

**Sant Gadge Baba Amravati University, Amravati**

**Faculty:** Science and Technology

**Programme:** B.Sc. (Bio-chemistry)

**POs:**

Students of undergraduate general degree programme at the time of graduation would be able to

PO1. Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO2. Effective Communication: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

PO3. Social Interaction: Elicit views of others, mediate disagreements and help reach conclusions in group settings.

PO4. Effective Citizenship: Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO5. Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

PO6. Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.

PO7. Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.

**PSOs:**

Upon completion of the programme successfully, Student would be able to -

1. Understand structure, energy value and function of Biomolecules.
2. Prepare buffers of different pH, can perform chromatography of plant pigments and separate biomolecules by electrophoresis, perform structural analysis of substances using NMR and ESR.
3. Apply knowledge of biomolecule metabolism to diagnose various diseases and their root causes.
4. Formulate and design various biomedical enzyme-based marker kits and apply in winery, leather, dairy and detergent industry.
5. Analyse unknown DNA samples using molecular biology techniques and perform plant tissue culture of medicinally important endangered plant species.
6. Interpret reason of abnormal blood reports, probable cause and effects on human health.

**Employability Potential of the Programme:**

Biochemistry is the branch of science which deals with study of chemistry of living organisms. Biochemistry focuses on processes happening at molecular level. It focuses on what happening inside our cells, studying components like proteins, lipids, carbohydrates, nucleic acid, vitamins and hormones. 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 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 subjects 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 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 Bio-chemistry 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 Bio-chemistry 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 syllabus 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.

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:**

Students are trained in

- 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:
  - o Chromatography
  - o Electrophoresis
  - o Spectrometry
  - o Polymerase Chain Reaction (PCR)
  - o Plant Tissue Culture
  - o Animal Tissue Culture
- 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
- 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 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.

**Government Sector :** Syllabus has been design keeping in view that students can apply for various government post filled by Maharashtra Public Service Commission (MPSC), Union Public Service Commission (UPSC), Food Corporation of India, Forensic department, Health department and Food

and Drug Administration. These departments recruit successful candidates for the post of Food safety officers in food and drug administration, Assistant Chemical Analyzers in forensic laboratories of Maharashtra and other states all over India, Laboratory Technicians in Clinical pathology laboratories Health department and Food Corporation of India, Sanitary inspectors for schools 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.

Thus 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 reflect the changing needs of the students.

Hence, Board of Studies in Biochemistry, Microbiology along with Food Science in its meeting held on 03/06/2022 and 04/06/2022 resolved to accept the revised syllabus for B. Sc. I Sem. I and II (Bio-chemistry) based on Choice Based Credit System (CBCS) as per UGC guidelines. The detailed syllabus for each paper is appended with a list of suggested readings.

**Sant Gadge Baba Amravati University Amravati**  
**Scheme of teaching, learning & Examination leading to the Degree Bachelors of Science (Choice Based Credit System) (Three Years Six Semesters Degree Programme- C.B.C.S)**  
**(B.Sc. Part-I) (Semester-I) BIOCHEMISTRY**

Sr. No	Subjects	Subject Code	Teaching & Learning Scheme							Duration of Exams Hrs.	Examination & Evaluation Scheme										
			Teaching Period Per week				Credits				Maximum Marks				Minimum Passing						
			L	T	P	Total	Theory	Internal Assessment	Practical		Total	Theory + MCQ External	Skill Enhancement module Internal	Practical		Total Marks	Marks	Grade			
														Internal	External						
1	BCM 1 (Theory)	BCM 1	6				6	4.5					4.5	3 Hours	80	20			100	40	P
2	BCM Lab 1 (Practical)	BCM P0 1			6	6			2.25	2.25	2.25			3 Hours				50	50	25	P
3																					
4																					
5	AEC (Theory)																				
6	AEC (Practical)																				
7	GOEC - 1													College level evaluation							
8	Induction Programme		30 Hrs.(One week) at the beginning of semester-1 only								Non exam credit, Evaluation at college level.										
		Internship/ Field work/ Work Experience																			
		Open elective/ GIC/Open skill/MOOC (This will be offered by the Department to the students of other discipline)																			
	<b>Total</b>																		150	65	P

**Sant Gadge Baba Amravati University Amravati**  
**Scheme of teaching, learning & Examination leading to the Degree Bachelors of Science (Choice Based Credit System) (Three Years Six Semesters Degree Programme- C.B.C.S)**  
**(B.Sc. Part-I) (Semester-II) BIOCHEMISTRY**

Sr. No	Subjects	Subject Code	Teaching & Learning Scheme							Duration of Exams Hrs.	Examination & Evaluation Scheme							
			Teaching Period Per week				Credits				Maximum Marks				Minimum Passing			
			L	T	P	Total	Theory	Internal Assessment	Practical		Total	Theory + MCQ External	Skill Enhancement module Internal	Practical		Total Marks	Marks	Grade
														Internal	External			
1	BCM 2 ( Theory )	BCM 2	6			6	4.5			4.5	3 Hours	80	20			100	40	P
2	BCM Lab 2 ( Practical )	BCM P0 2			6	6		2.25	2.25	2.25	3 Hours				50	50	25	P
3																		
4																		
5	AEC ( Theory )																	
6	AEC ( Practical )																	
7	GOEC - 1										College level evaluation							
8	Induction Programme		30 Hrs.(One week) at the beginning of semester- 1 only								Non exam credit, Evaluation at college level.							
	Internship/ Field work/ Work Experience																	
	Open elective/ GIC/Open skill/MOOC (This will be offered by the Department to the students of																	

		<b>other discipline)</b>															
	<b>Total</b>													<b>15</b>	<b>0</b>	<b>65</b>	<b>P</b>

**Syllabus Prescribed for 2022-2023 UG Programme**

**Programme: UG in Biochemistry**

**Semester 1**

<b>Code of the Course/Subject</b>	<b>Title of the Course/Subject</b>	<b>(Total Number of Periods)</b>
<b>BCM - 1</b>	<b>Biomolecules</b>	<b>90</b>

**Cos**

At the end of the course, students would be able to

1. Understand Chemical structure, properties, types of classification and biological importance of Carbohydrates.
2. Differentiate between saturated and unsaturated fatty acids and suggest good quality edible oil.
3. Study physiochemical properties, types, classification and biological importance of Proteins.
4. Distinguish between gene, genome and chromosome structure and able to learn basic structure and properties of nucleic acid.
5. Recognize chemistry of vitamins and hormones, suggest daily allowances of vitamins and importance of both.
6. Calculate energy value of all food types and design complete food plan.

<b>Course module</b>	<b>Unit</b>	<b>Content</b>
DSC	1. Carbohydrates	Definition, classification, asymmetric carbon, optical isomerism, D & L isomerism, Epimerism, ring structure of pentoses & hexoses, $\beta$ anomers, mutarotation, Reactions of aldehyde, ketone groups & hydroxyl groups, amino sugars, deoxy sugars, types of glycosidic bonds, structure, occurrence & biological importance of polysaccharides like starch, glycogen, cellulose & mucopolysaccharides like heparin, hyaluronic acids, chondroitin sulphates. <b>(15 Periods)</b>
	2. Lipids	Definition & classification. Fatty acids: introduction, nomenclature, structure & properties of saturated & unsaturated fatty acids, cis & trans isomerism, positional isomerism, triacylglycerols; nomenclature, structure & characterization of fats (hydrolysis, saponification value, acid value, rancidity of fats, iodine number) biological significance of fats, structure & functions of lecithins, cephalins, phosphoinositides & spingomyelins, glycolipids cerebrosides, gangliosides & steroids (properties & functions of ergosterol, cholesterol, bile acids) <b>(15 Periods)</b>
	3. Proteins	Definition, classification based on solubility, shape composition & function. Amino acids: classification, structure & isomers of standard amino acids, Zwitter ionic structure Physiochemical properties, glucogenic & ketogenic amino acids, non proteinous amino acids (ornithine, citrulline & $\beta$ alanine) Peptides: structure of peptide bonds, important peptides (structure & functions). Protein structure: Levels of structure, forces stabilizing the tertiary & quaternary structure of proteins, Denaturation & renaturation of proteins, salting in and salting out of proteins, structure & biological functions of fibrous proteins (keratins, collagen, elastins), globular proteins (haemoglobin & myoglobin) catalytic proteins. <b>(15 Periods)</b>
	4. Nucleic acid and Porphyrins.	A) Nucleic acids: Structure of nitrogenous bases, nucleosides, nucleotides, structure of DNA & RNA. denaturation & annealing of DNA, evidence that DNA is genetic material, gene, genome, chromosomes. B) Chemistry of porphyrins nucleus: Classification, important, metalloporphyrins (haemoglobin, cytochromes, chlorophyll) Bile pigments: chemistry & physiological role. <b>(15 Periods)</b>

	5. Vitamins and Hormones	A) Vitamins: Chemistry, sources, daily allowance's function & deficiencies of water soluble & fat soluble vitamins. B) Hormones: Definition, classification, mode of action & target sites, chemistry & function of hormones of pituitary, thyroid, parathyroid, adrenal, pancreas, gonads & corpus luteum. <b>(15 Periods)</b>
SEM	6. Nutritional Biochemistry	A) Nutritive value of different foods: cereals and millets, pulses, nuts and oils, vegetables, fruits, milk and milk products, eggs, meat, fish and other animal foods, fats and oils, sugar and other carbohydrate food, condiments and spices  B) Classification of food based on function: energy yielding, body building and protective food, Five food group plan as per ICMR, Energy value of food: carbohydrate, protein, lipid, Energy unit: calorie, kilo calorie, Joule, mega Joule, Respiratory quotient: definition, RQ for carbohydrate, fat and protein. Basal Metabolic Rate: definition, determination, factors affecting BMR, Recommended dietary allowance: definition, factors affecting RDA, RDA for adult <b>(15 Periods)</b>

**\*SEM**

Course Outcome:

At the end of the module, students would be able to

1. Student can design and recommend Balanced diet, BMR and RDA.
2. Student will be able to get employment as a Food Safety officer in food and Drug administration, Technician in Food Corporation of India, QC and QA Officer in Food, Pharmaceuticals, Fertilizer and Cosmetic industry. Dietician in Gym etc.

**\*\*Activities**

1. Group discussion
2. Seminars and projects.
3. Guest lectures of eminent Dietitians.
4. Organize camps for measurement of BMR.
5. Visits to food processing industries.



**Syllabus Prescribed for 1<sup>st</sup> Year UG Programme**

**Programme: B.Sc. in Bio-chemistry**

**Semester 1**

<b>Code of the Course/Subject</b>	<b>Title of the Course/Subject</b> (Laboratory/Practical/practicum/hands-on/Activity)	<b>(No. of Periods/Week)</b>
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<b>BCM P 01</b>	<b>Biochemical Preparations, Colorimetry and Titrometry.</b>	<b>06/week/batch</b>
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**Cos**

Upon completion of the course, the student would be able to:

1. Perform qualitative analysis of Carbohydrates, proteins, amino acids and lipids.
2. Analyse quality of ideal cooking oil and Vitamin C contents of various fruits and vegetables.
3. Estimate concentration of biomolecules in the given sample by using principles of Beer's Lambert's law
4. Formulate buffers of different pH and measure pH of the given sample.

**\* List of Practical/Laboratory Experiments/Activities etc.**

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|------------|--|
| Section 1. | Qualitative Tests and Biochemical Preparations   |
|            | a) Qualitative tests for carbohydrates.  |
|            | b) Qualitative tests for proteins, lipids and amino acids.                                   |
|            | c) Preparation of buffer of different pH.  |
|            | d) Measurement of pH of given sample by Universal indicator solution, pH strip and pH meter. |
| Section 2. | Titrometry   |
|            | a) Determination of acid value of fat.   |
|            | b) Determination of Saponification number of oil.  |
|            | c) Estimation of Glycine by Formal titration.  |
|            | d) Estimation of ascorbic acid by Dye method.  |
| Section 3. | Colorimetry  |
|            | a) Verification of Beer's Lambert's law.   |
|            | b) Estimation of Protein by Biuret method.   |
|            | c) Estimation of Protein by Lowry's method.  |

The distribution of marks in practical shall be as follows:

- A) Any five tests for section –I - 15 marks
- B) Any one experiment from sec-II - 10 marks
- C) Any one Experiment from sec.-III - 10 marks
- D) Viva Voce - 8 marks
- E) Class Work & Practical Record - 7 marks

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Total - **50 marks**

**Course Material/Learning Resources**

## 1. Text books and reference books.

- 1) Text Book of Biochemistry by Dr. O. P. Agrawal.
- 2) Text book of Biochemistry by S.M. Patil and A. B. Patil (Nabh Prakashan)
- 3) Essentials of Biochemistry by Dr. M. C. Pant.
- 4) Text book of Biochemistry by West and Todd.
- 5) Practical manual in Biochemistry by Jairaman.
- 6) Essentials of Food and Nutrition, Volume I & II by Swaminathan.
- 7) Advanced Text Book of Food and Nutrition Volume-I & II by Swaminathan.
- 8) Text book of Biochemistry by Sucheta Dandekar.
- 9) Text book of Biochemistry by U. Sattyanarayan Fundamentals of Biochemistry by J. L. Jain
- 10) Principles of Biochemistry Lehinger
- 11) Physical Biochemistry (2nd Ed. 1985) by Vantolde K.E., Prentice Hall, INC, New Delhi.
- 12) Biophysical chemistry by Upadhyay, Upadhyay and Nath.
- 13) Physical Biochemistry (II ed. 1983) by D. Friefelder, WH Freeman & Co., USA.
- 14) Chromatography : A Laboratory handbook of chromatography and Electrophoretic Methods (IIIrd 1975), BY Erich Haffman, Van
- 15) Lehinger's Principles of Biochemistry (2000) by- Nelson, Cox, M.M. Macmillan, New York.
- 16) Fundamentals of Biochemistry (1999) by Donald Voet, Judith Voet, Charlotte Pratt, John Wiley & Sons, N.Y. 145 146
- 17) Biochemistry 3rd edition (1994) by Lubert Stryer WH Freeman and Co. San Francisco.

## Semester 2

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
DSC BC - 102	Biophysical and Biochemical techniques.	90

## COs

At the end of the course, students would be able to

1. Apply knowledge of thermodynamics to understand biochemical reactions.
2. Formulate Buffers of different pH by using Handerson – Hasselbalch equation.
3. Separate biomolecules using different Chromatographic and Electrophoresis techniques.
4. Estimate quantity of biomolecules present in the given sample by Beers Lamberts law and to analyze the structure of Biomolecules using different spectroscopic techniques like NMR/ESR.
5. Perform biochemical analysis with proper care and precaution.

Course module	Unit	Content
DSC	Concepts of Bioenergetics:	Principles of thermodynamics & their applications in biochemistry, introduction, thermodynamic systems, Laws of thermodynamics, concept of free energy, standard free energy, determination of G of reaction, relation between equilibrium constant & standard free energy changes, standard free energy change in coupled reactions. Biological oxidation-reduction reactions-introduction, redox potentials, relation between standard redox potentials & free energy Change (derivation & numerical involved). <b>(15 Periods)</b>
	Acids, bases, buffers & bio membranes:	A) Acids, bases & buffers: Concept of water as biological solvent, weak acids & bases, pH, buffers, Handerson-Hasselbalch equation, Physiological buffers, Principles of glass & reference electrodes, measurement of pH by indicators (liquid & pH papers) & pH meter. B) Bio membranes: Structure & characteristics of biological membranes, active & passive transport, Donnan membrane equilibrium, Dialysis & osmosis, Sedimentation velocity, preparative & analytical ultra-centrifugation. <b>(15 Periods)</b>
	Chromatography:	General Principles & applications of 1. Adsorption chromatography. 2. Ion Exchange chromatography. 3. Thin layer chromatography. 4 Molecular sieve 5 Gas liquid chromatography. 6 HPLC 7 Affinity chromatography. 8 Paper chromatography. <b>(15 Periods)</b>
	Electrophoresis:	Basic principles of agarose & paper electrophoresis, PAGE, SDS-PAGE, 2-D electrophoresis & its importance, isoelectric focusing, western, southern & northern blotting techniques. <b>(15 Periods)</b>
	Spectroscopic techniques:	Beers Lamberts law, Light absorption & its transmittance, determination & application of extinction coefficient principles & application of visible & UV spectroscopic techniques. Principles & application of NMR, ESR, Mass spectroscopy, Fluorometry & flame photometry. <b>(15 Periods)</b>
SEM	Handling and care of Instruments and equipments.	<ul style="list-style-type: none"> <li>• Safety Measures in the laboratory</li> <li>• Introduction to Laboratory Instruments and Equipment's including</li> </ul>

1. Blood cell counter
  2. Biochemistry autoanalyzer
  3. Cooling Centrifuge
  4. Double beam spectrophotometer.
  5. Autoclave, Laminar air flow, Hot air oven, Incubator.
  6. Colorimeter
  7. UV Illuminizer
  8. Soxhlet Apparatus
  9. Lab Centrifuge
  10. Electrophoresis Assembly.
- Use, Handling and care of Instruments and Equipment's.
  - Standard operating procedures.
  - Qualitative analysis of Carbohydrates, Proteins, Amino acids and Nucleic acids **(15 Periods)**

**\*SEM**

Course Outcome:

At the end of the module, students would be able to

- 1) handle instrument and equipment with proper care.
- 2) Get recruited in Government hospitals, private hospitals, Blood banks as Lab technician. In food, Pharmaceutical, fertilizer and cosmetic industry as a quality control officer, Quality assurance officer, production officer etc.

**\*\*Activities**

1. Demonstration
2. Seminars
3. Guest lectures of eminent Scientist from well reputed research institutes.
4. Hands-on training programmes.

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**Syllabus Prescribed for 1<sup>st</sup> Year UG Programme**

**Programme: B.Sc. in Biochemistry**

**Semester 2**

<b>Code of the Course/Subject</b>	<b>Title of the Course/Subject</b> (Laboratory/Practical/practicum/hands-on/Activity)	<b>(No. of Periods/Week)</b>
<b>BCM P 02</b>	<b>Biophysical and Analytical Techniques</b>	<b>06/week/batch</b>

**COs**

Upon completion of the course, the student would be able to:

1. Perform quantitative estimation of Carbohydrates, DNA and RNA.
2. Develop technique for isolation of biologically important products from natural sources.
3. Formulate technique for separation of biomolecules by using physicochemical principles.

**\* List of Practical/Laboratory Experiments/Activities etc.**

**Section I : Section I: Colorimetry**  
**Colorimetry**

- a) Estimation of Carbohydrate by Anthron method.
- b) Estimation of RNA by Orcinol method.
- c) Estimation of DNA by Diphenylamine method.

**Section II : Section II: Isolation of biomolecules from natural sources.**

- a) Starch from potato/sweet potato.
- b) Casein from milk.
- c) Glycogen from liver.
- d) Total lipid from egg yolk by Folch method.

**Section III : Section III: Demonstration of Analytical Techniques.**

- a) Amino acid separation by Paper Chromatography.
- b) Separation of Sugars by Paper/Thin Layer Chromatography.
- c) Flame photometry for estimation of Na & K.
- d) Separation of serum proteins by Paper Electrophoresis.

**Distribution of Marks for Practical Examination :-**

- A) Any one experiment from Section-I (10 Marks)
- B) Isolation of any one compound from Section II (10 Marks)
- C) Performance of any one Technique from Section III (15 Marks)
- D) Viva-voce (08 Marks)
- E) Practical record (07 Marks).

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Total - **50 marks**  
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**Course Material/Learning Resources**

- 1) Lehinger's Principles of Biochemistry (2000) by- Nelson, Cox, M. M. Macmillan, New York.
- 2) Text book of Biochemistry by S.M. Patil and A. B. Patil (Nabh Prakashan)
- 3) Biochemistry 3rd edition (1994) by Lubert Stryer WH Freeman and Co. San Francisco.
- 4) Outline of biochemistry (1987), Conn, Stumpf, Bruening, Doi, John Wiley & Sons, N.Y.
- 5) Text Book of Biochemistry by Dr. O. P. Agrawal.
- 6) Fundamentals of Biochemistry by J. L. Jain.
- 7) Essentials of Biochemistry by Dr. M. C. Pant.
- 8) Principles of Biochemistry Lehinger.
- 9) Text book of Biochemistry by West and Todd.
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- 14) Text book of Biochemistry by U. Sattyanarayan.
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- 16) Biophysical chemistry by Upadhyay, Upadhyay and Nath.
- 17) Physical Biochemistry (II ed. 1983) by D. Friefelder, WH Freeman & Co., USA.
- 18) Chromatography : A Laboratory handbook of chromatography and Electrophoretic Methods (III 1975), BY Erich Haffman, Van Nostrand Reinhold, NY.
- 19) Fundamentals of Biochemistry (1999) by Donald Voet, Judith Voet, Charlotte Pratt, John Wiley & Sons,
- 20) Practical Biochemistry by D. Plumer.