>
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<tbody>
<tr>
<td>4 credits</td>
<td>Biochemistry 301</td>
<td>Biochemistry 307</td>
</tr>
<tr>
<td>4 credits</td>
<td>Biochemistry 302</td>
<td>Biochemistry 308</td>
</tr>
<tr>
<td>4 credits</td>
<td>Biochemistry 303</td>
<td>Biochemistry 309</td>
</tr>
<tr>
<td>4 credits</td>
<td>Biochemistry 304</td>
<td>Biochemistry 310</td>
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<tr>
<td>5 credits</td>
<td>Biochemistry 305 (Practical)</td>
<td>Biochem 3011 (Practical)</td>
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<tr>
<td>2 credits</td>
<td>Biochem sub. Elective 301</td>
<td>Biochem sub. Elective 303</td>
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<tr>
<td>2 credits</td>
<td>Biochem sub. Elective 302</td>
<td>Biochem sub. Elective 304</td>
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<td></td>
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<tr>
<td>Total 25 credits</td>
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</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Semester I</th>
<th>Semester II</th>
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<tr>
<td><strong>4 credits</strong></td>
<td><strong>3 credits</strong></td>
</tr>
<tr>
<td>101: Biomolecules</td>
<td>103: Biomolecules Adv.</td>
</tr>
<tr>
<td>Unit 1: Nature and Scope of Biochemistry</td>
<td>Unit 1: Complex carbohydrates</td>
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<tr>
<td>Origin of life</td>
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</tr>
<tr>
<td>Unit 2: Carbohydrate chemistry</td>
<td>Unit 2: Proteins</td>
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<tr>
<td>Unit 3: Amino acids</td>
<td>Unit 3: Complex lipids and sterols</td>
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<tr>
<td>Unit 4: Lipid chemistry</td>
<td>Unit 4: Nucleic acids</td>
</tr>
<tr>
<td><strong>3 credits</strong></td>
<td><strong>2 credits</strong></td>
</tr>
<tr>
<td>102: Practical</td>
<td>104: Practical</td>
</tr>
<tr>
<td><strong>Biochem Elec:</strong></td>
<td><strong>Biochem Elec:</strong></td>
</tr>
<tr>
<td>101: Elective: Nutrition &amp; dietetics</td>
<td>103: Environmental studies</td>
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<tr>
<td>102: Elective: Food adulteration</td>
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</tbody>
</table>

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, Stereosimism, Optical isomerism and measurement of optical activity, enantiomers, diastereoisomers, 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, Dinitrosalicyclic 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:**

   MacGraw-Hill Publications.
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.
6. Ranjana Chawla: Clinical Chemistry
7. Sadasivan and Manickam: Biochemical methods.
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:

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
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, alginate acid, mannans.

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

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

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.


Unit 3: Complex lipids and sterols


Unit 4: Nucleic acids


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

104: Practicals  
(3 credits)

Duration: 2hr  
Marks: 100  
Total 45 hrs

1. Experiments involving oxidometry
   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

Ref:

1. A Manual of Laboratory Techniques, MIN, ICMR Publications
3. Jayaraman, J: Laboratory manual in Biochemistry
4. Malhotra VK: Handbook of practical biochemistry
5. Mukherjee L: Medical Laboratory Technology, Vol 1,2,3.
7. Ranjana Chawla: Clinical Chemistry
8. Sadasivan and Manickam: Biochemical methods.
Semester II

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