

# North Maharashtra University, Jalgaon



'A' Grade  
NAAC Re-Accredited  
(3<sup>rd</sup> Cycle)

**Structure of syllabus for**

**B. Sc. [Biochemistry]**

**F. Y. B. Sc.**

**Choice Based Credit System (CBCS)**

**[2018 - 19]**

## F. Y. B. Sc. Biochemistry (CBCS Structure)

### Prelude

The cumulative demand for trained and skilled manpower in the area of Biochemistry requires in depth functional knowledge of modern biology through hands-on training to the students.

The syllabus has been prepared anticipating the requirements of B.Sc. Biochemistry students under CBCS Program. The contents have been drawn to accommodate the widening horizons of the Biochemistry discipline and reflects the changing needs of the students. The detailed syllabus for each paper is appended with a list of suggested readings.

The degree of Bachelor of Science in Biochemistry (Choice Based Credit System) aims to introduce various aspects of Biochemistry and interdisciplinary subjects to the students. The program in Biochemistry as one of the core subject is designed to cultivate a scientific attitude and interest towards the modern areas of Biochemistry in particular and life science in general. This will help the students to become critical and curious in their outlook. The courses are designed to impart the essential basics in Biochemistry, Chemistry, Botany, Microbiology, Zoology and Biotechnology at the initial level of graduation. The basic courses are infused with application in modern life sciences, and awareness on Biochemistry and its influence in human life. The integration of various courses in the program is aimed to develop proficiency in the theory as well as practical experiments, common equipment, laboratory, along with the collection and interpretation and presentation of scientific data in proper manner. Beside this, the students will be equipped with knowledge in the newer areas of Biochemistry and its application in medical science, agriculture, industry, proteomics, genomics, metabolomics, bioinformatics, nano-biotechnology etc. This will create awareness about Biochemistry and contribution of Biochemistry among the society. At the end of the course, the students are expected to have good working knowledge in the field of Biochemistry and in addition knowledge gained from courses of interdisciplinary in nature. Students will surely have an urge to continue higher studies in Biochemistry and contribute significantly in the development.

The present syllabi is restructured anticipating the future needs of Biochemistry with more emphasis on imparting hands-on skills. The main thrust is laid on making syllabus compatible with developments in Education, Research and Industrial sectors. The Theory and Practical course in new restructured course will lead to impart skill-set essentials to further Biochemistry.

Hence, Board of Studies in Life Sciences in its meeting held on 23/06/2018 resolved to accept the revised syllabus for F. Y. B. Sc. (Biochemistry) based on Choice Based Credit System (CBCS) of UGC guidelines.

### Scheme for B.Sc. program (Faculty of Science and Technology)

		First Year				Second Year				Third Year				Total Credit value
		Semester I		Semester II		Semester III		Semester IV		Semester V		Semester VI		
1	<b>Core courses (16)</b>	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	
	(i) Theory	4	4	4	4	4	3	4	3					4 X 14=56
	(ii) Practical	2	4	2	4	2	3	2	3					2 X 14=28
2	<b>Ability enhancement compulsory course (AECC) (2)</b>	2	1	2	1									2 X 2 =04
3	<b>Skill Enhancement Course (SEC) (4)</b>					2	1	2	1	2	1	2	1	2 X 4 = 16
4	<b>Discipline Specific Elective DSE (6)</b>													
	(i) Theory									4	3	4	3	4 X 6 =24
	(ii) Practical									2	3	2	3	2 X 6 =12
	<b>Total Credit value (Credit x No. of Courses )</b>	26		26		20		20		20		20		132

## Course Structure:

**Duration:** The duration of B.Sc. (Biochemistry) degree program shall be three years.

**Medium of instruction:** The medium of instruction for the course shall be English.

The present syllabus has been prepared to (i) accommodate the advanced topic on the Biochemistry discipline, (ii) build the basic science knowledge at the level of first year of Biochemistry and (iii) reflect the changing needs of the students. The detailed syllabus for each paper is appended with a list of suggested readings.

At first year of under-graduation, students are given exposure to basic science to build the foundation of advance Biochemistry. For this purpose, more focus on relevant experimentation on the topics are included in practical course. In practical course, students will be trained in preparing laboratory manuals, standard operating practices and log books.

At second year under-graduation, students will be introduced to different areas necessary to form the basis of biotechnology like microbiology, biochemistry, human physiology. The relevant practicals are included to enrich their knowledge.

At third year under-graduation, six theory and three practical papers each for two semesters are included to uncover all applied areas of Biochemistry.

The courses codes and titles for the courses are as given below: BC: Biochemistry,

### Core Courses [DSC] (12 Courses)

Semester	CC - A and B	Paper code	Paper I	Paper code	Paper II	Practical paper code	Biochemistry Practical Paper
I	CC A I	BC101	Chemistry of Biomolecules	BC102	Cell Biology	BC103	Practical paper I
II	CC AII	BC 201	Basic Biochemistry	BC 202	Basic Microbiology	BC 203	Practical paper II
III	CC A III	BC 301	Food Biochemistry	BC 302	Human Physiology I	BC 303	Practical Paper III
IV	CC A IV	BC 401	Environmental Biochemistry	BC 402	Human Physiology II	BC 403	Practical Paper IV

### Discipline Specific Elective [DSE] (6 theory and 3 practicals each semester)

	DSE	Paper code	Paper I	Paper code	Paper II	Practical paper code	Biochemistry Practical Paper
V	A I	BC 501	Genetics	BC 502	Plant Biochemistry	BC 503	Practical Paper V
	A II	BC 504	Clinical Biochemistry I	BC 505	Metabolism	BC 506	Practical Paper VI
	A III	BC 507	Biophysical Chemistry	BC 508	Fermentation Technology	BC 509	Practical Paper VII
VI	A IV	BC 601	Genetic Engineering	BC 602	Agrobiotechnology	BC 603	Practical Paper VIII
	A V	BC 604	Clinical Biochemistry II	BC 605	Enzymology	BC 606	Practical Paper IX
	A VI	BC 607	Bioanalytical techniques	BC 608	Biostatistics and Bioinformatics	BC 609	Practical Paper X

### More Options to Discipline Specific Elective

DSE	Paper I	Paper II	Practical Paper
DSE 4	Nutritional Biochemistry	Neutraceuticals	Practical Paper
DSE 5	Membrane Biology and Bioenergetics	Immunology	Practical Paper
DSE 6	Research Methodology	Bioethics and Biosafety	Practical Paper
DSE 7	Project Dissertation Course		

### Skill enhancement courses (SEC) (any Four):

Student has choice to study any four courses from respective semester subject to the availability of particular course at respective college

Semester	SEC	Course Title	SEC	Course Title
III	SEC I	Protein Purification Techniques	SEC II	Diagnostic Techniques in Biochemistry
IV	SEC III	Plant Tissue Culture Techniques	SEC IV	Sample and Solution Preparation
V	SEC V	Microbial Isolation and Identification Techniques	SEC VI	Biochemical Techniques in Quality Control
VI	SEC VII	Recombinant DNA Technology	SEC VIII	Electrophoresis and chromatography techniques

### Scheme for F. Y. B. Sc. (Biochemistry)

Semester	Core Course				Ability Enhancement Compulsory Course (AECC)		
	DSC		Credits	Lectures		Credits	Lectures
I	DSC - 1 A: Core Course I: <b>Biochemistry</b>	Paper I	2	30	<b>AECC 1:</b> English/Marathi/ Communication	2	60
		Paper II	2	30			
		Practical Paper	2	60			
	DSC - 2 A: Core Course II	Paper I	2	30			
		Paper II	2	30			
		Practical Paper	2	60			
	DSC - 3 A: Core Course III	Paper I	2	30			
		Paper II	2	30			
		Practical Paper	2	60			
	DSC - 4 A: Core Course IV	Paper I	2	30			
		Paper II	2	30			
		Practical Paper	2	60			
II	DSC - 1 B: Core Course I: <b>Biochemistry</b>	Paper I	2	30	<b>AECC 2:</b> Environmental Science	2	60
		Paper II	2	30			
		Practical Paper	2	60			
	DSC - 2 B: Core Course II	Paper I	2	30			
		Paper II	2	30			
		Practical Paper	2	60			
	DSC - 3 B: Core Course III	Paper I	2	30			
		Paper II	2	30			
		Practical Paper	2	60			
	DSC - 4 B: Core Course IV	Paper I	2	30			
		Paper II	2	30			
		Practical Paper	2	60			

Student has choice to study three subsidiary subjects from **DSC 2, DSC 3 and DSE 4** among Chemistry/ Botany/ Zoology /Geography during I, II, III and IV semester; subject to availability of course at respective college.

Duration of Lecture: 30 Lectures of 60 minutes or 36 Lectures of 50 min. Each theory and practical course has to be completed in 30 and 60 lectures, respectively of 60 min duration

Each theory and practical course will be of 100 marks comprising of 40 marks internal (20 marks of 2 internal examinations) and 60 marks external examination.

- **Theory examination** (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each). The pattern of question papers shall be:
  - **Question 1** (12 marks): 9 sub-questions, each of 2 marks; answerable in 2 -3 line and based on entire syllabus, attempt any 6 out of 9 questions.

- **Question 2, 3 and 4** (12 marks each): based from Unit I, II, and III, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4 in brief.
- **Question 5** (12 marks): answer only 3 out of 5 in brief, based from all 3 units, Each 4 marks.
- **Internal examination** (40 marks each semester): Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions.
- **Practical Examination:** Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 5 – 6 hours duration and shall be conducted as per schedule (10 am to 5 pm on schedule date or can be scheduled 10 am -1pm/ 2 – 5 pm for 2 consecutive days) in case of microbiology practicals where incubation condition, allied aspect are essential. There shall be 5 marks for laboratory log book and well written journal, 10 marks for viva-voce and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one expert and two examiners (external and internal) per batch for the practical examination

**Equivalence** for F.Y. B.Sc. (Biochemistry) is furnished in the following table:

<b>Old Syllabus (w.e.f. June 2015) (Semester pattern 60:40)</b>	<b>New Syllabus (w.e.f. June 2018) CBCS pattern (Semester pattern 60:40)</b>
BC-111 Chemistry of Biomolecules	BC-101 Chemistry of Biomolecules
BC-112 Cell Biology	BC-102 Cell Biology
BC-121 Basic Biochemistry	BC-201 Basic Biochemistry
BC-122 Fundamentals of Microbiology	BC-202 Basic Microbiology
BC-113 Basic techniques in Biochemistry – I	BC-103 Basic techniques in Biochemistry – I
BC-123 Basic techniques in Biochemistry – II	BC-203 Basic techniques in Biochemistry – II

## F. Y. B. Sc. (Biochemistry) Semester – I

Semester	CC -A and B	Paper code	Paper I	Paper code	Paper II	Paper code	Biochemistry Practical Paper
I	CC A I	BC101	Chemistry of Biomolecules	BC102	Cell Biology	BC113	Practical Paper I
II	CC A II	BC201	Basic Biochemistry	BC202	Basic Microbiology	BC203	Practical Paper II

### CC A I: Paper I BC101: Chemistry of Biomolecules (Theory)

Total Hours: 30

Credits: 2

Unit	Title	Topic Particular	Lectures
<b>Course objective</b>	To acquaint students with basic concepts of biomolecule chemistry		
<b>Learning outcome</b>	<p>Students will be able to:</p> <ul style="list-style-type: none"> <li>• Learn the elements present in biomolecules</li> <li>• Differentiate between monomers and polymers.</li> <li>• Explain the role of water in synthesis and breakdown of polymers.</li> <li>• Compare and contrast the structure and function of the oligo and polysaccharides.</li> <li>• Summarize the functions of proteins and able to recognize the importance of the three dimensional shape of a protein on its function and the role of non-covalent bonds in maintaining the shape of a protein.</li> <li>• Compare and contrast saturated, mono-unsaturated, and poly-unsaturated fatty acids</li> </ul>		
<b>I</b>	<b>Carbohydrates</b>	<ul style="list-style-type: none"> <li>▪ Definition, scope of Biochemistry</li> <li>▪ Biomolecules: Names of Biomolecules, their repeating units and their main function</li> <li>▪ Definition and biological importance of Carbohydrate</li> <li>▪ Classification of Carbohydrates: Monosaccharides, Oligosaccharides and Polysaccharides (definition, general formulae, and examples)</li> <li>▪ D and L forms of carbohydrates, epimers of glucose</li> <li>▪ Cyclic structure of monosaccharides: pyranose and furanose form (glucose and fructose)</li> <li>▪ Mutarotation: definition, example &amp; mechanism</li> <li>▪ Derivatives of monosaccharides: sugar alcohols, sugar acids, sugar phosphates, deoxysugars, and amino sugars</li> <li>▪ Reactions of glucose – oxidation with bromine water and nitric acid, reduction, acetylation, addition of HCN, NH<sub>2</sub>OH and phenyl hydrazine</li> <li>▪ Diasaccharides: sucrose, lactose, maltose</li> <li>▪ Homopolysaccharides: Starch, Glycogen, Cellulose</li> <li>▪ Heteropolysaccharides: Mucopolysaccharides, Hyaluronic acid, Chondroitin sulphate</li> </ul>	<b>10</b>
<b>Unit II</b>	<b>Lipids</b>	<ul style="list-style-type: none"> <li>▪ Definition and functions of lipids</li> </ul>	<b>10</b>

		<ul style="list-style-type: none"> <li>▪ Classification of lipids: Simple lipids, Compound lipids and Derived lipids with examples</li> <li>▪ Fatty acids: definition, nomenclature, Even &amp; odd chain fatty acids, Saturated and unsaturated fatty acids</li> <li>▪ Essential fatty acids: definition, examples, functions, deficiency</li> <li>▪ Triacylglycerol: definition, occurrence, functions, structure (mono, di and tri-glycerols), simple and mixed triacylglycerol</li> <li>▪ Properties of triacylglycerol: hydrolysis, saponification, rancidity, antioxidant, lipid peroxidation</li> <li>▪ Purity evaluation of fats and oils: Iodine number, saponification number, Reichert-Meissl number, acid number</li> <li>▪ Comparative account on animal and plant fat</li> <li>▪ Functions of phospholipids</li> <li>▪ Classification of phospholipids: Glycerophospholipids; phosphatidic acid, lecithins, cephalins (structure and importance); Sphingophospholipids- structure and importance.</li> <li>▪ Steroids: structure and function of cholesterol and progesterone</li> </ul>	
<b>Unit III</b>	<b>Amino acids, peptides and proteins</b>	<ul style="list-style-type: none"> <li>▪ Amino acids - definition, general structure, optical isomers, classification of amino acids based on structure, nutrition and metabolic fate.</li> <li>▪ Chemical properties of amino acids – general reactions of amino acids with NaOH, alcohol, ammonia, ninhydrin, decarboxylation, transamination, oxidative deamination</li> <li>▪ Peptides – definition and formation of peptide bonds, N- and C- terminals, representation of peptide chain, naming of peptide chain</li> <li>▪ Protein - definition and levels of organization (primary, secondary, tertiary and quaternary).</li> <li>▪ Bonds responsible for protein structure - covalent bonds (peptide and disulfide), non-covalent bonds (hydrogen, hydrophobic, and electrostatic bonds. Van der Waal's forces).</li> <li>▪ Classification of proteins based on shape, composition and solubility, biological functions and nutrition.</li> <li>▪ Denaturation of protein - agents and characteristics of denaturation</li> </ul>	<b>10</b>

<b>Suggested readings</b>	<ol style="list-style-type: none"> <li>1. Nelson, D. L. and Cox, M.M. (2007) Lehninger's Principles of Biochemistry 4<sup>th</sup> edition, W.H. Freeman and Company, New York, USA.</li> <li>2. Conn, E. E., Stumpf, P. K., Bruening G., Doi R. H. (2007) Outlines of Biochemistry, Wiley India (P) Ltd., New Delhi.</li> <li>3. Stryer, L., Tymoczko J. L., Berg J. M. (2012) Biochemistry, W. H. Freeman and Company, New York, USA.</li> <li>4. Rastogi S.C. (2001) Biochemistry, 7<sup>th</sup> edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi.</li> <li>5. Satyanarayana, U. and Chakrapani U. (2010) Biochemistry, Books and Allied Pvt. Ltd., Kolkata, India.</li> <li>6. Agarwal, G. R. Agarwal K., Agarwal O. P. (2005) Text Book of Biochemistry, 13<sup>th</sup> edition, Goel Publishing House, A unit of, Krishna Prakashan Media Pvt. Ltd., Meerut, India.</li> <li>7. Jain, J.L., Jain, S. And Jain, N. (2005) Fundamentals of Biochemistry, 6<sup>th</sup> edition, S. Chand and Company Ltd., Delhi.</li> </ol>	
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**CC A I: Paper II**  
**BC-102: Cell Biology (Theory)**

**Total Hours: 30**

**Credits: 2**

Unit	Title	Topic Particular	Lectures
<b>Course objective</b>	To complement the students with the basic understanding on the general aspects of animals and plants cell biology		
<b>Learning outcome</b>	<b>Students will be able to:</b> <ul style="list-style-type: none"> <li>• Differentiate prokaryotic from eukaryotic cells and plant cells from animal cells</li> <li>• Discern structure and functions of cell organelles</li> <li>• Understand mitosis and meiosis processes.</li> <li>• Explain types of tissues and types of cell junctions</li> </ul>		
<b>I</b>	<b>Ultra structure of cell</b>	<ul style="list-style-type: none"> <li>▪ Definition of cell and its elemental composition</li> <li>▪ Characteristics of prokaryotic and eukaryotic cell</li> <li>▪ Comparative account on plant and animal cell</li> <li>▪ Structure and functions of - cell wall, cell membrane (Fluid Mosaic model), cytoplasm, mitochondria, golgi complex, endoplasmic reticulum (smooth and rough), chloroplast, nucleus, ribosomes, lysosomes</li> </ul>	<b>10</b>
<b>Unit II</b>	<b>Cell division</b>	<ul style="list-style-type: none"> <li>▪ Introduction to cell division</li> <li>▪ Mitosis- interphase, different phases and significance of mitosis</li> <li>▪ Meiosis- different phases of meiosis-I and II and its significance</li> <li>▪ Comparative account on mitosis and meiosis</li> <li>▪ Seed dormancy and seed germination, Photoperiodism, Vernalization, Flowering, Senescence</li> </ul>	<b>10</b>



<b>Unit III</b>	<b>Tissues and cell junctions</b>	<ul style="list-style-type: none"> <li>▪ Tissues- definition and types</li> <li>▪ Epithelial tissues- general characteristics, functions and classification</li> <li>▪ Simple and compound epithelial tissues- types, brief description, functions and locations</li> <li>▪ Connective tissues- general characteristics and functions</li> <li>▪ Types of connective tissues (cartilage, bone and blood)- brief overview, functions and locations</li> <li>▪ Muscular tissues (skeletal, cardiac and smooth)- concise description, functions and locations</li> <li>▪ Nervous tissues (neuron and neuroglia)- introductory description, functions and locations</li> <li>▪ Cell junctions (complexes)- definition and types- tight junction, belt desmosome, spot desmosome and gap junction</li> </ul>	<b>10</b>
	<b>Suggested readings</b>	<ol style="list-style-type: none"> <li>1. Powar C.B. (2012) Cell Biology, 3<sup>rd</sup> edition, Himalaya Publishing House, Mumbai</li> <li>2. Chatterjee C.C. (2004) Human physiology Vol. I, 11<sup>th</sup> edition, Medical allied Agency, Kolkata, India.</li> <li>3. Nelson, D.L. and Cox, M.M. (2007) Lehninger's Principles of Biochemistry 4<sup>th</sup> edition, W.H. Freeman and Company, New York, USA.</li> <li>4. Conn, E. E., Stumpf, P. K., Bruening G., Doi R. H. (2007) Outlines of Biochemistry, Wiley India (P) Ltd., New Delhi.</li> <li>5. Stryer, L., Tymoczko J. L., Berg J. M. (2012) Biochemistry, W. H. Freeman and Company, New York, USA.</li> <li>6. Rastogi S.C. (2001) Biochemistry, 7<sup>th</sup> edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi.</li> <li>7. Satyanarayana, U. and Chakrapani U. (2010) Biochemistry, Books and Allied Pvt. Ltd., Kolkata, India.</li> </ol>	

### CC A I: Biochemistry Practical Paper I BC – 103: Basic Techniques in Biochemistry

**Total Hours: 60**

**Credits: 2**

Sr., no.	Title of the Practical	Hours
<b>Course objective</b>	<b>To acquaint with various techniques used in biochemistry</b>	
<b>Learning outcome</b>	<b>Students will be able to:</b> <ul style="list-style-type: none"> <li>• Understand hazards and safety measure in laboratory.</li> <li>• Do normality, molarity, and percent solution based calculations.</li> <li>• Perform qualitative tests for carbohydrates, lipids and amino acids</li> <li>• Use, handling and care of compound microscope</li> <li>• Identify various phases of mitosis</li> <li>• Temporary mount available tissue</li> </ul>	

1	▪ First aid, Hazardous Chemicals, Antidotes to hazardous and toxic chemicals, Safety measures in laboratory	4
2	▪ Introduction of laboratory instruments - water bath, autoclave, hot-air oven, incubator, refrigerator, centrifuge, laminar air flow cabinet, pH meter, weighing balance, spectrophotometer	4
3	▪ Preparation of normal and molar, and percent solutions	4
4	▪ Preparation of buffers	4
5.	▪ Qualitative tests for carbohydrates- anthrone test, iodine test, Barfoed test, Seliwanoff's test, Fehling's test, Bial's test	4
6.	▪ Isolation of starch from potato	4
7.	▪ Qualitative tests for lipids- solubility test, acrolein test, presence of free fatty acids and unsaturated fatty acids	4
8.	▪ Qualitative tests for amino acids- Ninhydrin test, Xanthoproteic test, Ehrlich's test, Sodium nitroprusside test, Sullivan and McCarthy's test, Millon's test	4
9.	▪ Isolation of casein from milk	4
10	▪ Estimation of protein by Biuret method	4
11.	▪ Use, handling and care of compound microscope	4
12	▪ Study of various phases of mitosis using suitable sample	4
13	▪ Temporary mounting of available tissues	4
14	▪ Differential staining for DNA and RNA in human cheek epithelial cells	4
15	▪ Visualization of mitochondria by Janus green stain	4
<b>Suggested readings</b>	<ol style="list-style-type: none"> <li>1. Cappuccino J. G. and Sherman N. (2014) Microbiology – a Laboratory Manual, 10<sup>th</sup> edition, Addison Wesley Publishing Company Inc., Boston, USA.</li> <li>2. Wilson K. and Walker J. (2003) Practical Biochemistry: Principles and techniques, 5<sup>th</sup> edition, Cambridge University Press, UK.</li> <li>3. Plummer D. T. (2005) An Introduction to Practical Biochemistry, 3<sup>rd</sup> edition, Tata McGraw Hill Publishing Company Ltd., New Delhi.</li> <li>4. Baker F. J. (1967) Handbook of bacteriological techniques, 2<sup>nd</sup> edition, Butterworth &amp; Co Publishers Ltd., UK.</li> <li>5. Oser B. L. (ed.) (1965) Hawk's physiological chemistry, 14<sup>th</sup> edition, McGraw-Hill Book Company, New York, USA.</li> <li>6. Jayaraman J. (2008) Laboratory Manual in Biochemistry, New Age International (P) Ltd. Publishers, New Delhi.</li> <li>7. Sadashivam S. and Manikam A. (2008) Biochemical Methods, 3<sup>rd</sup> edition, New Age International (P) Ltd. Publishers, New Delhi.</li> <li>8. Aneja K. R. (2007) Experiments in Microbiology, Plant Pathology, and Biotechnology, 4<sup>th</sup> edition, New Age International (P) Ltd. Publishers, New Delhi.</li> <li>9. Gunasekaran P. (2005) Laboratory Manual in Microbiology, 1<sup>st</sup> edition, New Age International (P) Ltd. Publishers, New Delhi.</li> <li>10. Rao B. S. and Deshpande V. (2005) Experimental Biochemistry: A student companion, I. K. International Pvt. Ltd., New Delhi.</li> <li>11. Gunasekaran, P (2011) Laboratory Manual in Microbiology, New Age International Publishers,</li> </ol>	

**Note: Mandatory to perform at least 12 - 13 practicals**

**F. Y. B. Sc. (Biochemistry) Semester – II**  
**CC A I: Paper I**  
**BC- 201: Basic Biochemistry (Theory)**

Total Hours: 30

Credits: 2

Unit	Title	Topic Particular	Lectures
<b>Course objective</b>	To complement the students with the fundamental concepts of biochemistry		
<b>Learning outcome</b>	<b>Students will be able to:</b> <ul style="list-style-type: none"> <li>• Recall DNA structure and functions</li> <li>• Discuss types and functions of RNA</li> <li>• Describe classification and properties of enzymes</li> <li>• Understand industrial applications of enzymes</li> <li>• Differentiate water soluble vitamins from fat soluble vitamins and Understand clinical significance of the vitamins</li> </ul>		
<b>I</b>	<b>Enzymes</b>	<ul style="list-style-type: none"> <li>▪ Definition and historical background of enzyme.</li> <li>▪ Terminologies: intracellular enzymes, extracellular enzymes, holoenzymes, apoenzymes, prosthetic group, cofactor, coenzymes, isoenzymes, katalas, international unit, turnover number and active site.</li> <li>▪ Nomenclature on the basis of – substrate acted upon by enzyme, type of reaction catalysed, substrate acted upon and type of reaction catalysed, substance (product) that is synthesized, over all chemical reaction taken into consideration (Enzyme commission number).</li> <li>▪ Classification of enzymes - six major classes with description and examples each with EC number and reaction.</li> <li>▪ Factors affecting enzyme activity - effect of substrate concentration, enzyme concentration, product concentration, pH, temperature, activators, time, and inhibitors.</li> <li>▪ Specificity of enzyme action - absolute specificity, group specificity, optical specificity and geometrical specificity.</li> <li>▪ Active site - definition and salient features of active site.</li> <li>▪ Mechanism of enzyme action – lock and key model, induced fit model.</li> <li>▪ Industrial applications of enzymes</li> </ul>	<b>10</b>
<b>Unit II</b>	<b>Nucleic acids</b>	<ul style="list-style-type: none"> <li>▪ Definition and types of nucleic acid-DNA and RNA.</li> <li>▪ Structural components of DNA and RNA-phosphoric acid, pentose sugar, nitrogenous bases - purines and pyrimidine (numbering of purine and pyrimidine rings and chemical names).</li> <li>▪ Nucleosides-deoxyribonucleosides, ribonucleosides and nomenclature of nucleosides.</li> </ul>	<b>10</b>

		<ul style="list-style-type: none"> <li>▪ Nucleotides-deoxyribonucleotides, ribonucleotides, nomenclature of nucleotides, mono-, di- and tri- ribo and deoxyribonucleotides, functions of nucleotides.</li> <li>▪ DNA: formation of 3'5'-phosphodiester bond, Watson and Crick model of DNA, Chargaff's rule.</li> <li>▪ Forms of DNA: A-DNA, B-DNA, C-DNA and Z-DNA (condition, shape, helix diameter, rise per base pair, base pair per turn of helix, helix pitch, major and minor grooves).</li> <li>▪ Denaturation of DNA: definition and its effect on UV absorption, viscosity, and specific optical rotation.</li> <li>▪ Effect of pH and temperature on DNA denaturation, definition of renaturation of DNA.</li> <li>▪ RNA: Structure, differences with DNA and types of RNA; rRNA: prokaryotic and eukaryotic rRNA and types; tRNA: cloverleaf structure. mRNA - hnRNA, exons, introns, splicing, 5' capping, 3' poly A tail</li> </ul>	
<b>Unit III</b>	<b>Vitamins</b>	<ul style="list-style-type: none"> <li>▪ Definition, history and nomenclature, Classification - fat-soluble and water soluble vitamins.</li> <li>▪ Fat-soluble vitamins: chemistry, dietary sources, recommended dietary allowance, biochemical functions, deficiencies, hyper-vitaminosis of vitamin A, D, E and K.</li> <li>▪ Water-soluble vitamins: chemistry, dietary sources, recommended dietary allowance, biochemical functions, deficiencies, hyper-vitaminosis of vitamin C, B1, B6, and B12</li> </ul>	<b>10</b>
	<b>Suggested readings</b>	<ol style="list-style-type: none"> <li>1. Nelson, D. L. and Cox, M.M. (2007) Lehninger's Principles of Biochemistry 4<sup>th</sup> edition, W.H. Freeman and Company, New York, USA.</li> <li>2. Conn, E. E., Stumpf, P. K., Bruening G., Doi R. H. (2007) Outlines of Biochemistry, Wiley India (P) Ltd., New Delhi.</li> <li>3. Stryer, L., Tymcozko J. L., Berg J. M. (2012) Biochemistry, W. H. Freeman and Company, New York</li> <li>4. Rastogi S.C. (2001) Biochemistry, 7<sup>th</sup> edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi.</li> <li>5. Satyanarayana, U. and Chakrapani U. (2010) Biochemistry, Books and Allied Pvt. Ltd., Kolkata, India.</li> <li>6. Agarwal, G. R. Agarwal K., Agarwal O. P. (2005) Text Book of Biochemistry, 13<sup>th</sup> edn., Goel Publishing House, Krishna Prakashan Media Pvt. Ltd., Meerut, India.</li> <li>7. Jain, J.L., Jain,S. and Jain,N. (2005) Fundamentals of Biochemistry, 6<sup>th</sup> edn., S. Chand and Company Ltd., Delhi.</li> </ol>	

**CC A I: Paper II**  
**BC - 202 Basic Microbiology (Theory)**

Total Hours: 30

Credits: 2

Unit	Title	Topic Particular	Lectures
Course objective	To complement the students with the various concepts about microorganisms		
Learning outcome	Students will be able to: <ul style="list-style-type: none"> <li>• Explain types, characteristics and significance of microorganisms</li> <li>• Describe the structure and functions of major components of microbial cells</li> <li>• Understand microbial growth, its measurement and bacterial growth curves</li> <li>• Classify microorganisms based on nutrition</li> <li>• Apply isolation techniques to screen bacteria on solid media</li> <li>• Acquainted with various methods of sterilization and disinfection</li> </ul>		
I	Characteristics of microbes	<ul style="list-style-type: none"> <li>▪ Types of microorganisms. General characteristics and significance of bacteria, algae, fungi, virus and protozoa. Nutrition, classification and mode of reproduction.</li> <li>▪ Major characteristics of microorganisms – morphological, chemical, metabolic, antigenic, and genetic characteristics.</li> <li>▪ Role of microorganisms in infection, fermentation, environment and agriculture.</li> <li>▪ Morphology and fine structure of bacteria - size, shape, arrangements, structure of bacterial cell,</li> <li>▪ Structure and functions of flagella, Pilli, fimbriae, glycocalyx, capsule and cell wall of Gram positive and Gram negative bacteria</li> </ul>	10
Unit II	Growth, Nutrition and Isolation of microorganisms	<ul style="list-style-type: none"> <li>▪ Concept of growth. Growth curve: lag, logarithmic, stationary and death phase.</li> <li>▪ Mathematical expression of growth – growth rate and generation time.</li> <li>▪ Measurement of growth: Cell number, Cell mass, Cell activity</li> <li>▪ Nutritional classification of microorganisms. Media – ingredients, types on the basis of physical state, composition and use.</li> <li>▪ Methods of isolation of bacteria on solid media - streak plate method, pour plate method, roll tube method and spread plate method.</li> <li>▪ Staining - concept of stains, acidic and basic stain, leuco compounds, intensifiers and mordant, aims of staining</li> </ul>	10
Unit III	Control of microorganisms	<ul style="list-style-type: none"> <li>▪ Definitions- sterilization, disinfection, antisepsis, sanitization, decontamination, pasteurization, preservation, germicidal and bactericides</li> <li>▪ Sterilization</li> </ul>	10

		<ul style="list-style-type: none"> <li>• Heat- thermal death point, thermal death time, decimal reduction time <ul style="list-style-type: none"> <li>• Moist heat- mode of action, steam under pressure, Fractional sterilization, Boiling water, Pasteurization and canning</li> <li>• Dry heat- mode of action, incineration, hot air oven</li> </ul> </li> <li>• Radiation-ionizing and non-ionizing radiations</li> <li>• Chemical sterilization- ethylene oxide, formaldehyde</li> <li>• Filtration</li> <li>▪ Disinfection: characteristics of an ideal disinfectant, Disinfectants: phenol and phenolic compounds, alcohol, heavy metals, halogens, dyes, detergents, hydrogen peroxide</li> </ul>	
	<b>Suggested readings</b>	<ol style="list-style-type: none"> <li>1. Stanier R. Y., Ingraham J. L., Wheelis M. L. and Painter P. R. (1992) General Microbiology, 5<sup>th</sup> edition, Macmillan Press Ltd. UK.</li> <li>2. Pelczar M. J. Jr, Chan E. C. S., Krieg N. R. (1985) Microbiology, 5<sup>th</sup> edition, Tata McGraw-Hill Education Pvt. Ltd, India</li> <li>3. Madigan M. T., Martinko J. M., Dunlap P. V. and Clark D. P. (2008) Brock Biology of Microorganisms 12<sup>th</sup> edition, Pearson Benjamin-Cummings, USA.</li> <li>4. Chincholkar S. B., Chaudhari A. B., and Patil U. K. (2006) Foundation of Microbiology, 4<sup>th</sup> edition, Nirali Prakashan, Pune, India.</li> <li>5. Wiley J. M., Sherwood L. M. and Woolverton C. J. (2017) Prescott's Microbiology 10<sup>th</sup> edition, McGraw Hill International, USA.</li> <li>6. Frobisher M. Hindsill R., Crabtree K. T. and Goodheart C.R. (1974) Fundamentals of Microbiology, 9<sup>th</sup> edition, W. B. Saunder's Co. USA.</li> <li>7. Powar C. B. And Daginawala H. F. (1995) General Microbiology Vol.I and II, 2<sup>nd</sup> edition, Himalaya Publishing House, Mumbai</li> </ol>	

## CC A I: Biochemistry Practical Paper II BC – 203: Basic Techniques in Biochemistry – II

Total Hours: 60

Credits: 2

Sr. no.	Title of the Practical	Hours
<b>Course objective</b>	To impart practical knowledge on basic techniques adopted in Biochemistry	
<b>Learning outcome</b>	Students will be able to understand: <ul style="list-style-type: none"> <li>• Working principle of spectrophotometer and able to handle spectrophotometer</li> <li>• Various staining techniques and Isolate bacteria by streak plate method</li> <li>• Familiarize with viable count of the micro-organisms.</li> <li>• Analysis quality of drinking water/potable water</li> </ul>	
<b>1</b>	▪ Qualitative test for amylase	<b>4</b>

2	▪ Effect of substrate concentration on enzyme activity	4
3	▪ Quantitative determination of DNA and RNA by spectrophotometric method	4
4	▪ Thermal denaturation of DNA	4
5.	▪ Estimation of ascorbic acid by volumetric method	
6.	▪ Monochrome staining	4
7.	▪ Negative staining	4
8.	▪ Gram staining	4
9.	▪ To study motility of bacteria by hanging drop method	4
10	▪ Preparation of culture media for bacterial cultivation (Nutrient broth and nutrient agar/ MacConkey's broth and MacConkey's agar)	
11.	▪ Isolation of bacteria by spread plate method from water/soil sample	4
12	▪ Isolation and culture characterization of bacteria by streak plate techniques	4
13	▪ Determination of viable count	4
14	▪ Demonstration of bacterial growth by spectrophotometer	4
15	▪ Demonstration of quality of drinking water	4
<b>Suggested readings</b>	<ol style="list-style-type: none"> <li>1. Cappuccino J. G. and Sherman N. (2014) Microbiology – a Laboratory Manual, 10<sup>th</sup> edition, Addison Wesley Publishing Company Inc., Boston, USA.</li> <li>2. Wilson K. and Walker J. (2003) Practical Biochemistry: Principles and techniques, 5<sup>th</sup> edition, Cambridge University Press, UK.</li> <li>3. Plummer D. T. (2005) An Introduction to Practical Biochemistry, 3<sup>rd</sup> edition, Tata McGraw Hill Publishing Company Ltd., New Delhi.</li> <li>4. Baker F. J. (1967) Handbook of bacteriological techniques, 2<sup>nd</sup> edition, Butterworth &amp; Co Publishers Ltd., UK.</li> <li>5. Oser B. L. (ed.) (1965) Hawk's physiological chemistry, 14<sup>th</sup> edition, McGraw-Hill Book Company, New York, USA.</li> <li>6. Jayaraman J. (2008) Laboratory Manual in Biochemistry, New Age International (P) Ltd. Publishers, New Delhi.</li> <li>7. Sadashivam S. and Manikam A. (2008) Biochemical Methods, 3<sup>rd</sup> edition, New Age International (P) Ltd. Publishers, New Delhi.</li> <li>8. Aneja K. R. (2007) Experiments in Microbiology, Plant Pathology, and Biotechnology, 4<sup>th</sup> edition, New Age International (P) Ltd. Publishers, New Delhi.</li> <li>9. Gunasekaran P. (2005) Laboratory Manual in Microbiology, 1<sup>st</sup> edition, New Age International (P) Ltd. Publishers, New Delhi.</li> <li>10. Rao B. S. and Deshpande V. (2005) Experimental Biochemistry: A student companion, I. K. International Pvt. Ltd., New Delhi.</li> </ol>	

**Note: Mandatory to perform at least 12 - 13 practical during the semester**

## Skills acquired and Job prospectus for the Biochemistry students

Biochemistry is the molecular basis of life. Degree program in Biochemistry teaches students how inanimate, lifeless chemicals combine to produce a functional living organism. A significant attraction of the course is the ability to combine in-depth scientific knowledge with practical laboratory skills and the career opportunity in all sectors.

After successful completion of three years degree course in Biochemistry, student will be well versed with laboratory skills and transferable skills.

### Laboratory Skills:

- Laboratory safety practices
- Accurate weighing and reagent preparation
- Skillful handling of basic and advanced instruments
- Calibration of basic instruments like pH meter, micropipettes etc
- Advanced techniques like-
  - Chromatography
  - Electrophoresis
  - Spectrometry
  - Polymerase Chain Reaction (PCR)
  - Plant Tissue Culture
  - Animal Tissue Culture
- Aseptic techniques
- Logical thinking
- Analysis and interpretation of results
- Collection, organization and presentation of data

### Transferable Skills

During the course student will develop skills other than laboratory skills that are transferable across the number of career areas. These are:

- Analytical skill
- Report writing skill
- Presentation skill
- Time management
- Creative thinking
- Problem solving
- IT skills
- Planning
- Observational skill

### Job Opportunities:

After successful completion of B.Sc. in Biochemistry, student may continue further studies like M.Sc. in Biochemistry and then Ph.D. in Biochemistry and make career in research field. Students have opportunities in private as well as public (Government) sectors.

#### Private Sector:

Biochemist can work in quality control, quality assurance and R & D divisions of companies like-Biotech companies, Pharmaceutical companies, Chemical manufacturing companies, Food and Drink (includes brewing), Health and Beauty Care, Medical Instrument companies, Agricultural companies, Research Companies and Laboratories etc.

#### Public Sectors:

Blood Service, Cancer research institutes, Environmental Pollution Control, Forensic Science, Hospitals, National Blood Services, Overseas Development, Public Health Entities, Public Health Laboratories, Agriculture and fisheries etc.

#### Job profiles:

Biochemist, Biologist, Biomedical Scientist, Biotechnologist, Chemical Examiners, Chemist, Clinical Scientist, Food Scientist, Forensic Scientist, Laboratory Technician, Microbiologist, Research Associates, Research Officers, Research Scientist etc.