

**Shree Manibhai Virani and Smt. Navalben Virani Science College, Rajkot  
(Autonomous)**

**Affiliated to Saurashtra University, Rajkot**

**Department of Biotechnology  
B. Sc. BIOTECHNOLOGY**

**SCHEME OF INSTRUCTION AND EXAMINATIONS  
For Students Admitted from A.Y. 2016-2017 & Onwards**

**OBJECTIVES OF THE PROGRAMME**

The Curriculum is designed to attain the following learning goals which students shall accomplish by the time of their graduation:

- This programme will enable students to acquire knowledge on the fundamentals of Biochemistry, Cell biology, Microbiology, Immunology, Bioprocess Technology and Molecular biology to enable them to understand emerging and advanced concept in modern biology and help them to take their career in this field.
- After completion of the programme, the students can able to acquire the necessary theoretical and practical competencies in Biotechnology to enable them to undertake higher studies in recognized Institutions of higher learning and engage gainful self-employment.
- The Programme is intended to help the students to be the innovative and versatile personalities in the field of Life Science with quality education and provide the skilled manpower required by Research and Development, Institutions of Higher Learning and Industry.

Semester I							
Course Code	Course	Hrs. of Instruction / week	Exam Duration (Hours)	Maximum Marks			Credits
				CIE	SEE	Total	
<b>Part -I</b>							
16ULCEN01	Functional English-I	3	3	40	60	100	3
<b>Part -II</b>							
16UBTCC01	<b>Core 1:</b> Cell Biology	4	3	30	70	100	4
16UBTCC02	<b>Core 2:</b> Biomolecules	4	3	30	70	100	4
16UBTDA01	<b>DSE-Allied 1:</b> Chemistry-I	4	3	30	70	100	4
16UBTCC03	<b>Core Practical 1:</b> Cell Biology Practical	4	3	20	30	50	2
16UBTCC04	<b>Core Practical 2:</b> Biomolecules Practical	6	3	20	30	50	3
16UBTDA02	<b>DSE-Allied Practical 1:</b> Chemistry –I Practical	2	3	20	30	50	1
-	Lab to Land	1	-	-	-	-	-
		<b>28</b>				<b>550</b>	<b>21</b>
<b>Part-III</b>							
	<b>AECC-I :</b> Environmental Science	1	--	-	-	-	-
	<b>SEC-I:</b> Value Education -I	1	--	Remarks			1
		<b>30</b>					

Semester II							
Course Code	Course	Hrs. of Instruction / week	Exam Duration (Hours)	Maximum Marks			Credits
				CIE	SEE	Total	
<b>Part- I</b>							
16ULCEN02	Functional English- II	3	3	40	60	100	3
<b>Part –II</b>							
16UBTCC05	<b>Core -3:</b> Fundamentals of Microbiology	4	3	30	70	100	4
16UBTCC06	<b>Core -4:</b> Cellular Metabolism	4	3	30	70	100	4
16UBTDA03	<b>DSE- Allied 2:</b> Chemistry -II	4	3	30	70	100	4
16UBTCC07	<b>Core Practical 3:</b> Fundamentals of Microbiology Practical	5	6*	20	30	50	3
16UBTCC08	<b>Core Practical 4:</b> Cellular Metabolism Practical	5	3	20	30	50	2
16UBTDA04	<b>DSE- Allied Practical 2:</b> Chemistry-II Practical	2	3	20	30	50	1
	Lab to Land	1	-	-	-	-	-
		<b>28</b>				<b>550</b>	<b>21</b>
<b>Part –III</b>							
	<b>AECC-I :</b> Environmental Science	1	--	Remarks			2
	<b>SEC-I:</b> Value Education -II	1	--	Remarks			1
		<b>30</b>					

\* 3hrs each on Day1 and Day 2.

Semester III							
Course Code	Course	Hrs. of Instruction / week	Exam Duration (Hours)	Maximum Marks			Credits
				CIE	SEE	Total	
<b>Part –I</b>							
16ULCEN03	Advanced English Language -I	3	3	40	60	100	3
<b>Part- II</b>							
16UBTCC09	<b>Core -5:</b> Genetics	4	3	30	70	100	4
16UBTCC10	<b>Core -6:</b> Molecular Biology	4	3	30	70	100	4
16UBTCC11	<b>Core -7:</b> Mathematics for Biologist	4	--	100	--	100	4
16UBTDA05	<b>DSE- Allied 3:</b> Plant Science	4	3	30	70	100	4
16UBTCC12	<b>Core Practical 5:</b> Genetics and Molecular Biology Practical	6	6	40	60	100	3
16UBTDA06	<b>DSE- Allied Practical 3:</b> Plant Science Practical	2	3	20	30	50	1
	Lab to Land	2	--	--	-	-	-
		<b>29</b>				<b>650</b>	<b>23</b>

Semester IV							
Course Code	Course	Hrs. of Instruction / week	Exam Duration (Hours)	Maximum Marks			Credits
				CIE	SEE	Total	
<b>Part –I</b>							
16 U LCEN04	Advanced English Language - II	3	3	40	60	100	3
<b>Part- II</b>							
16UBTCC13	<b>Core -8:</b> Analytical Techniques	4	3	30	70	100	4
16UBTCC14	<b>Core -9:</b> Plant Biotechnology	4	3	30	70	100	4
16UBTDA07	<b>DSE- Allied 4:</b> Animal Science	4	3	30	70	100	4
16UBTCC15	<b>Core Practical 6:</b> Analytical Techniques Practical	4	3	20	30	50	2
16UBTCC16	<b>Core Practical 7:</b> Plant Biotechnology Practical	5	3	20	30	50	2
16UBTDA08	<b>DSE- Allied Practical 4:</b> Animal Science Practical	2	3	20	30	50	1
16UBTCC17	Lab to Land	2	--	100	-	100	1
		<b>28</b>				<b>650</b>	<b>21</b>

Semester V							
Course Code	Course	Hrs. of Instruction / week	Exam Duration (Hours)	Maximum Marks			Credits
				CIE	SEE	Total	
<b>Part –II</b>							
16UBTCC18	<b>Core 10:</b> Bioprocess Engineering	4	3	30	70	100	4
16UBTCC19	<b>Core 11:</b> Immunology	4	3	30	70	100	4
16UBTCC20	<b>Core 12:</b> Physiology (Self Study)	1	2	15	35	50	4
16UBTDC01/ 16UBTDC02/ 16UBTDC03	<b>DSE-Core 1:</b> Food and Dairy Science / Forensic Science/ Pharmaceutical Biotechnology	4	3	30	70	100	4
16UBTCC21	<b>Core Practical 08:</b> Bioprocess Engineering Practical	5	6	20	30	50	3
16UBTCC22	<b>Core Practical 09:</b> Immunology Practical	4	4	20	30	50	2
16UBTDC04/ 16UBTDC05/ 16UBTDC06	<b>DSE-Core Practical 1:</b> Food and Dairy Science Practical / Forensic Science Practical / Pharmaceutical Biotechnology Practical	2	4	20	30	50	1
16UBTCC23	<b>Core 13:</b> CBT	-	-	100	-	100	1
	<b>Generic Elective -I</b>	2	-	100	-	100	2
	Project / Internship / Training	2	-	-	-	-	-
		<b>28</b>				<b>700</b>	<b>25</b>

Semester VI							
Course Code	Course	Hrs. of Instruction/ week	Exam Duration (Hours)	Maximum Marks			Credits
				CIE	SEE	Total	
<b>Part- II</b>							
16UBTCC24	<b>Core- 14:</b> rDNA Technology	4	3	30	70	100	4
16UBTCC25	<b>Core- 15:</b> Bioinformatics	3	3	30	70	100	3
16UBTCC26	<b>Core- 16:</b> Environmental Biotechnology	3	3	30	70	100	3
16UBT DC07/ 16UBT DC08/ 16UBT DC09	<b>DSE-Core 4:</b> Molecular Diagnosis and Drug Designing/ Biosafety and IPR / Animal Biotechnology	4	3	30	70	100	4
16UBTCC27	<b>Core Practical 10:</b> rDNA Technology and Environmental Biotechnology Practical	3	6	40	60	100	1
16UBTCC28	<b>Core Practical 11:</b> Bioinformatics Practical	2	4	20	30	50	1
16UBT DC10/ 16UBT DC11/ 16UBT DC12	<b>DSE-Core Practical 4:</b> Molecular Diagnosis and Drug Designing Practical /Biosafety and IPR Practical / Animal Biotechnology: Practical	2	4	20	30	50	1
16UBTCC29	Project / Internship / Training	6	3	60	40	100	2
	<b>Generic Elective - II</b>	2	-	100	-	100	2
		<b>29</b>				<b>800</b>	<b>21</b>
<b>Total Marks : 3900</b>							

### Part III

<b>Part III</b>						
Course Code	Semester	Particulars	Hrs of instruction/week	No. of Courses	Credit/Course	Total Credits
<b><i>Ability Enhancement Compulsory Course (AECC)</i></b>						
As per common list	I & II	<b>AECC-I</b> Environment Science	1	1	2	2
	IV & V	<b>AECC-II</b> Communication Skill/Soft Skills	2	2	1	2
					<b>Sub Total</b>	<b>4</b>
<b><i>Skill Enhancement Course (SEC)</i></b>						
As per common list	I	<b>SEC-I</b> Value Education-I	1	1	1	1
	II	Value Education-II	1	1	1	1
	Any Semester between II - V	<b>SEC-II</b> *Co-Curricular Course	> 40 hours in total	1	1	1
	Any Semester between II - V	<b>SEC-III</b> **Value Added Courses	40 hours in total	1	1	1
					<b>Sub Total</b>	<b>4</b>
					<b>Grand Total</b>	<b>8</b>

**\*Co-Curricular Courses** - Option to students to choose 1 from a list of courses offered by the college, such as Add on Courses, Gandhian Studies Certificate Course, Women Studies Course, etc.

**\*\*Value Added Courses** - Option to student to choose at least 1 from a list of courses offered by UG departments.

## TOTAL MARKS & CREDIT DISTRIBUTION

S.No	PART	Total Marks	Total Credits
1.	<b>PART I:</b> Language Course	400	12
2.	<b>PART II :</b> Core, DSE Allied, DSE Elective, Generic Elective	3500	120
3.	<b>PART III:</b> AECC- I & II, SEC- I,II & III	Remarks	08
<b>TOTAL</b>		<b>3900</b>	<b>140</b>

- PART-I: LANGUAGE COURSE**

The following are compulsory courses offered in First to Fourth semesters

S.No	Semester	Course Code	Course
1.	<b>I</b>	16ULCEN01	Functional English- I
2.	<b>II</b>	16ULCEN02	Functional English- II
3.	<b>III</b>	16ULCEN03	Advanced English Language -I
4.	<b>IV</b>	16ULCEN04	Advanced English Language -II

- PART-II: CORE, DSE ALLIED, DSE CORE, GE  
CORE COURSES [Theory]**

S.No	Semester	Course Code	Course
1.	<b>I</b>	16UBTCC01	Cell Biology
2.		16UBTCC02	Biomolecules
3.	<b>II</b>	16UBTCC05	Fundamentals of Microbiology
4.		16UBTCC06	Cellular Metabolism
5.	<b>III</b>	16UBTCC09	Genetics
6.		16UBTCC10	Molecular Biology
7.		16UBTCC11	Mathematics for Biologist
8.	<b>IV</b>	16UBTCC13	Analytical Techniques
9.		16UBTCC14	Plant Biotechnology
10.	<b>V</b>	16UBTCC18	Bioprocess Engineering
11.		16UBTCC19	Immunology
12.		16UBTCC20	Physiology (Self-Study)
13.		16UBTCC23	Computer Based Test (MCQs on Fundamentals and Principles of Core up to 5 <sup>th</sup> Semester)
14.	<b>VI</b>	16UBTCC24	rDNA Technology
15.		16UBTCC25	Bioinformatics
16.		16UBTCC26	Environmental Biotechnology

- CORE COURSE [Practical]**

S.No	Semester	Course Code	Course
1.	<b>I</b>	16UBTCC03	Cell Biology Practical
2.		16UBTCC04	Biomolecules Practical

3.	<b>II</b>	16UBTCC07	Fundamentals of Microbiology Practical
4.		16UBTCC08	Cellular Metabolism Practical
5.	<b>III</b>	16UBTCC12	Genetics & Molecular Biology Practical
6.	<b>IV</b>	16UBTCC15	Analytical Techniques Practical
7.		16UBTCC16	Plant Biotechnology Practical
8.	<b>I-IV</b>	16UBTCC17	Lab to Land
9.	<b>V</b>	16UBTCC21	Bioprocess Engineering
10.		16UBTCC22	Immunology
11.	<b>VI</b>	16UBTCC27	rDNA Technology & Environmental Biotechnology
12.		16UBTCC28	Bioinformatics

• **OTHER CORE COURSES**

S.No.	Semester	Course Code	Course
1.	V-VI	16UBTCC29	Project / Internship / Training

**DSE CORE COURSE (Theory & Practical)**

Students are required to opt for any one of the courses offered in the Fifth and Sixth semester respectively

S.No	Semester	Theory		Practical	
		Course Code	Course	Course Code	Course
1.	V	16UBTDC01/	Food and Dairy Science/	16UBTDC04/	Food and Dairy Science Practical/
		16UBTDC02/	Forensic Science/	16UBTDC05/	Forensic Science Practical/
		16UBTDC03	Pharmaceutical Biotechnology	16UBTDC06	Pharmaceutical Biotechnology Practical
2.	VI	16UBTDC07/	Molecular Diagnosis and Drug Designing/	16UBTDC10/	Molecular Diagnosis and Drug Designing Practical/
		16UBTDC08/	Biosafety and IPR /	16UBTDC11/	Biosafety and IPR Practical/
		16UBTDC09	Animal Biotechnology	16UBTDC12	Animal Biotechnology Practical

**DSE ALLIED COURSES (Theory)**

Sr.No	Semester	Course Code	Course
1.	I	16UBTDA01	Chemistry I
2.	II	16UBTDA03	Chemistry II
3.	III	16UBTDA05	Plant Science

4.	IV	16UBTDA07	Animal Science
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- **DSE ALLIED SUBJECT [Practical]**

Sr.No	Semester	Course Code	Course
1.	I	16UBTDA02	Chemistry I
2.	II	16UBTDA04	Chemistry II
3.	III	16UBTDA06	Plant Science
4.	IV	16UBTDA08	Animal Science

- **GENERIC ELECTIVE**

S.No	Semester	Course
1.	V	Any one course from list of courses offered under UG Departments
2.	VI	

• **PART III :- AECC & SEC**

<b>Part III</b>						
Course Code	Semester	Particulars	Hrs of instruction/week	No. of Courses	Credit/Course	Total Credits
<b><i>Ability Enhancement Compulsory Course (AECC)</i></b>						
As per common list	I & II	<b>AECC-I</b> Environment Science	1	1	2	2
	IV & V	<b>AECC-II</b> Communication Skill/Soft Skills	2	2	1	2
					<b>Sub Total</b>	<b>4</b>
<b><i>Skill Enhancement Course (SEC)</i></b>						
As per common list	I	<b>SEC-I</b> Value Education-I	1	1	1	1
	II	Value Education-II	1	1	1	1
	Any Semester between II - V	<b>SEC-II</b> *Co-Curricular Course	> 40 hours in total	1	1	1
	Any Semester between II - V	<b>SEC-III</b> **Value Added Courses	40 hours in total	1	1	1
					<b>Sub Total</b>	<b>4</b>
					<b>Grand Total</b>	<b>8</b>

**\*Co-Curricular Courses** - Option to students to choose 1 from a list of courses offered by the college, such as Add on Courses, Gandhian Studies Certificate Course, Women Studies Course, etc.

**\*\*Value Added Courses** - Option to student to choose at least 1 from a list of courses offered by UG departments.

**Courses offered by the department to UG students of other department**

**I. Generic Elective Course**

<b>S.No</b>	<b>Semester</b>	<b>Course Code</b>	<b>Course</b>	<b>Name of Programme</b>
1.	<b>V</b>			For all Other UG Programmes
2.	<b>VI</b>			

**B.Sc. Biotechnology**  
**SEMESTER- I**

<b>16UBTCC01</b>	<b>Core 1: Cell Biology</b>	<b>4hrs/wk</b>	<b>4 Credits</b>
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**Objectives:**

To enable the students to

1. Understand basic concept of cell and recognize the different levels of biological organization, from molecules to organism.
2. Understand the structures and function of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
3. Explore the fundamental mechanisms of cell cycle & its regulation along with the mitotic & meiotic cell division and the contribution of cytoskeleton in the mechanisms of intracellular transport and cell locomotion

**Unit 1: Basic Concepts and Understanding of Cell (7hrs)**

- Concept of Life, Cell As a Basic Unit of Living System and Cell Theory
- Origin and Evolution of Cell
- Cell Structure [Prokaryotes & Eukaryotes] and cell Organization
- Chemical Composition of Cell; Comparison of microbial, plant and animal cells
- Diversity of Cell Size and Shape

**Unit 2: Structure and function of Prokaryotic Cell (8hrs)**

- Size, Shape and Arrangement of Bacteria
- The cell wall of Bacteria : Structure and chemical composition of Gram Positive and Gram Negative Bacteria
- Bacterial Structure : External to Cell Wall -Capsule, Flagella, Pili, Prostheca, Sheath & Stalk
- Bacterial Structure : Internal to Cell Wall Cell Membrane, Protoplast, Spheroplast, Cytoplasm, mesosome, Cytoplasmic inclusions, Vacoules and Nuclear Material
- Bacterial Spore and Cyst-Types of Spore, Structure and Formation of Endospore [Sporogenesis]

**Unit 3: Structure and function of Eukaryotic Cell (15hrs)**

- Cell Wall and Plasma Membrane
- Mitochondria, Chloroplast
- Endoplasmic Reticulum, Golgi Bodies
- Lysosomes, Glyoxisomes, Peroxisomes
- Nucleus & Ribosomes

**Unit 4: Cell Cycle and Cell Division (10hrs)**

- Structure and Ultrastructure of Chromosome
- Polytene and Lampbrush Chromosomes
- Overview of Cell Cycle
- Mitosis and Meiosis
- Regulation of Cell Cycle

## Unit 5: Advance Studies in Cell Biology

(8 hrs)

- Cytoskeleton
- Cell Locomotion – Amoeboid, Flagella, Cilia, Cytoplasmic Streaming
- Cell – Cell Interaction
- Membrane Transport : Exocytosis & Endocytosis
- Overview of Stem Cells Cancer Biology

### Text Books

1. Verma, P. S., & Agarwal, V. K. (2005). *Cell biology*. Molecular Biology, Evolution and Ecology. S Chand & Company Ltd. Ram Nagar, New Delhi, 110, 055.
2. Powar, C. B., & Powar, C. B. (1970). *Cell Biology*. Himalaya Publishing House.

### Reference Books

1. Berk, A., Zipursky SL (2000). *Molecular Cell Biology* (Vol. 4). New York: WH Freeman
2. Cooper, G. M., & Hausman, R. E. (2000). *The cell* (pp. 725-730). Sunderland: Sinauer Associates
3. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J. D., & Grimstone, A. V. (1995). *Molecular Biology of the Cell* (3rd edn). Trends in Biochemical Sciences, 20(5), 210-210.
4. Pollard, T. D., Earnshaw, W. C., & Lippincott-Schwartz, J. (2007). *Cell Biology*. Elsevier Health Sciences

<b>16UBTCC02</b>	<b>Core 2 : Biomolecules</b>	<b>4hrs/wk</b>	<b>4 Credit</b>
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### **Objectives:**

To enable the students to

1. Understand Fundamentals of Biochemistry from atom to molecule level
2. Identification and functions of five classes of polymeric Biomolecules (Carbohydrate, Protein, Lipid, Nucleic acid and Vitamins) and their monomeric building blocks.
3. Understand the laws of thermodynamics and how it dictates the behaviour of chemical substances.

### **Unit 1: Chemistry of Life: An Introduction (10hrs)**

- The Properties of Water
- The Properties of Biomolecules
- Chemical Bonds/Interactions: Ionic, Covalent, Nonpolar, Polar, Hydrogen Bonds, Hydrophobic Interactions, Vander Wall's Attractive Force
- pH, pKa, Acids, Bases and Buffers
- Thermodynamics of Biological System: The First Law, the Second Law, The Third Law, Free Energy, ATP and other High Energy Compounds

### **Unit 2: The Molecule of Life: Carbohydrate (10hrs)**

- Chemistry of Carbohydrates: Functions And Classifications, Monosaccharides: Configuration and Conformation
- Reactions of Monosaccharides and Sugar Derivatives
- Disaccharides: Classifications and Functions
- Polysaccharides: Classifications and Functions
- Glycoconjugates: Proteoglycans, Glycoproteins and Glycolipids

### **Unit 3: The Molecule of Life: Protein (10hrs)**

- Amino Acids: Structures, General Properties, Classifications and nomenclature of Amino Acids, Nonstandard Amino Acid (Amino Acid Derivatives)
- Proteins: An Overview of Four Levels of Structures in Proteins
- Classifications of Proteins and Properties of Proteins, Biologically Important Peptides
- Protein Folding
- Protein – Protein Interaction, DNA Protein Interaction

### **Unit 4: The Molecule of Life: Nucleic Acid (10hrs)**

- Basic Understanding of Nucleotides, Structure and Properties of Nitrogen Bases, Functions of Nucleotides. Nucleotide Analogs
- Nucleic Acids: Historical aspects of DNA as Genetic Material, X ray diffraction Studies of DNA, Chargaff's Rule
- Watson and Crick DNA Double Helix Structure
- Types of DNA Structure, Denaturation and Renaturation of DNA
- Types of RNA and their Functions, Catalytic RNAs (Ribozymes)

## Unit 5: The Molecule of Life: Lipid, Vitamins

(8hrs)

- Lipids: Classifications of Lipids
- Structure of Fatty Acids
- Functions of Lipids, Fatty Acids, Triacylglycerols, Phospholipids, Steroids
- Vitamins: Classification, Functions,
- Sources and Deficiency Disorder

### Text Books

1. Satyanarayan, U., & Chakrapani, U. (1999). *Textbook of Biochemistry*.
2. Hames, B. D., & Hooper, N. M. (1997). Instant notes in Biochemistry. *Biochemical Education*, 25, 4.
3. Jain, J. L. (2004). *Fundamentals of Biochemistry*. S. Chand.

### References Books

1. Voet, D., Voet, J. G., & Pratt, C. W. (1999). *Fundamentals of Biochemistry* (pp. 408-409). New York: Wiley.
2. Zubay, G. L. P., Vance, W. W., Zubay, D. E. G. L., Parson, W. W., & Vance, D. E. (1995). *Principles of biochemistry* (No. QD 415. Z82 1995).
3. Stryer L. (1981). *Biochemistry*, W.H. Freeman & Company, New York, 2

<b>16UBTCC03</b>	<b>Core Practical 1: Cell Biology Practical</b>	<b>4hrs/wk</b>	<b>2 Credits</b>
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### Objectives:

Students will be able to:

1. Learn the proper use and care of compound microscopes and learn staining techniques used in light microscopy
2. Understand the process of cell division and different stages of Mitosis and Meiosis.
3. Isolate cell organelles including mitochondria and Chloroplast from the eukaryotic cell

### List of Experiments

Exp.1. Introduction to LAB and lab environment

Exp.2. Preparation of solutions

Exp.3. Staining techniques (Simple, Differential and Special)

A. Monochrome Staining

B. Negative Staining

C. Gram Staining

D. Spore Staining

E. Capsule Staining

Exp.4. Calibration of stage and ocular micrometer and measurement of given biological samples

Exp.5. Isolation and Staining of Chloroplast

Exp. 6. Isolation and Staining of Mitochondria

Exp.7. Preparation of slides showing different stages of cell division – Mitosis & Meiosis

Exp.8. Study of Polytene & Lamp brush Chromosome [Giant Chromosome]

Exp.9 Cell Locomotion Study through Hanging drop Method

Exp.10 Cytology and histology of various organs (Permanent slides preparation)  
[Demonstration]

Exp.11. To study Pinocytosis

### Reference Books

1. Davey, J. (2003). *Essential Cell Biology: A Practical Approach* (Vol. 2). Oxford University Press, USA.
2. Verma, A., Das, S., & Singh, A. (2014). *Laboratory Manual for Biotechnology*. S. Chand and Co. Pvt. Ltd, New Delhi. ISBN, 978-93.

<b>16UBTCC04</b>	<b>Core Practical 2: Biomolecules Practical</b>	<b>6hrs/wk</b>	<b>3 Credits</b>
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### Objectives:

Student will be able to

1. Operate pH meter and prepare buffer of specific pH
2. Qualitatively and Quantitatively analyze biomolecules, including Carbohydrate, Protein, Lipid, Nucleic acid and Vitamins

### List of Experiments

- Exp.1. Operation of pH meter and measurement of pH
- Exp.2. Preparation of buffer solution
- Exp.3. Qualitative tests for carbohydrates
- Exp.4. Isolation of Starch from grain
- Exp.5. Qualitative tests for Amino acids
- Exp.6. Titration curve of amino acids and determination of pI, pK1 and pK2.
- Exp.7. Qualitative analysis of Lipid
- Exp.8. Test for the unsaturation for Lipid & Solubility of Fatty Acid
- Exp.9. Saponification Value of Lipid
- Exp.10. Qualitative analysis of Nucleic acid
- Exp.11. Titrimetric analysis of Ascorbic Acid

### Reference Books

1. Seidman, L. A., & Moore, C. J. (2009). *Basic laboratory methods for biotechnology: textbook and laboratory reference*. Pearson/Benjamin Cummings.
2. Dr. Ramesh Goyal, Dr. Shailesh Shah & Dr. Anita Mehta, (2006). "*Practicals in Biochemistry and Clinical Pathology*" B. S, Prakashan.
3. Deb, A. C. (2013). *Comprehensible viva and practical biochemistry*. New Central Book Agency.

## SEMESTER II

<b>16UBTCC05</b>	<b>Core 3 : Fundamentals of Microbiology</b>	<b>4hrs/wk</b>	<b>4 Credits</b>
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### Objectives:

To enable students to:

1. Describe the historical perspectives in development of microbiology and describe current diversity and categorize Prokaryotic, Unusual Prokaryotic, Eukaryotic and Akaryotic microbial diversity.
2. Successfully perform growth of microbes using different isolation techniques and compare various methods for controlling microorganisms.
3. Describe microbial metabolic pathways in general terms and specifically and summarize basic bacterial genetic principles and analyze consequences of mutation.

### **Unit 1: Microbiology- An Overview (8hrs)**

- Mile stones in Microbiology: - Biogenesis and abiogenists, Historical Development
- Introduction to Groups of Microorganisms -Algae, Bacteria, Fungi, Protozoa & viruses.
- Distribution of Microorganisms in Nature – Occurrence and Habitat.
- Place of Microorganisms in the living world – Classification.
- Applications of Microorganisms in various fields – Scope of Microbiology.

### **Unit 2: Microbial Diversity of Bacteria (10hrs)**

- Classification system, taxonomic rank of microorganisms.
- Microbial taxonomy and major characteristics used in taxonomy,
- Microbial Diversity: Prokaryotic (Gram positive and negative bacteria) and unusual prokaryotic (Rickettsia, Chlamydia and extremophiles )
- Microbial Diversity: Eukaryotic (Fungi, algae and protozoa) and akaryotic diversity (viruses).
- Microbial phylogeny of bacteria.

### **Unit 3: Growth, Reproduction and Cultivation of Bacteria (10hrs)**

- Nutritional requirements and classification of Microorganisms
- Chemical & Physical requirement of Growth (nutrients, temperature, oxygen, pH, osmotic pressure) and types of Bacteriological culture media
- Reproduction, Definition of growth, mathematical expression of growth. Growth Curve, Growth yield, Monoauxic, diauxic, Synchronous Culture, Continuous culture and batch culture.
- Measurement of Bacterial growth (generation time, growth rate, cell number, cell mass and cell activity Cell count, direct and indirect method, turbidometric method.

Plate count method, membrane filter count method, dry weight and wet weight method by measurement of cellular activity).

- Isolation, enumeration, cultivation and Preservation of microorganisms

#### **Unit 4: Control of Microorganisms**

**(10hrs)**

- Fundamentals of Microbial Control Principle and Types, Definition of Sterilization, Disinfectant, Antiseptic, Sanitizer, Germicidal and Bactericides.
- Characteristics, Evaluation and Selection of Ideal antimicrobial agent
- Physical Agents of Microbial Control – High Temperature, Low temperature, Desiccation, Osmotic Pressure, Radiation, Ultraviolet lights, X- rays, Gamma rays, Cathode rays, surface tension and interfacial tension, filtration, pH, light, osmotic pressure, ultrasonication, tyndalization and filtration.
- Chemical Agents of Microbial Control – Phenol and phenolic compound, antiseptics and chemical sterilants, Alcohol, Halogen, Heavy metals and their compounds, Dyes, Detergents, Quaternary ammonium compounds, Aldehydes, Gaseous sterilization
- Biological Agents of Microbial Control – Types, Mode of Action (Antibiotics)

#### **Unit 5: Microbial Metabolism and Genetics**

**(10hrs)**

- Respiration: EMP, HMP and ED Pathways, Krebs's cycle,
- Bacterial Photosynthesis: Photosynthetic apparatus in prokaryotes,
- Oxidative Phosphorylation, Photophosphorylation & Dark reaction.
- Gene transfer mechanisms in bacteria: Transformation- Griffith's exp. Conjugation- Davis experiment
- Transduction-generalised (basic concept).

#### **Text Books**

1. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (1993). *Microbiology*. 5<sup>th</sup> Edition. McGraw Hill Book Company.
2. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. (1987). *General microbiology* (No. Ed. 5). MacMillan Education Ltd..
3. Prescott, L. M. H., Klein, J. P., Prescott, D. A. L. M., Harley, J. P., & Klein, D. A. (2004). *Microbiologia*. McGraw-Hill.

#### **Reference Books**

1. Tortora, G. J., Funke, B. R., & Case, C. L. (2009). *Microbiologia*. Artmed Editora.
2. Dubey, R. C., & Maheshwari, D. K. (1999). *Text book of Microbiology*. S. Chand & Company Limited.
3. Madigan, M. T., Martinko, J. M., Dunlap, P. V., & Clark, D. P. (2008). *Brock Biology of microorganisms* 12th edn. International Microbiology, 11, 65-73.
4. Schlegel, H. G. (2002). *General Microbiology*. Cambridge University Press.

<b>16UBTCC06</b>	<b>Core 4: Cellular Metabolism</b>	<b>4hrs/wk</b>	<b>4 Credits</b>
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### **Objectives:**

To enable students to

1. Understand the basic concept of Enzyme, its kinetics, inhibition and its regulation
2. Understand the various metabolic pathway and regulation of carbohydrate, amino acid and fat as well as its correlation
3. Understand the structure of membrane, transport of molecules across it, signal transduction and hormones

### **Unit1: Enzyme**

**(10hrs)**

- Enzymes: - General properties, Nomenclature and Classification. Biocatalyst and Chemical catalyst, Coenzymes and Cofactors.
- Catalytic Mechanism (Proximity and Orientation effects, Acid base Catalysis, Covalent Catalysis and Metal ion catalysis and Transition state analog).
- Enzyme Kinetics (derivation of Michaelis–Menten constant, linear transformation of the equation). Enzyme Inhibition: Mechanism and Types (Irreversible and Reversible).
- Allosteric Enzymes and Isoenzymes.
- Mechanism of Enzyme Regulation: Covalent and Allosteric Regulation

### **Unit 2: Carbohydrate Metabolism**

**(10hrs)**

- Introduction to Metabolism, Types of Metabolic reactions
- Carbohydrate Metabolism: Glycolysis, Acetyl CoA formation (PDH complex)
- Oxidative processes: Citric Acid cycle & Pentose Phosphate pathway
- Electron transport and Oxidative Phosphorylation.
- Gluconeogenesis: Carbohydrate biosynthesis

### **Unit 3: Protein and Amino acid and Metabolism**

**(10hrs)**

- Protein degradation, Transamination, Oxidative Deamination, Decarboxylation,
- Ammonia Formation/Urea Cycle, Catabolism of carbon skeleton of amino acid, Glucose-alanine Cycle
- Glycogenic and ketogenic amino acid, Disorder in amino acid metabolism
- Metabolic transformation of amino acid
- Inborn errors in Metabolism.

### **Unit 4: Lipid metabolism**

**(10hrs)**

- Fatty acid catabolism: Type of fatty acid oxidation, Beta Oxidation of fatty acid and energetics of palmitic acid, oxidation of fatty acid with odd number of carbon, Alpha and Omega oxidation of fatty acid
- Fatty Acid anabolism: FAS Complex, Fatty acid biosynthesis and Chain elongation

- Cholesterol Metabolism: Cholesterol biosynthesis, molecule derived from cholesterol(steroid hormones, vitamin, bile salt)
- Eucosanoids Metabolism: Prostaglandin, Thromboxane and Leucotriens synthesis
- Role of Hormones in regulation of lipid metabolism

### **Unit: 5 Membrane transport, Signal Transduction and hormone**

**(8hrs)**

- Plasma Membrane: History , Structure and Functions
- Movement of ions and molecule across membrane: Passive Transport, Active transport, Exocytosis and endocytosis
- Signal transduction: Types of Signaling molecules, Membrane receptors and their mechanism,
- Secondary messengers
- Hormones: Introduction, Definition, Classification, Structure, Function and Applications of plant hormone Auxin and Gibberellins, Animal hormones – Pancreas and Thyroid.

#### **Text Books**

1. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2000). *Principles of biochemistry*. New York: Worth Publishers.
2. Voet, D., & Voet, J. G. (2011). *Biochemistry*, 4-th Edition. NewYork: John Wiley& SonsInc, 492-496.

#### **Reference Books**

1. Mathews, C. K., Van Holde, K. E., & Ahern, K. G. (2000). *Biochemistry*. 2000. *San Francisco: BenjaminCummings*.
2. Garrett, R. H., & Grisham, C. M. (2001). *Principles of Biochemistry: with a human focus*. Thomson Brooks/Cole.
3. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). *Lehninger principles of biochemistry*. Macmillan.
4. Berg, J. M., Tymoczko, J. L., & Stryer, L. (2002). *Biochemistry*, ; W. H.
5. Murray, R. K. (2009). *Harper's illustrated biochemistry*. New York: McGraw-Hill
6. Palmer, T., & Bonner, P. L. (2007). *Enzymes: biochemistry, biotechnology, clinical chemistry*. Elsevier.

16UBTCC07	<b>Core Practical 3: Fundamentals of Microbiology Practical</b>	<b>5hrs/wk</b>	<b>3 Credits</b>
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### Objectives:

1. Acquire and demonstrate competency in laboratory safety rules and procedures, especially the constant use of aseptic technique and the proper handling of biohazards. Correctly perform microbiologic lab skills and display a habit of good lab practices.
2. Evaluate specialized microbiological laboratory skills applicable to microbiological research or clinical methods, including accurately reporting observations and analysis

### List of Experiments

- Exp:1. Safety measures, cleaning, sterilization of glassware and media in microbiology laboratory
- Exp:2. Determination of growth curve and generation time of E. coli
- Exp:3. Methods for isolation of microorganisms.
- Exp:4. Isolation of Gram positive microorganisms from air, water and soil samples.
- Exp:5. Identification of Gram positive microorganisms from given pure culture using biochemical characteristics
- Exp:6. Isolation of Gram negative microorganisms from air, water and soil samples.
- Exp:7. Identification of Gram negative microorganisms from given pure culture using biochemical characteristics.
- Exp:8. Enumeration of microorganism - total & viable count.
- Exp:9. Isolation and identification of pathogenic bacteria from sewage and waste water.
- Exp:10. Antibiotics sensitivity of microbes using antibiotic discs .
- Exp:11. Isolation and microscopic observation of Algae, Protozoa and fungi from given sample.
- Exp:12. Isolation and microscopic observation of Actinomycetes, halophiles and Thermophiles from given sample.

### Reference Books:

1. Ogbulie, J. N., Uwaezuoke, J. C., & Ogiehor, S. T. (1998). *Introductory microbiology practical*. Springfield Pub. Lagos.
2. Cappuccino, J. G., Sherman, N., & Microbiology, A. (1983). A laboratory manual.

<b>16UBTCC08</b>	<b>Core Practical 4: Cellular Metabolism Practical</b>	<b>5hrs/wk</b>	<b>2 Credits</b>
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### Objectives:

The student will be able to:

1. Quantitatively estimate biomolecules including Protein, Carbohydrate, Nucleic Acid and Chlorophyll
2. Determine enzyme activity and enzyme kinetics.

### List of Experiments

Exp:1 Estimation of Protein by Biuret Method.

Exp:2 Estimation of Reducing Sugar by Nelson- Somogyi method

Exp:3 Estimation of RNA by Orcinol Method.

Exp:4 Estimation of DNA by DPA Method.

Exp:5 Estimation of Chlorophyll.

Exp:6 Determination of Enzyme Activity of Salivary amylase by DNSA Method.

Exp:7 Determination of Enzyme Activity of Invertase by GOD/POD Method

Exp:8 Qualitative assay of Phenol oxidase

#### Enzyme Kinetics:

Exp:9 Effect of Substrate concentration (Determination of  $K_m$  and  $V_{max}$ ).

Exp:10 Determine the temperature optima of the enzyme.

Exp:11 Effect of pH on enzyme activity.

Exp:12 Effect of Enzyme Inhibitors on Enzyme Activity

### References Books

1. Mu, P., & Plummer, D. T. (1988). *Introduction to practical biochemistry*. Tata McGraw-Hill Education.
2. Thimmaiah, S. K. (2006). *Standard methods of biochemical analysis*. Kalyani publishers.
3. Sawhney, S. K., & Singh, R. (2000). *Introductory practical biochemistry*. Alpha Science Int'l Ltd..
4. Jayaraman, J. (1981). *Laboratory manual in biochemistry*. Wiley Eastern.