

**Rayat Shikshan Sanstha's**



**YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE,  
SATARA**

**(AUTONOMOUS)**

**Reaccredited by NAAC with 'A+' Grade**

**New Syllabus For**

**BIOCHEMISTRY - IDS**

**Part - II**

**Semester - III & IV**

**Syllabus to be implemented from June, 2019 onwards**

**Rayat Shikshan Sanstha's**  
**YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE, SATARA**  
**(AUTONOMOUS)**

**Syllabus for B. Sc. II: Biochemistry (IDS)**  
**(Semester - III & IV)**

**Syllabus to be implemented from June 2019 onwards.**

**1. TITLE : Biochemistry ( IDS)**

**2. YEAR OF IMPLEMENTATION:-** Syllabus will be implemented from June, 2019 onwards.

**3. PREAMBLE :**

This syllabus is framed to give sound knowledge with understanding of biochemistry to undergraduate students at second year of three years of B.Sc. degree course.

The goal of the syllabus is to make the study of biochemistry popular, interesting and encouraging to the students for higher studies including research.

The aim of syllabus is to prepare the students to gain knowledge in life sciences.

The new and updated syllabus is based on a basic and applied approach with vigour and depth. At the same time, precaution is taken to make the syllabus comparable to the syllabi of Shivaji university and other universities and the needs of industries and research.

The syllabus is prepared after discussion at length with number of faculty members of the subject and experts from industries and research fields.

The units of the syllabus are well defined, taking into consideration the level and capacity of students.

**4. GENERAL OBJECTIVES OF THE COURSE / PAPER :**

- 1) To make the students knowledgeable with respect to the subject and its practicable applicability.
- 2) To promote understanding of basic and advanced concepts in biochemistry.
- 3) To expose the students to various emerging areas of biochemistry .
- 4) To prepare students for further studies, helping in their bright career.
- 5) To expose the students to different processes used in industries and in research field.
- 6) To develop their ability to apply the knowledge of biochemistry in day to day life.

7) To prepare the students to accept the challenges in life sciences.

8) To develop skills required in various industries, research labs and in the field of human health.

**5. DURATION:** The course shall be a full time course.

**6. PATTERN:** Pattern of examination will be semester.

**7. MEDIUM OF INSTRUCTION:** The medium of instruction shall be in english.

**8. OTHER FEATURES :**

(A) LIBRARY :

Reference Books – Latest Editions, Journals and Periodicals.

(B) SPECIFIC EQUIPMENTS NECESSARY TO RUN THE COURSE:

OHP, Computer, L.C.D. Projector.

(C) INTERNET

(D) LIST OF THE LABORATORY EQUIPMENTS :

1. Colorimeter
2. Spectrophotometer
2. pH meter
3. Electrophoresis apparatus
4. Computer with printer & internet.
5. Water bath
6. Incubator
7. Mixer
8. Oven
9. Balance
10. Suction pump
12. Centrifuge machine
13. Heating mantle with magnetic stirrer
14. Soxhlet extraction apparatus.
15. Micropipetes
16. Glassware
17. Chromatographic jar  
Chromatography column

**9. STRUCTURE of B.Sc. II Biochemistry IDS COURSE :****1) Semester III ( No. of Papers- 02)**

Sr. No.	Subject title	Theory				Practical		
		Paper No. & Paper code	Title of paper	No. of lectures per week	Credits		No. of lectures per week	Credits
1.	Biochemistry	Paper I BBCT 301	Biomolecules	6	4	Practical I BBCP 303	8	4
		Paper II BBCT 302	Metabolism and Nutrition	6	4			

**2) Semester IV ( No. Of Papers- 02)**

Sr. No	Subject title	Theory				Practical		
		Paper No. & Paper code	Title of paper	No. of lectures per week	Credits		No. of lectures per week	Credits
1.	Biochemistry	Paper III BBCT 401	Biochemical techniques & Bioinformatics	6	4	Practical IV BBCP 403	8	4
		Paper IV BBCT 402	Molecular biology & Biotechnology	6	4			

**10. EXAMINATION STRUCTURE:**

<b>SEMESTER III</b>								
	Theory Exam	Internal Exams		Practical			Submission	Total
		CIA- I	CIA- I Online test		Exam	Journal	Seminar & Day to day performance	
Paper I	30	5	5	Practical course I BBCP 303	25	5	5	150
Paper II	30	5	5		25	5	5	
<b>SEMESTER IV</b>								
	Theory Exam	Internal Exams		Practical			Submission	Total
		CIA- I	CIA- I Online test		Exam	Journal	Seminar & Day to day Performance	
Paper III	30	5	5	Practical course II BBCP 403	25	5	5	150
Paper IV	30	5	5		25	5	5	

## SEMESTER – III

### Paper – I BBCT301 Biomolecules

Credit: - 02      45

#### Learning objectives:

1. To understand the biomolecules and their physiological significance.
2. To know structure and role of various biomolecules.
3. To learn biocatalyst action & other details.
4. To understand the membrane biochemistry.
5. To know about vitamins & their physiological role, requirement etc.

#### UNIT1. Carbohydrates:

(11)

Definition, aldoses and ketoses , Classification and brief account of

Monosaccharides: Trioses – Glyceraldehydes, Dihydroxyacetone, Tetroses – Erythroses, Erythrulose, Pentoses – Ribose, Ribulose, Hexoses – Glucose, Fructose

Disaccharides: Maltose, Lactose, Sucrose - Emphasis must be on nature of linkage, reducing properties and hydrolysis studies with acid and enzymes.

Polysaccharides : Structure and biological role of Starch, Glycogen, Cellulose.

Conformation of glucose – alpha, beeta; Hemiacetal & hemiketal ring formation of sugars, Glycosidic bond formation and its significance

Derived Monosaccharides : Deoxy sugars (deoxy ribose), sugar-acids (L-ascorbic acid), Amino sugars (glucosamine, galactosamine, Nacetyl glucosamine).

Mucopolysaccharides: Hyaluronic acid, Heparin.

#### UNIT2. Amino acids & Proteins

(11)

##### I) Amino acids (5)

Definition, Nomenclature, Structure and classification of amino acids based on nature of side chain

Neutral amino acids: Hydrocarbon chain amino acids - Glycine, Alanine, Valine, Leucine, Isoleucine.

Hydroxy amino acids - Serine, Threonine. Sulfur containing amino acids - Cysteine, Methionine.

Aromatic amino acids - Phenylalanine, Tyrosine, Tryptophan. Heterocyclic amino acids - Proline.

Acidic amino acids and their amides: Aspartic acid, Glutamic acid, Asparagine, Glutamine.

Basic amino acids : Lysine, Arginine, Histidine

Zwitter ion and isoelectric pH.

##### II) Proteins ( 6 )

Definition, classification based on functions of proteins, Peptide bond formation, nature & properties.

Structural studies of proteins – Primary structure , Secondary structure, Tertiary structure Quaternary structure. Forces involved in maintaining different structural levels of proteins. Structure and function of oxytocin and myoglobin

#### UNIT 3. Enzymes

( 11 )

Definition, Explanation of terms – Holoenzyme, Apoenzyme, Coenzyme, Prosthetic group, Cofactor. Classification of enzymes into in to six major classes with one example of each class. EC number of enzymes. Enzyme as catalyst, concept of activation energy in enzyme catalysed reaction. Units of enzyme activity, Specific activity, Turnover number, Enzyme specificity, Types of specificity. Active site of enzyme and its features.Theories of mechanism

of enzyme action - Lock and key and induced fit theory. Factors affecting enzyme activity - substrate concentration, pH, temperature.

Enzyme kinetics – Derivation of Michaelis - Menten equation, plot, advantages, disadvantages, Significance of  $K_m$  and  $V_{max}$ . Lineweaver Burk equation & plot, advantages, disadvantages, Enzyme inhibition - competitive, non-competitive inhibition.

Isoenzymes of LDH and its clinical importance.

#### **UNIT4. Lipids & Vitamins**

**(12)**

##### **I) Lipids (4)**

Definition and classification of lipids with two examples of each class, Structure and functions of i) Simple lipids: triglyceride and fatty acids ii) Compound lipids: Phospholipids, viz. lecithin, cephalin iii) Derived lipids: steroids (cholesterol).

Fatty acids – properties, classification, essential & non-essential fatty acids

Lipid bilayer and Fluid mosaic model of membrane

##### **II) Vitamins and minerals (8)**

Definition, classification of vitamins; Sources, structure, RDA value, coenzyme form, biochemical functions & deficiency symptoms of water soluble vitamins viz. Vitamin C, Thiamine, Riboflavin, Niacin, Pyridoxine and fat soluble vitamins viz. Vitamin A, D, E, K.

Classification of minerals; Sources, RDA value, cofactor form, biochemical functions & disease states of minerals.

#### **Learning outcomes**

Students should be able to

- i. understand the biomolecules and their physiological significance.
- ii. know structure and role of various biomolecules.
- iii. learn biocatalyst action & other details.
- iv. understand the membrane biochemistry.
- v. know about vitamins & their physiological role, requirement etc.

#### **References :**

1. Lehniger's Principles of Biochemistry nelson & Cox. Edn fourth & fifth [Unit I, II, III,IV]
2. Biochemistry-Lubert stryer. Edn Sixth Edn Sixth [Unit I, III,IV]
3. Fundamentals of Biochemistry-Voet, Voet & Pratt [Unit I, II, III,IV]
4. Fundamental of Biochemistry- J.L.Jain. [Unit I, II, III,IV]
5. Biochemistry-U. Satyanarayan. [Unit IV]
6. Fundamentals of Biochemistry – A. C. Deb. [Unit I, II, III,IV]

## Paper –II BBCT302 Metabolism and Nutrition

Credit: - 02

45

### Learning objectives:

1. To learn about energy generation mechanisms in cell.
2. To understand various biochemical processes and their physiological significance.
3. To know structure, function and reaction mechanisms in cell.
4. To learn about various metabolic pathways.
5. To understand various food requirements of body, nutrition & calorimetric significance.

### UNIT1. Biological oxidation

(11)

High-energy compounds and their significance viz. ATP, PEP, 1,3-BPG.

Mitochondrial respiratory chain, components & carriers of ETC ( Fe-S, Coenzyme Q, Cytochrome, Complex I , Complex II, Complex III, Complex IV), Mechanism of oxidative phosphorylation - chemiosmotic hypothesis, Inhibitors of ETC.

### UNIT 2.Carbohydrate metabolism

(11)

Glycolysis and its significance, Aerobic glycolysis - glucose to pyruvate synthesis and its energetic, Anaerobic glycolysis - glucose to lactate synthesis and its energetic, Oxidation of pyruvate to acetyl CoA, PDH complex composition, reaction mechanism, TCA cycle – reactions, significance and its energetic, Significance of Glycogen metabolism - Glycogenesis and Glycogenolysis

### UNIT3. Lipid & Amino acid metabolism

(12)

#### I) Lipid metabolism ( 6 )

$\beta$ - oxidation of fatty acid (Palmitic acid): activation of fatty acid, carnitine transport system,  $\beta$ -oxidation cycle, significance, energetic; Biosynthesis of fatty acid (Palmitic acid) & significance, Structure of Fatty acid synthetase complex (Eukaryotes).

#### II) Amino acid metabolism ( 6 )

General reaction of amino acid metabolism. i) Transamination, ii) Deamination, iii) Decarboxylation, Urea cycle

### UNIT4. Nutrition & Calorimeter

(11)

Nutrition, food, nutrient definition, Balanced diet, Nutritional importance of

i) Carbohydrate ii) Protein iii) Lipid

Caloric value of food stuffs and its measurement (bomb calorimeter), Respiratory quotient

BMR and its measurement (Douglass bag method), Factors affecting BMR and its significance.

Composition and nutritive value of Indian food. Concept & significance of prebiotic & probiotics.

### Learning outcomes

Students should be able to

- i. learn about energy generation mechanisms in cell.
- ii. understand various biochemical processes and their physiological significance.
- iii. know structure, function and reaction mechanisms in cell.
- iv. learn about various metabolic pathways.
- v. understand various food requirements of body, nutrition & calorimetric significance.



**References**

1. Lehninger's Principles of Biochemistry Nelson & Cox. Edn fourth & fifth [Unit I, II, III]
2. Biochemistry-Lubert Stryer. Edn Sixth Edn Sixth [Unit I, II, III]
3. Fundamentals of Biochemistry-Voet, Voet & Pratt [Unit I, II, III]
4. Fundamentals of Biochemistry-J. L. Jain. [Unit I, II, III, IV]
5. Biochemistry-U. Satyanarayan. [Unit IV]
6. Fundamentals of Biochemistry – A. C. Deb. [Unit I, II, III]
7. Text book of Biochemistry and Human biology- G. P. Talwar. [Unit IV]

## Practical Course-I BBP303

Credit: - 02

### Learning Objectives:

1. To updated with techniques used in present research
2. To updated with techniques and experimental systems required in biochemical research.
3. To updated with techniques used to study enzymes.
4. To updated with techniques used to isolate biomolecules.
5. To understand various biochemical methods to study biomolecules.
6. To know how to use the instruments.

### Group A

1. Preparation of normal & molar solutions.
2. Isolation and characterization of starch from potatoes.
3. Volumetric estimation of glycine by formal titration method.
4. Colorimetric estimation of protein by Biuret method.
5. Colorimetric estimation of glucose by DNSA method.
- 6.& 7. Quantitative estimation of amylase activity.
8. Osazone test for reducing sugars
- 9.& 10. Qualitative detection of Carbohydrates -Glucose, Fructose, Lactose, Starch

### Group B

1. Control and Accuracy in Biochemical practical.
2. Preparation of stock & working solutions.
3. Isolation and characterization of casein from milk.
4. Estimation of vitamin-C in biological samples & tablet by 2, 6 dichlorophenol indophenol method.
5. Detection of normal constituents of urine.
6. Detection of abnormal constituents of urine.
7. Colorimetric estimation of urea by DAM methods.
8. Effect of temperature on amylase enzyme.
9. Effect of pH on amylase enzyme.
10. Detection of enzymes (any four)  
(Urease, Amylase, Invertase, Phenol oxidase, Alkaline phosphatase).

### Learning outcomes

Students should be able to

- i. updated with techniques used in present research
- ii. updated with techniques and experimental systems required in biochemical research.
- iii. updated with techniques used to study enzymes.
- iv. updated with techniques used to isolate biomolecules.
- v. understand various biochemical methods to study biomolecules.
- vi. know how to use the instruments.
- vii. updated with software analysis used in bioinformatics.

**Reference Books for Practicals**

1. An Introduction to Practical Biochemistry-David Plummer.
2. Laboratory Manual in Biochemistry – J. Jayraman.
3. Introductory practical Biochemistry – S.K. Sawhney, Randir Singh.
4. Laboratory manual on Biotechnology- P.M. Swamy
5. Biotechnology Procedures and Experiments Handbook – S. Harisha
6. Practical Biochemistry – Rajgopal & Toora.
7. Biochemical methods- Sadashivam & Manikam.
8. Viva and Practical Biochemistry-Dr. A. C. Deb.

## SEMESTER IV

### Paper III BBCT401 Biochemical techniques & Bioinformatics

Credit: - 02

45

#### Learning objectives:

1. To understand the bioanalytical techniques useful in research and industries.
2. To know practical significance of separation techniques of biomolecules.
3. To learn about techniques related to molecular level analysis.
4. To updated with techniques used in present research.
5. To know how to use the instruments.
6. To updated knowledge of bioinformatics.

#### Unit 1 . Chromatography

(11)

Definition and classification, Principle, technique and applications of i) Paper ii) Thin layer iii) Ion exchange iv) Gel permeation chromatography. The discussion should include selection of matrix, preparation of plates, column packing, sample application, mechanism of separation, important applications and advantages of each one of the methods.

#### UNIT 2. Electrophoresis & Absorption spectroscopy

(11)

##### I) Electrophoresis (6)

Definition of the terms electrophoresis, electrophoretic mobility, Factors affecting on electrophoretic mobility. Principle, technique and applications of Paper, PAGE and SDS –PAGE. The discussion should include preparation of gel plates, sample application, mechanism of separation, development of plates, important applications and advantages of the method.

##### II) Absorption spectroscopy(5)

Beer Lambert's law, Limitations of Beer Lambert's law. Meaning of the terms transmittance, absorbance. Construction, working and applications of i) colorimeter ii) UV spectrophotometer. Advantages of spectrophotometer over colorimeter. Absorption spectra of proteins, nucleic acids.

#### UNIT 3. Immobilization, Sequencing, PCR, Blotting techniques

(12)

**Enzyme immobilization** - Definition, classification, types – i) Adsorption ii) covalent binding iii) intermolecular cross linking iv) Entrapment (gel), Industrial applications of immobilization.

Amino acid sequencing – a) Significance, Protein sequencing methods with reaction, advantages & disadvantages i) Sanger ii) Edman iii) Enzyme cleavage

PCR- Principal, working and applications of PCR.

Blotting techniques-southern, northern and western blotting and their application.

#### UNIT 4. Bioinformatics

(11)

Introduction to bioinformatics, Databases, Classification of databases (Primary, Secondary, Composite), Sequences & Nomenclature, IUPAC symbols, nomenclature of DNA & protein sequences & directionality of sequences. Information sources (NCBI). Data retrieval tools (ENTREZ) Database similarity searching (BLAST). Use of bioinformatics tools in analysis of biological data.

## **Learning outcomes**

Students should be able to

- i. understand the bioanalytical techniques useful in research and industries.
- ii. know practical significance of separation techniques of biomolecules.
- iii. learn about techniques related to molecular level analysis.
- iv. updated with techniques used in present research.
- v. know how to use the instruments.
- vi. updated knowledge of bioinformatics.

## **References**

1. Lehninger's Principles of Biochemistry Nelson & Cox. Edn fourth & fifth [Unit III]
2. Biochemistry-Lubert Stryer. Edn Sixth [Unit III]
3. Fundamentals of Biochemistry-Voet, Voet & Pratt [Unit III]
4. Fundamentals of Biochemistry-J. L. Jain. [Unit I, II]
5. Principles and Techniques of Biochemistry and Molecular Biology - Wilson and Walker [Unit I, II]
6. A Text Book of Biotechnology -R.C.Dubey. [Unit III, IV]
7. Biotechnology-B.D.Singh. [Unit III]
8. Introduction to Bioinformatics-T.K.Attwood & D.J.Parry- Smith [Unit IV]
9. Bioinformatics Methods and applications-Rastogi. [Unit IV]
10. Enzymes - Palmer.

**Learning objectives:**

1. To know about chemical & structural details of DNA & RNA.
2. To know mechanism of DNA, RNA & protein synthesis.
3. To understand genetic code, gene expression and its regulation.
4. To understand about genetics, molecular biology, genetic engineering & biotechnology.
5. To know about present research in vaccines and antiviral drugs useful to combat viral diseases.
6. To know about present status & details about diabetes mellitus.

**UNIT1. Nucleic acids**

**(11)**

Definition, types, Distinction between DNA and RNA, Chemical composition of nucleic acids i) purines ii) pyrimidine iii) phosphate iv) sugars, Nucleosides and nucleotides, Representation of primary structure of polynucleotide chain, Watson Crick model of DNA, Properties of DNA, Structure and functions of mRNA, rRNA and tRNA.

**UNIT 2. Molecular biology**

**(11)**

Prokaryotic replication – Mode of replication, Ori site, Direction of replication, Role of protein, Mechanism. Prokaryotic transcription- Role of protein, Initiation, Elogation, Termination. Prokaryotic translation – Activation of amino acid, Role of protein, Initiation, Elogation, Termination. Genetic code- History, Contribution of Scientists, Properties. Regulation of gene expression with operon concept (*E. coli* lac operon model).

**UNIT 3. Genetic engineering and biotechnology**

**(11)**

Introduction to tools and techniques used in genetic engineering. Enzymes a) Restriction endonucleases- introduction to class I, II and III, eg- EcoRI, Bam HI b) Reverse transcriptase, c) S1 nuclease, d) DNA ligases, e) Alkaline phosphatase. Cloning vectors: Plasmid PBR-322. Passenger DNA – cDNA synthesis. Host e.g. *E. Coli*. Basic concept of gene cloning technique (rDNA synthesis, Transfer of rDNA into host cell, Screening methods). Production of human insulin by rDNA technology. Applications of genetic engineering.

**UNIT 4. Diabetes Mellitus & AIDS**

**(12)**

**I) Insulin & Biochemistry of Diabetes Mellitus (6)**

Introduction structure of Insulin, Metabolic effects of insulin, Overview of mechanism of action of insulin. Role of hormones in blood glucose Homeostasis. Explanation of term of i) hyper and hypo glycemia ii) renal threshold value

Types of Diabetes Mellitus, Treatment and Management of Diabetes Mellitus 1) Hypoglycemic drugs e.g. i) Sulfonylureas ii) Metformin 2) Diet 3) Exercise 4) Insulin

**II) Biochemistry of AIDS (6)**

Structure of HIV, Transmission of HIV, Immunological abnormalities in AIDS, Entry and release of HIV, Natural course of AIDS – i) Acute ii) Chronic, iii) Crises phases. Graphical representation, Anti-AIDS drugs – AZT (Zidovudine) & DDI (Didanosine) : their structure and mechanism of action. Vaccine treatment.

## **Learning outcomes**

Students should be able to

- i. know about chemical & structural details of DNA & RNA.
- ii. know mechanism of DNA, RNA & protein synthesis.
- iii. understand genetic code, gene expression and its regulation.
- iv. understand about genetics, molecular biology, genetic engineering & biotechnology.
- v. know about present research in vaccines and antiviral drugs useful to combat viral diseases.
- vi. know about present status & details about diabetes mellitus.

## **References**

1. Lehninger's Principles of Biochemistry nelson & Cox. Edn fourth & fifth [Unit I, II, IV]
2. Biochemistry-Lubert stryer. Edn Sixth Edn Sixth [Unit II]
3. Fundamentals of Biochemistry-Voet, Voet & Pratt [Unit I, II]
4. Fundamentals of Biochemistry-J. L. Jain. [Unit I, II]
5. Biochemistry-U. Satyanarayan. [Unit IV]
6. Molecular biology of the gene – Watson [Unit I, II]
7. A Text Book of Biotechnology –R.C.Dubey. [Unit III]
8. Biotechnology-B.D.Singh. [Unit III]
9. Immunology.- Kuby. [Unit IV]
10. Text book of Biochemistry and Human biology- G. P. Talwar [Unit IV]
11. Fundamentals of biochemistry – A.C. Deb [Unit IV]

## Practical Course-II BBP403

Credit: - 02

### Learning objectives:

1. To updated with techniques used in present research
2. To updated with techniques and experimental systems required in biochemical research.
3. To updated with techniques used to study enzymes.
4. To updated with techniques used to isolate biomolecules.
5. To understand various biochemical methods to study biomolecules.
6. To know how to use the instruments.
7. To updated with software analysis used in bioinformatics.

### Group A

1. Preparation of buffer & reagents.
2. Paper chromatographic separation & identification of amino acids from binary mixture.
3. Paper chromatographic separation & identification of sugars from binary mixture.
4. Verification of Beer Lambert's law and estimation of copper sulphate.
5. Immobilization of baker's yeast cells by gel entrapment method.
6. Study of invertase activity by using immobilized yeast cells.
7. Separation of proteins by gel electrophoresis.
8. Study & use of pH meter.
9. Demonstration of DNA amplification by PCR.
- 10 & 11. Bioinformatics experiments
  - a. Study of three dimensional structure of proteins by visualizing software - RasMol
  - b. Study of secondary structure of proteins by visualizing software – RasMol
  - c. Study of prosthetic group of protein by visualizing software – RasMol
  - d. Determination of number of peptides in protein by visualizing software - RasMol

### Group B

1. Preparation of gel & reagents.
2. Colorimetric estimation of DNA by diphenylamine method.
3. Colorimetric estimation of RNA by Bial's orcinol method.
4. Spectroscopic analysis of Protein and DNA.
5. B-galactosidase induction study in *E. Coli*.
6. Problems on DNA - RNA sequence.
7. Problems on Genetic code and peptide sequence.
8. Study and detection of blood group antigens.
9. Study of three dimensional structure of DNA by visualizing software – RasMol.

### Learning outcomes

Students should be able to

- i. updated with techniques used in present research
- ii. updated with techniques and experimental systems required in biochemical research.
- iii. updated with techniques used to isolate biomolecules.
- iv. understand various biochemical methods to study biomolecules.



- v. know how to use the instruments.
- vi. updated with software analysis used in bioinformatics.

**Reference Books for Practicals**

1. An Introduction to Practical Biochemistry-David Plummer.
2. Laboratory Manual in Biochemistry – J. Jayraman.
3. Introductory practical Biochemistry – S.K. Sawhney, Randir Singh.
4. Laboratory manual on Biotechnology- P.M. Swamy
5. Biotechnology Procedures and Experiments Handbook - S. Harisha
6. Practical Biochemistry – Rajgopal & Toora.
7. Biochemical methods- Sadashivam & Manikam.
8. Viva and Practical Biochemistry-Dr. A. C. Deb.
9. Molecular biology of the gene – Watson

## Practical Examination

- A) Practical examination will be conducted separately for every semester of 25 Marks each course.
- B) The practical examination for semester III will be one day examination conducted for 6 hrs. and for semester IV will be conducted for one day for 6 hrs.
- C) Each candidate must produce certified journal, checked and signed by member of teaching staff and certified by the Head of the department at the end of each semester.
- D) Candidate must produce their journal at the time of practical examination.

Nature of question paper and distribution of marks in practical examination

Semester III

- Q.1. Major Experiment ..... 15 Marks
- Q.2. Minor Experiment..... 10 Marks
- O.3. Journal .....05 Marks

Semester IV

- Q.1. Major Experiment .....15 Marks
- Q.2. Minor Experiment.....10 Marks
- O.3. Journal / Study Tour Report .....05 Marks