



**PRAVARA INSTITUTE OF MEDICAL SCIENCES  
(DEEMED TO BE UNIVERSITY)**

Loni, Tal. Rahata, Dist. Ahmednagar 413736

NAAC Re-accredited with 'A' Grade

**SYLLABUS**

**B.Sc. (Medical Biotechnology)**

**(Center for Biotechnology)**

(Academic Council Meeting Dated 11<sup>th</sup> December 2020)

**B. Sc Medical Biotechnology**

Sr. No.	Code	Name of the subject	Page No.
<b>Semester I</b>			
1.	UMBTT 101	Basic Chemistry	03
2.	UMBTT 102	Mathematics & Biostatistics	05
3.	UMBTT 103	Evolutionary Biology	07
4.	UMBTT 104	Introduction to Biotechnology	09
<b>Semester II</b>			
5.	UMBTT 201	Biophysics	11
6.	UMBTT 202	Cell Biology	14
7.	UMBTT 203	Basic Laboratory Methods	16
8.	UMBTT 204	Computational Methods in Biotechnology	18
<b>Semester III</b>			
9.	UMBTT 301	General Microbiology	20
10.	UMBTT 302	Human Biochemistry	23
11.	UMBTT 303	Genetics & Molecular Biology	25
12.	UMBTT 304	Human Physiology	27
<b>Semester IV</b>			
13.	UMBTT 401	Medical Microbiology	29
14.	UMBTT 402	Cell Culture ( Animal & Plant)	31
15.	UMBTT 403	Immunology	33
16.	UMBTT 404	Bioinformatics	35
<b>Semester V</b>			
17.	UMBTT 501	Genetic Engineering	38
18.	UMBTT 502	Enzyme Technology	40
19.	UMBTT 503	Industrial & Fermentation Biotechnology	42
20.	UMBTPr 504	<b>Project Work</b>	<b>44</b>

<b>Semester VI</b>			
21.	UMBTT 601	Molecular Diagnostics	<b>45</b>
22.	UMBTT 602	Immuno Technology & Diagnostics	<b>47</b>
23.	UMBTT 603	Food Biotechnology	<b>49</b>
24.	UMBTT 604	Plant Biotechnology	<b>51</b>

## Semester I

### BASIC CHEMISTRY (UMBTT 101)

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)
UMBTT 101	Core	Basics Chemistry	4	0	4	60	4+2=6
Objective: The main objective of the paper is to expose students to.							
Outcome: At the end of this course student should be able to understand basic principles of organic & Inorganic chemistry and develop skills in handling organic molecules. This is essential for undertaking practical training in Biochemistry and genetic engineering at the later stage.							
Sr. No.	Topic	Detail of syllabus	Hrs.				
Unit I	Atoms & Molecules	Structure of atoms & molecules: Concept of orbital's, aufbau principle, periodic trends in atomic properties, atomic spectra. Molecules: PE diagram, diatomic molecules, valence bond theory, hybridization, VSEPR theory, linear combination of atomic orbitals, homo and heteronuclear molecules, bond orders, magnetic properties, polyatomic molecules.	8				
Unit II	Periodic Table	Periodic table- group and periods, s and p block elements, transition metals, d orbitals splitting in octahedral, tetrahedral and square planar environment – spectral and magnetic properties.	10				
Unit III	Thermodynamics	Thermodynamics- second law of thermodynamics, entropy, spontaneous change, free energy, enthalpy, adiabatic demagnetization, reactions at equilibrium, interpretation of equilibrium constants, acid and bases, solubility equilibria, biological activity, thermodynamics of ATP.	10				
Unit IV	Electrochemistry	Electrochemical cells, half cell reactions, reduction potentials, the electrochemical series, thermodynamic functions from cell potential measurements, liquid junction potentials, Debye Huckel Theory, over voltage	8				
Unit V	Classification of organic compounds	Nomenclature structural and constitutional isomers, functional group chemistry (alcohol, aldehydes, ketones, esters, amines, amides etc.)	10				

## METHODOLOGY

The course would be taught through lectures.

## BOOKS RECOMMENDED:

1. Physical Chemistry- A molecular approach by McQuairee and Simon
2. Physical Chemistry by G M Barrow
3. Concise Inorganic Chemistry by J D Lee
4. Inorganic Chemistry by Shriver and Atkin
5. Physical Chemistry by P W Atkin
6. Physical Chemistry by Venullapalli
7. Physical Chemistry for Life Science and Biosciences by R Chang
8. Organic Chemistry by R T Morrison and R N Boyd
9. Organic Chemistry by P Y Bruice

## PRACTICALS:

1. To Determine pKa Value of Weak Acid by pH Metry
2. To Determine Dissociation Constant of Oxalic Acid By pH Metry Titration
3. Organic Qualitative Analysis Compounds - 1,2,3,4
4. To Determine the Amount of Acetone in the Given Solution
5. To Determine the Amount of Phenol in the Given Solution
6. To Standardize NaOH Solution and Hence Find Strength of HCl By Using Standardized NaOH Solution.
7. To Standardize  $\text{KMnO}_4$  solution and To Estimate Fe(II) Volumetrically By Using Standardized  $\text{KMnO}_4$
8. To Determine The Molecular Weight of Given Monobasic Acid Volumetrically
9. To Find The Amount of Glucose In the Given solution
10. Preparation of Pthalimide from Pthalic Anhydride
11. Molecular Evolution in Plants- To Study and Specify Chlorophyll Pigment and Other Light absorbing Pigments in Variety of Plants.

## MATHEMATICS & BIOSTATISTICS (UMBTT 102)

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)
UMBTT 102	Core	Mathematics & Biostatistics	4	0	4	60	4+2=6

### Objective:

The objective of this course is learning and understanding basic concepts of Mathematics and Biostatistics.

### Outcome:

At the end of this course student should be able to:

- Critically evaluate the strengths and weaknesses of study designs and can select a study design that is appropriate for addressing a specific research question.
- Use statistical reasoning, formulate a problem in statistical terms, perform exploratory analysis of data by graphical and other means.
- Frame problems using multiple mathematical and statistical representations of relevant structures and relationships and solve using standard techniques.

Sr. No.	Topic	Detail of syllabus	Hrs.
<b>Unit I</b>	Elements of mathematics-I	Derivatives: derivative of function, Derivatives of First Principles, Derivatives of inverse, exponential functions and trigonometric functions, Integration: Methods of Integration: direct integration, integration by parts	8
<b>Unit II</b>	Elements of mathematics-II	Determinant: determinant of order 2 or 3, expansion of determinant, properties of determinant, Cramer rule Matrix: Types of matrix, Algebra of matrices, Inverse matrix. Logarithm : Fundamentals of logarithm, natural logarithm and logarithm to other bases, significance of logarithmic scales	8
<b>Unit III</b>	Basic concepts in Statistics	Terms and Definitions in Statistics, Population and Sample, Raw Data, Types of variables, Numerical variable (Continuous and discrete), Categorical variables (Nominal and ordinal), Outcome and exposure variables, Display of data for 1 variable, For categorical data: Bar Chart and Pie Chart, For numerical data: Histogram (different shapes) and Frequency Polygon Measurements of central tendency: Mean, Median, quartiles, percentiles, Mode Measures of spread: Range, Variance and Standard Deviation and its interpretation Normal deviation and its characteristics	12

Sr. No.	Topic	Detail of syllabus	Hrs.
<b>Unit IV</b>	Probability and combinations	Probability: Definition and basic formula, Probability of an event not occurring, Multiplicative rule to calculate the probability of occurrence of both of two events. Independent events, Non-independent events (conditional probability), Additive rule to calculate the probability of occurrence of at least one of two events, mutually exclusive events. Combinations: Definition and basic formula ( $nCr = \frac{n!}{r!(n-r)!}$ ), Application in biology (pedigree analysis), Problems involving Combinations and Probability	10
<b>Unit V</b>	Sampling, Hypothesis and significance	Sampling Variation, Population mean and standard error, Concept of Hypothesis test and null-hypothesis, t-test (concept and calculation), ANOVA, One way Anova (concept and calculation), SPSS and its application	10

## METHODOLOGY

The course would be taught through lectures.

## BOOKS RECOMMENDED:

1. Introduction to Mathematics for life scientist – by Edward Batschelet
2. Discrete Mathematics- Semyour Lipschutz & Marc Lipson-McGraw Hill
3. S. C. Gupta and V. K. Kapoor : Mathematical Statistics, Sultan Chand & Sons
4. Introduction to Biostatistics, Le and Chap (2009), Wilay and Sons.
5. Fundamentals of Biostatistics, B. Rosner (2005), Duxbury Press.
6. Medical Statistics from Scratch, Bowers (2008), Wiley and Sons.
7. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press

## EVOLUTIONARY BIOLOGY (UMBTT 103)

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)
UMBTT 103	Core	Evolutionary Biology	4	0	4	60	4+2=6

### Objective:

This is a course in evolutionary biology that uses Flora and fauna examples to exemplify fundamental concepts in evolution. The course will concentrate on basic evolutionary mechanisms and its theory.

### Outcome:

Students shall be able to understand evolution among non living and living things.

- Compressive and stepwise evolution among non living things.
- Emergence of life with simple geochemistry to complex biochemistry of current time.
- Relatedness among life forms through studying fossils & molecular evidence of evolution.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Introduction	History of Life, theories of Evolution and Extinction Chemogeny, Biogeny, RNA World, Major Events in History of Life; Lamarckism; Darwinism; Neo-Darwinism; Background of extinction, Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail) and Role of extinction in evolution.	10
Unit II	Fossils and molecular phylogeny evidences	Evidences of Evolution Fossils and its types; Dating of fossils, Phylogeny of horse and human; Molecular evidences (Globin gene families as an example) and Molecular clock concept.	6
Unit III	Natural Selection	Processes of Evolutionary Change Organic variations; Isolating mechanisms; Natural selection (Industrial melanism, Pesticide / Antibiotic resistance); Types of natural selection (Directional, Stabilizing, Disruptive), Sexual Selection and Artificial selection.	12
Unit IV	Evolution in classes	Evolution in Plants and Fungi- Terrestrial algae, bryophytes, from swamps to uplands, angiosperm, fungi From Protozoa to Metazoa–The Cambrian explosion, protistan ancestry, the coelom,metamerism.	6
Unit V	Evolution in higher classes	Evolution Among Invertebrates The Origin of Vertebrates Evolution of Mammals Primate Evolution and Human Origins	12
Unit VI	Social and cultural aspects of Evolution	Culture and the Control of Human Evolution – Learning society & culture, cultural & biological evolution, Eugenics.	2

## **METHODOLOGY**

The course would be taught through lectures.

## **BOOKS RECOMMENDED:**

Evolution – by Monroe W. Strickberger

## INTRODUCTION TO BIOTECHNOLOGY (UMBTT 104)

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)
UMBTT 104	Core	Introduction to Biotechnology	4	0	4	60	4+2=6

### Objective:

The objective of the course is to enlighten the student with knowledge of biotechnology with techniques involved in Biotechnology and its use in the field of Medical and health care.

### Outcome:

The anticipated knowledge, skills and/or attitude to be developed by the student are:

1. Be able to define the term “biotechnology” and appreciate its scope.
2. Have an awareness of the global significance of biotechnology and its resultant industries, and a broad knowledge of which are represented nationally and locally.
3. Be familiar with the key events in the development of biotechnology.
4. Be able to state the broad categories of biotechnological processes based on the products formed and/or the process or substrates used, and have detailed knowledge of examples of each of these
5. Have an understanding of the multidisciplinary nature of biotechnology and the associated role that has been played by enabling technologies in the development of biotechnology
6. Have an awareness of some of the current and future issues surrounding the relationship between biotechnology and government, investors, the environment and consumers and the impact of these on the development of future biotechnology enterprises.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Modern Biotechnology	What is biotechnology? Ancient Biotechnology Classical Biotechnology The Foundation of Modern Biotechnology	6
Unit II	The DNA Revolution: Promise and Controversy	The First Recombinant DNA Experiments Concerns about Safety Drafting the NIH Guidelines Current and Future Concerns	6
Unit III	Microbial Biotechnology	Commercial Production of Microorganisms Bioconversion Microorganisms and Agriculture Products from Microorganisms Bioremediation	6
Unit VI	Animal Biotechnology	Gene Transfer Methods in Animals Transgenic Animals Animal Diseases Animal Propagation Conservation Biology Regulation of Transgenic Animals	6
Unit V	Marine Biotechnology	Aquaculture Marine Animal Health	8



Sr. No.	Topic	Detail of syllabus	Hrs.
		Algal Products Fuels from Algae Algal Cell culture Medical Application Transgenic Fish	
Unit VI	The Human Genome Project	Goals of the human genome Genetic Linkage Maps Polymorphic DNA Markers Ethical, legal, and social implications	4
Unit VII	Medical Biotechnology	Gene Therapy Gene Delivery Methods Viral Delivery Models Commercialization Vaccines Tissue Engineering Xenotransplantation Drug Delivery	8
Unit VIII	Forensic and DNA Profiling	Satellite DNA Single and Multi-locus VNTRs, RFLPs DNA Profiling, PCR,	4

## METHODOLOGY

The course would be taught through lectures.

## BOOKS RECOMMENDED:

1. Biotechnology: An Introduction - by Susan R. Barum
2. Biotechnology A Laboratory course - by Jeffrey M. Becker, Guy A. Caldwell, Eve Ann Zachgo
3. Basic of Biotechnology – by Dr. A. Jayakumaran Nair
4. Biotechnology – by Keshav Trehan

## Semester II

### BIOPHYSICS (UMBTT 201)

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)	
UMBTT 201	Core	Biophysics	4	0	4	60	4+2=6	
<p><b>Objective:</b></p> <ul style="list-style-type: none"> <li>➤ To introduce the concepts in Biophysics and allied subjects</li> <li>➤ To enrich students' knowledge</li> <li>➤ To help the students to build interdisciplinary approach</li> <li>➤ To inculcate sense of scientific responsibilities and social and environment awareness.</li> <li>➤ To help students build-up a progressive and successful career</li> </ul> <p>The restructured syllabus combines basic principles of Biophysics in light of advancements in technology. The syllabus aims to impart basic knowledge with emphasis on its applications to make the students industry ready.</p> <p><b>Outcome:</b></p> <p>At the end of the course student will be able to demonstrate knowledge of fundamental concept in physics &amp; chemistry that underlie biological process. Define characteristic nucleic acid protein and examine parameter that determine their stability &amp; function</p>								
Sr. No.	Topic	Detail of syllabus						Hrs.
Unit I	Introduction	Concept of biophysics, divisions of biophysics						1
Unit II	Thermodynamics	Thermodynamics terms and basic concepts, laws of thermodynamics and living organisms. First law of thermodynamics; enthalpy. Second law of thermodynamics, entropy, comparison of living and non-living system as thermodynamic system						2
Unit III	Transport across the cell membrane	Structure of the cell membrane, ECF and ICF, pores and channels of the cell membrane, Types of transport: diffusion, active transport, osmosis. Importance of various transport mechanisms.						5
Unit IV	Membrane potentials	Resting membrane potential and action potentials, definition, generation, propagation in tissues (nerve, muscle), ionic basis for development of potentials						5
Unit V	Nerve	Structure, classification of nerve fibers, properties of nerve fibers, strength duration curve, saltatory conduction in myelinated and unmyelinated fibers						5
Unit VI	Muscle	Structure of skeletal muscle-contractile proteins, molecular basis of muscle contraction, types of muscle fibers, properties of skeletal muscle – all or none law, types of contraction, refractory period. Neuromuscular junction and impulse transmission across NMJ and factors affecting neuromuscular junction impulse transmission. EMG.						6

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit VII	Haemodynamics	Composition of blood, functions of blood, plasma proteins-types, functions, formed elements of blood, blood flow resistance, factors affecting haemodynamics, Poiseuille's law.	5
Unit VIII	C.V.S.	Structure of cardiac muscle, properties, cardiac cycle-pressure-volume changes, heart sounds, correlation of pressure volume, ECG, heart sound, cardiac output-factors affecting cardiac output, methods to determine cardiac output. Generation and conduction of cardiac impulse, ECG: lead arrangement, normal waves and their significance with reference to lead II.	6
Unit IX	Biophysics of vision	Properties of light, basics of optics, structure of the eye, errors of refraction, colour vision, functions of rods and cones, colour blindness, ERG.	5
Unit X	Bioacoustics	Physics of sound, decibel system, Structure of the ear, sound perception. Ultrasound and its application.	5
Unit XI	Structure of atom, isotopes and isobars, application of isotopes in biological science Radioactivity	Types of radiation, properties of radiations, detection and measurement of radioactivity. Units of radioactivity, application of radioactivity, radiation hazards and radiation protection. Application of radiobiology in treatment of cancer, 3D printing.	5
Unit XII	Environmental factors	Noise, noise hazards, vibrations-effect, EMF properties, hazards. Protection measures.	5
Unit XIII	Cybernetics	Homeostasis, Control of Mechanisms, feedback mechanisms – types.	5

## METHODOLOGY

The course would be taught through lectures.

## BOOKS RECOMMENDED:

1. Biophysics, an introduction. 1st edition. (2002) Cotteril R. John Willey and Sons Ltd., USA
2. Textbook of optics and atomic physics, 8th edition (1989) P.P. Khandelwal, Himlaya Publishing House, India.
3. Nuclear Physics: An Introduction. 2nd edition (2011). S. B. Patel. Anshan Publication, India
4. Biophysics.1st Edition (2004).M.P. Arora. Himalaya publishing House, India.
5. A Text Book of Biophysics.1st Edition (1996).R. N. Roy. New Central Book Agency (P) Ltd, Calcutta, India.
6. Text Book Of Physiology, Vol.1,2..6th Edition (2016). Avichal Publishing Company, India.

**CELL BIOLOGY (UMBTT 202)**

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)	
UMBTT 202	Core	Cell Biology	4	0	4	60	4+2=6	
<b>Objective:</b>								
The objective of the course is to familiarize the students with basic concepts of cell Biology. This is essential for taking further courses in Biotechnology during the next couple of years.								
<b>Outcome:</b>								
At the end of the course, the students will be familiar with cell science and cell-cell interaction. This would help him to take further courses in biotechnology in the subsequent semesters.								
Sr. No.	Topic	Detail of syllabus						Hrs.
Unit I	Cells and Genomes	Universal features of cells Genome diversity and tree of life Genetic information in eukaryotes						6
Unit II	Principles of microscopy	Working principle & uses of: Light Microscopy Phase contrast microscopy Electron microscopy (EM): Scanning EM (SEM) & Transmission EM (TEM)						8
Unit III	Ultra structure and functions of cellular organelles	Nucleus and Chromosomes Biosynthesis of mitochondria, Chloroplast (genomes) Ribosomes; Golgi complex Lysosomes (Vacuoles and micro bodies) Endoplasmic Reticulum and Golgi apparatus						10
Unit VI	Intracellular compartments and Protein Sorting	The compartmentalization of cells The Transport of molecules between the nucleus and the cytosol The Transport of Proteins into Mitochondria and Chloroplasts; Peroxisomes; The Endoplasmic Reticulum						10
Unit V	Intracellular Vesicular Traffic	The Molecular Mechanisms of Membrane Transport Transport from the ER through the Golgi Apparatus Transport from the <i>trans</i> Golgi Network to Lysosomes Transport into the Cell from the Plasma Membrane: Endocytosis Transport from the trans Golgi Network to the Cell Exterior: Exocytosis						14

## **METHODOLOGY:**

The course would be taught through lectures.

## **BOOKS RECOMMENDED:**

### **Reference Book:**

- |   |                            |
|---|----------------------------|
| 1. Cell Biology                         | - S.C. Rastogi             |
| 2. Cell and Molecular Biology           | - De Robertis              |
| 3. Cell and Molecular Biology           | - Lodish                   |
| 4. Cytology, Genetics and mol. Biology  | - P.K. Gupta               |
| 5. Biotechnical cell biology            | - Veer Bala Rastogi        |
| 6. Cell biology, Genetics, Mol. Biology | - P.S.Verma & V.K. Agrawal |
| 7. Mol. Biology of cell                 | - Albert et al             |
| 8. The Cell                             | - Cooper                   |

## **PRACTICALS:**

1. Understanding principle, working and handling of light microscope.
2. Squash preparation of meiotic cells
3. Squash preparation of mitotic cells
4. Examination of various stages of mitosis and meiosis

## BASIC LABORATORY METHODS (UMBTT 203)

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)	
UMBTT 203	Core	Basic Laboratory Methods	4	0	4	60	4+2=6	
<b>Objective:</b>								
<p>This course has been designed to introduce the student to laboratory, Preparations of reagents, measurements and various classical and modern techniques used in biochemical research. The course encompasses the principles, significance, applications, and limitations of these techniques. The basic instrumentation is also included.</p>								
<b>Outcome:</b>								
<p>At the end of this course student will be able to understand advanced level concepts of analytical tools, their principle and applications in the area of Biotechnological.</p>								
Sr. No.	Topic	Detail of syllabus						Hrs.
Unit I	Introduction to Biotechnology Lab and workplaces	Introduction, Technologies of modern biotechnology, Applications of Biotechnology; Organization of a biotechnology company, Biotechnology workplaces and safety in Laboratory.						9
Unit II	Math's in Biotechnology Laboratory	Exponents and Scientific notations; use of Logarithms; Units of measurements; Proportional relationships- Percent solution preparations, units of conversions; concentration and dilutions						10
Unit III	Laboratory measurements	Measurement of weight, measurement of volume, measurement of temperature, measurement of pH and measurement of light						8
Unit VI	Laboratory solutions	Preparation of molar solution, buffers. Cleaning glassware's						6
Unit V	Basic Laboratory Techniques	Spectrophotometry, Quantification of Protein and Nucleic acid Concentration, Chromatography, Gel Electrophoresis of Proteins and Nucleic acids, Overview of Protein Purification-Isolation and Characterization of the Enzyme Alkaline Phosphatase From <i>Escherichia Coli.</i> , Enzymatic Methods of Analysis, Polymerase Chain Reaction (PCR).						15

## **METHODOLOGY:**

The course would be taught through lectures.

## **BOOKS RECOMMENDED:**

Basic Laboratory methods for Biotechnology – by Lisa Seidman

## **PRACTICALS:**

1. Laboratory Instrumentation
2. Glassware Washing And Sterilization
3. Pipetting: Handling
4. Normality and Molarity: Preparation
5. Preparation of Buffer Solution
6. Verification of Beer's Law
7. Spectrophotometry: Principles And Handling
8. Microscopy: Principles and Working
9. Basic Rules of Handling Enzymes, Microbes and DNA
10. Centrifugation: Principles and Handling
11. Filtration: Principles and Handling
12. Column Chromatography
13. Examination of Mammalian Blood Smear
14. Monochrome Staining
15. Gel Electrophoresis

## COMPUTATIONAL METHODS IN BIOTECHNOLOGY (UMBTT 204)

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)	
UMBTT 204	Core	Computational Methods in Biotechnology	4	0	4	60	4+2=6	
<p><b>Objective:</b> The objective of the course is to enlighten the student with knowledge of biotechnology with techniques involved in Biotechnology and its use in the field of Medical and health care.</p> <p><b>Outcome:</b> At the end of this course student would be able to understand basic principles of Computing, Networking and Programming.</p>								
Sr. No.	Topic	Detail of syllabus						Hrs.
Unit I	Knowing Computers	Basic Applications of Computer, Components of Computer System- Input devices; Output devices; Computer Memory; Concept of Hardware and Software; Antivirus						8
Unit II	Operating System	Basics of Operating System; Basics of popular operating system (LINUX, WINDOWS); the User Interface; Task Bar; Icons; Menu; Running an Application; Changing Mouse Properties						10
Unit III	Power point & Spreadsheet	Basics of PowerPoint presentation; Entering and Editing Text; Preparation of Slides and slideshow; Inserting Word Table or An Excel Worksheet; Adding Clip Art Pictures; Inserting Other Objects; Resizing and Scaling an Object Presentation of Slides; Choosing a Set Up for Presentation; Rehearse timing; Short cut keys Introduction – Basics of Spreadsheets; Manipulation of Cells; Entering Text, Numbers and Dates; Creating Text, Number and Date Series; Editing Worksheet Data; Formatting spread sheet; Formulas and Function; Short cut keys						12
Unit IV	Programming Languages	Flowcharts – Algorithms - Pseudocodes – Programming languages: data types, variables, constants, operators, input output, expressions, control flow constructs (conditional and loop statements) - functions, arrays, structures and unions - Pointers - Data structures - File handling. Programming languages for Bioinformatics.						8
Unit V	Communication Using The Internet	Basic of Computer Networks; Local Area Network (LAN); Wide Area Network (WAN); Internet; Concept of Internet; Applications of Internet; Connecting to the Internet; Troubleshooting; World Wide Web (WWW). E-mail Account & Its Functions. Role of computer in						10



Sr. No.	Topic	Detail of syllabus	Hrs.
		Biological field.	

## METHODOLOGY

The course would be taught through lectures.

## BOOKS RECOMMENDED:

### REFERENCE BOOKS

1. The complete reference Microsoft Reference access 2007 by Virginia Anderesen.
2. Microsoft Office 2003: The Complete Reference (Osborne Complete Reference Series) by Jennifer Kettell, Guy Hart-Davis, Curt Simmons and Jennifer Kettell
3. E-Book: Microsoft Office 2010 Ultimate Tips & Tricks
4. Computer Fundamentals , 4th edition (2004) P.K. Sinha, BPB publication, India
5. Computer Networks. 4th edition (2008). Tanenbaum. Pearson Education, India
6. Introduction To Database Management Systems, 1st edition, (2004), Atul Kahate, Pearson education, India

## PRACTICALS:

1. Use of internet – Downloading & Installing software/plugin on
2. Windows 98/XP and later versions (Acrobat Reader, Post Scripts Viewer, etc.)
3. Searching/Surfing on the WWW
4. Spreadsheet Applications (Microsoft Excel): Worksheet Basics: Entering information in a Worksheet, Saving & Opening a Worksheet, Editing, Copying & Moving data, Inserting, Deleting & Moving Columns & Rows, Clearing
5. PowerPoint Presentation- Creating a Presentation Using a Template, Entering and Editing Text, Inserting Word Table or an Excel Worksheet; Adding Clip Art Pictures and Other Objects, Resizing and Scaling an Object Presentation of Slides, Transition and Slide Timings

## Semester III

### GENERAL MICROBIOLOGY (UMBTT 301)

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)
UMBTT 301	Core	General Microbiology	4	0	4	60	4+2=6

**Objective:**

The objective of course is to familiarize the students with bacteria viruses their structure metabolism, disease caused by bacteria & viruses & their control

**Outcome:**

On completion of this course students are able to

1. Get an idea about historic events in micro
2. Know about microscope
3. Get theoretical concepts of related stain, staining tech.
4. Understand concept of growth & reproduction of bacteria
5. Get knowledge about control of microorganism

Sr. No.	Topic	Detail of syllabus	Hrs.
<b>Unit I</b>	<b>Introduction to micro</b>	Scope and history of Microbiology. Classification and identification of microorganism. A. Discovery of microscope & microorganism, (Antony van leeuwenhoek & Robert Hooke), Abiogenesis v/s biogenesis (Aristotle's notice about spontaneous generation, Francesco Redi's expt. Louis pasteur & tyndall expt.) B. Golden Era of Micro <ol style="list-style-type: none"> <li>a. Contribution               <ol style="list-style-type: none"> <li>i. Louis pasteur (fermentation, Rabies, Pasteurization &amp; cholera vaccine)</li> <li>ii. Robert Koch ( Koch postulate, germ theory of disease)</li> <li>iii. Discovery of viruses (TMv &amp; BQ)</li> <li>iv. River's postulate</li> <li>v. Contribution of Joseph lister Antiseptic surgery</li> <li>vi. Paul ehrlich (Chemotherapy)</li> <li>vii. Elie metchnikoff (phagocytosis)</li> <li>viii. Edward jenner (vaccination)</li> <li>ix. Alexander fleming (vaccination)</li> <li>x. Discovery of streptomycin by Waksman</li> </ol> </li> <li>b. Modern ERa of microbiology- carl woese classification based on 16sr RNA.</li> </ol>	10

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit II	Types of Microorganism & their differentiating characters	Prokaryote, Eukaryotes, 3 domain & 5 domain system of classification: Bacteria, Protozoa, Fungi, Algae, Viruses	10
Unit III	Staining technique	Definition of stain- types of stain (Basic & advance) Properties & role of fixative, mordants, decolourisers & accentuator Monochrome & negative staining Differential staining – gram staining	10
Unit IV	Cultivation of Microorganism	Cultivation of bacteria – culture media, preservation methods of bacteria culture & maintenance.	05
Unit V	Growth	Kinetics of bacterial growth (exponential growth mode) Growth curve & generation time, Diauxic growth Measurement of bacterial growth – methods <ol style="list-style-type: none"> <li>i. Microscopic method ( direct microscopic count, counting cells using improved neubaur petroff – haussers chamber</li> <li>ii. Plate count (total viable count)</li> <li>iii. Turbidostatic method ( including nephelometry)</li> <li>iv. Estimation of biomass (dry mass, packed cell volume)</li> </ol>	15
Unit VI	Control of Microorganism	Sterilization & disinfection <ol style="list-style-type: none"> <li>1. Sterilization – physical agent –heat, radiation, filtration</li> <li>2. Disinfection-               <ol style="list-style-type: none"> <li>a. chemical agents &amp; their mode of action – aldehyde, halogens, quaternary ammonium compound, phenol &amp; phenolic comp.</li> <li>b. heavy meals, alcohols, dyes, detergents</li> <li>c. cha of an idea disinfectant</li> </ol> </li> </ol>	10

## **METHODOLOGY**

The course would be taught through lectures, demonstrations and practical classes.

### **BOOKS RECOMMENDED:**

1. General Microbiology: Vol. I & 2 by Powar & Dagainawala
2. Microbiology by Prescottte
3. Microbiology by H. A. Modi
4. General microbiology by stanier

### **PRACTICALS:**

1. To study compound Microscope.
2. Sterilization and disinfections
3. Preparation of culture media
4. Staining procedures
5. Monochrome staining
6. Gram Staining
7. Motility of microorganisms
8. Aseptic transfer techniques
9. Streak plate method
10. Spread plate method
11. Pour plate method
12. Biochemical tests
13. IMViC test

**HUMAN BIOCHEMISTRY (UMBTT 302)**

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)
UMBTT 302	Core	Human Biochemistry	4	0	4	60	4+2=6

**Objective:**  
To introduce and familiarize the undergraduate students with overall concept of metabolism and basic bioenergetics with respect to significant biomolecules and their metabolism.

**Outcome:**  
Undergraduate students should be able to have comprehensive understanding of significant biomolecules and their metabolism through evolved biochemical pathway.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Introduction to Biochemistry	Introduction to basic features of Carbohydrates, Lipids, Amino acids, Nucleotides	6
Unit II	Overview of metabolism	Anabolic and catabolic processes that forms core metabolic pathways Essential role of coenzymes and co-factors, such as, NAD, FAD, Acetyl-CoA, ATP etc.	8
Unit III	Glycolysis & the Oxidation of Pyruvate	Essential features of glycolysis Features of first phase and second phase of glycolysis Regulation of glycolysis, oxidation of pyruvate to Acetyl-CoA	6
Unit VI	The Citric Acid Cycle	The logic of TCA cycle Production of reducing equivalents and their use in ETC TCA cycle intermediate and their use in biosynthesis of biomolecules such as amino acids, fatty acids, Energetics of TCA cycle	6
Unit V	The Respiratory Chain & Oxidative Phosphorylation	Features of mitochondrial membrane, location of various enzyme complex Electron transport chain (ETC), generation of proton gradient across inner mitochondrial membrane , Chemiosmotic coupling and generation of ATP	6
Unit VI	Biosynthesis and oxidation of Fatty Acids	Initial and controlling steps in fatty acid synthesis Fatty acid synthase complex and its features Regulation of fatty acid synthesis, Oxidation of fatty acid through beta oxidation pathway	6
Unit VII	Biosynthesis and catabolism of the Nutritionally Nonessential Amino Acids	Use of intermediates from TCA Cycle, Glycolysis and other pathways as precursors of hydrocarbon skeleton for amino acid biosynthesis Significance of Nitrogenase in N <sub>2</sub> Fixation, Glutamate dehydrogenase, Glutamine synthase, Transaminases in amino acid metabolism, Biosynthesis of Urea	8

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit VIII	Conversion of Amino Acids to Specialized Products	Participation of amino acids into biosynthesis of diverse products, compounds and derivatives Such as heme, purines, pyrimidines, hormones, neurotransmitters and biological active peptides	6
Unit IX	Metabolism of Purine & Pyrimidine Nucleotides	Biosynthesis of purine nucleotides Biosynthesis of pyrimidine nucleotides Regulation of purine and pyrimidine biosynthesis Metabolic disorders of purine and pyrimidine metabolism	8

## METHODOLOGY:

The course would be taught through lectures.

## BOOKS RECOMMENDED:

1. Harper's Illustrated Biochemistry –30th Ed @2015, 31st Ed @2018 Robert Murray, Peter A., Mayes, Victor W. Rodwell, Daryl K. Granner ( McGrawHill Lange)
2. Leninger: Principles of Biochemistry 4th Ed @2007, 7th International Ed @2017(W.H. Freeman and Co. NY)
3. Zubay's Principles of Biochemistry, 5th Ed @2017 by Veer Bala Rastogi., K R Aneja (Medtech)
4. Biochemistry 4th Ed, Reginald Garret., Charles Grisham @2010 Brooks/Cole, Cengage Learning
5. Textbook of Biochemistry 7th Ed @2011 by Thomas Devlin (John Willey and Sons Inc)

## PRACTICALS:

- 1) Separation of plasma from blood
- 2) Estimation of protein by Biuret's Method
- 3) Estimation of protein Folin Lowry Method
- 4) Estimation of serum albumin by BCG Method
- 5) Estimation of serum carbohydrates by Anthrone Method
- 6) Estimation of Urea Nitrogen by Diacetyl Monoxime Method

**GENETICS & MOLECULAR BIOLOGY (UMBTT 303)**

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)	
UMBTT 303	Core	Genetics & Molecular Biology	4	0	4	60	4+2=6	
<p style="text-align: center;">Objective:</p> <p style="text-align: center;">This course is designed to give an understanding about the basics of molecular biology classical genetics &amp; molecular aspects.</p> <p style="text-align: center;">Outcome:</p> <p style="text-align: center;">To study the structure of nucleic acids:</p> <ul style="list-style-type: none"> <li>❖ To understand the gene expression and regulation in Prokaryotes &amp; Eukaryotes.</li> <li>❖ To gain better knowledge in both Prokaryotes &amp; Eukaryotes about the Gene Mutation, Repair Mechanisms, Nuclear Genome Organization, Genes and gene numbers.</li> <li>❖ Comprehensive and detailed analysis of fine structure of the gene.</li> <li>❖ <input type="checkbox"/> Analyze the role of transposable elements in prokaryotes and eukaryotes.</li> </ul>								
Sr. No.	Topic	Detail of syllabus						Hrs.
<b>Unit I</b>	Mendelian genetics	Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes.						10
<b>Unit II</b>	Chromosome Structure and Function	Chromosome Morphology, Chromosome Abnormalities, Types of Chromatin. Codominant alleles. Incomplete dominance, Multiple alleles, Epistasis. Polygenic Inheritance, Pleiotropy, Human Chromosome Abnormalities, Cytogenetics						6
<b>Unit III</b>	Nucleic Acid Structure and Function	Introduction, Deoxyribonucleic acid, Ribonucleic acid, Chemical differences between DNA & RNA, DNA Replication, DNA as genetic material, Structure of DNA, Types of DNA, Semiconservative nature of DNA replication, Replication of DNA in prokaryotes and eukaryotes						6
<b>Unit IV</b>	DNA Damage and Repair	Causes and types of DNA damage, DNA repair mechanism: Photoactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombination repair.						10
<b>Unit V</b>	Transposable Elements	General features of Transposable elements, Transposable elements in prokaryotes-IS element, Retroviruses Retrotransposons- Ty elements in yeasts						4
<b>Unit V</b>	Gene Transfer in Bacteria	Introduction, Conjugation, Transduction Transformation, Transposition, Recombination.						6

Sr. No.	Topic	Detail of syllabus	Hrs.
<b>Unit VI</b>	Transcription and Translation	Introduction, Transcription, Translation, Genetic Code, Transfer RNA, Function of Ribosome, The Central Dogma, Protein Synthesis	8
<b>Unit VII</b>	Control of Gene Expression	Introduction, Gene Control in Prokaryotes, The lac Operon, The trp Operon, Gene Control in Eukaryotes, Control of Eukaryotic Transcription Initiation, Transcription and Processing of mRNA	10

## METHODOLOGY:

The course would be taught through lectures.

## BOOKS RECOMMENDED

**Text Books:** A text book of genetics by Sambhamurthy

### Reference Books

1. Garder, Principles of genetics, Wiley Publications, 8th edition
2. Levin, Gene VI to Gene VIII, Oxford Pub.
3. Friefelder, Essentials of Molecular Biology, Panima Pub
4. T. A. Brown, Genome-4 4th Edition
5. Old & primrose, Principle of Gene Manipulation, Blackwell Pub.
6. Weaver Molecular Biology, Mc Graw Hill
7. Brown, Gene Cloning and DNA analysis, Blackwell Pub.
8. Winnacker, From genes to clones , Panima Pub.
9. Snustard & Simmons- 5<sup>th</sup> Ed. Principles of Genetics

## PRACTICALS:

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Study of polyploidy in onion root tip by colchicine treatment.
4. Karyotyping with the help of photographs
5. Preparation of solutions for Molecular Biology experiments.
6. Isolation of chromosomal DNA from bacterial cells & Agarose Gel electrophoresis.
7. Isolation of chromosomal DNA from plant cells & Agarose Gel electrophoresis.
8. Quantification of DNA by UV spectrophotometer
9. Demonstration of SDS-PAGE



**HUMAN PHYSIOLOGY (UMBTT 304)**

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)	
UMBTT 304	Core	Human Physiology	4	0	4	60	4+2=6	
Objective:								
<ul style="list-style-type: none"> <li>➤ The learning provides a solid foundation for understanding the structure and function of the human body.</li> <li>➤ To introduce the students to the Physiological concepts, control mechanisms and to study the functions of body systems- with emphasis on clinical relevance.</li> </ul>								
Outcome:								
<ul style="list-style-type: none"> <li>➤ On completion of the course, student will be able to</li> <li>➤ have an enhanced knowledge and appreciation of human physiology</li> <li>➤ understand the functions of important physiological systems including the respiratory, excretion, digestive and circulatory systems.</li> <li>➤ be able to perform, analyze and report on experiments and observations in physiology</li> </ul>								
Sr. No.	Topic	Detail of syllabus						Hrs.
Unit I	Digestive system	Organization of Gastro Intestinal Tract (Overview of Buccal cavity, Oesophagus, Stomach, Small intestine, Large intestine, Liver and Pancreas). Digestive Enzymes, Secretion of saliva, Gastric juice, Intestinal juice, Bile. Digestion and absorption of Carbohydrate, Lipid and Protein & their nutritional importance.						12
Unit II	Circulatory system	Structure of Heart, Arterial system, Venous system, Portal system, Conducting system of heart, Heart beat, Arterial Blood Pressure, ECG, Artificial pace maker, Blood coagulation: process & disorder						12
Unit III	Endocrinology	Properties of Hormones, Function and Disease associated with Hypo and Hyper secretion of Hormones secreted by Pituitary gland, Thyroid gland, Parathyroid gland, Pancreas, Mechanism of hormone action.						12
Unit IV	Respiration	Hemoglobin and myoglobin, Transport of Oxygen and Carbon dioxide in Blood, Oxygen dissociation curve, Bohr's effect and Haldane's effect, Common respiratory disorders (Asthma, Pneumonia, Diphtheria).						12
Unit V	Excretion	Excretory system: Kidney, Ureter and Urinary bladder, Urea formation, Urine formation, Composition of urine, Acid base balance, Haemodialysis, Renal disorders.						12

## **METHODOLOGY**

The course would be taught through lectures, demonstrations, assignments and practical classes.

## **BOOKS RECOMMENDED:**

1. Ross and Wilson, Anatomy and Physiology in Health and Illness, Churchill Livingstone, 9th Edition, 2001.
2. Gerard. J. Tortora. Principles of Human Anatomy and physiology, Harper Collins College Publishers, 7th Edition, 2005.
3. Arthur C. Guyton & John E. Hall, Text Book of Medical Physiology, W.B.Saunders Company, London, 12th Edition, 2015.
4. Saraswathi, P., Handbook of Anatomy for Nurses Jaypee Brothers Medical Publishers (P) Ltd, 1st Edition, 2014.
5. Gillian Pocock, Christopher D. Richards, The human Body – An introduction for Biomedical and Health Sciences, Oxford University Press, USA, 2013.
6. William F.Ganong, Review of Medical Physiology, 22nd Edition, McGraw Hill, New Delhi, 2010.
7. Animal Physiology, 1990 4th edn. Kunt Schmidt, Neilson, Cambridge University Press Cambridge.
8. Physiology of Mammals & other vertebrates, 1980, 2nd edn. Marshall & Hughes. Cambridge Univrsity Press Cambridge.
9. Human Physiology, Vol.I & II 1980.12th edn.Dr.C.C.Chatterjee, Medical applied,Agency, Calcutta.

## **PRACTICALS:**

1. Determination of Blood Group
2. Estimation of hemoglobin

## Semester IV

### MEDICAL MICROBIOLOGY (UMBTT 401)

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)
UMBTT 401	Core	Medical Microbiology	4	0	4	60	4+2=6

**Objective:**

The objective of the course is to familiarize the students with bacteria, viruses & other pathogens related with infection diseases in human.

**Outcome:**

On completion of this course students will be able to understand different bacteria viruses & pathogen that cause infection in different systems of human body. Also students will be able to understand how to control these infections.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	The clinical manifestation of infection – an introduction	Upper respiratory tract infection Lower respiratory tract infection Urinary tract infection Sexually transmitted disease Gastrointestinal tract infection Obstetric & prenatal infection Multisystem zoonoses Worldwide virus infection Infection in compromised host	12
Unit II	Strategies for control – an introduction	Antimicrobial agents & chemotherapy	12
Unit III	Vaccination	Vaccination – history, aims of vaccination, vaccines can be of different type	12
Unit IV	Passive and non specific immunotherapy	Passive immunization with antibody, non specific cellular immunostimulation, correction of host immunodeficiency, Probiotics.	12
Unit V	Hospital acquired infection, sterilization and disinfection	Common hospital infections, important causes of hospital infection, sources and routes of spread hospital infection host factors and hospital infection, prevention of hospital infection, sterilization and disinfection	12

## **METHODOLOGY**

The course would be taught through lectures, demonstrations and practical classes.

## **BOOKS RECOMMENDED:**

1. Medical microbiology- Mims
2. Medical microbiology - David Greenwood
3. Diagnostic microbiology - Bailey & Scott

## **PRACTICALS:**

### **LIST OF EXPERIMENTS**

1. Staining procedures
2. Negative staining
3. Capsule staining
4. Endospore staining
5. Isolation of microorganism- staphylococcus aureus
6. Antibiotic sensitivity test by disc diffusion method
7. Antibiotic sensitivity by serial dilution method

**ANIMAL TISSUE CULTURE (UMBTT 402)**

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)	
UMBTT 402	Core	Animal Tissue Culture	4	0	4	60	4+2=6	
<b>Objective:</b>								
To improve theoretical & Practical fundamental of cell and tissue culture techniques in animals. To provides to students with the ability to adopt basic cell culture procedure for various research requirements.								
<b>Outcome:</b>								
At the end of this course the student will able to understand how to initiate grow & harvest the Animal cell & their uses.								
Sr. No.	Topic	Detail of syllabus						Hrs.
Unit I	Introduction to animal tissue culture	Historical background, The application of tissue culture(Stem Cells tissue engineering, industry and Research), Terminology, Stages in cell culture						12
Unit II	Outline of the key techniques of animal cell culture	Setting up the laboratory, Culturing cells, Maintaining the culture, Quantification of cells in cell culture, Cloning and selecting cell lines, Hazards and safety in the cell culture laboratory						12
Unit III	Animal Cell Culture media	General cell culture media design, Natural media, Synthetic media, Further considerations in media formulation, Nutritional components of media, The role of serum in cell culture, Choosing a medium for different cell type						12
Unit VI	Cell Separation and Characterization of cell lines	Cell separation – Methods of Cell separation – Density, antibody based, FACS, MACS technology. Cell Characterization - Species identification, linkage of tissue markers. Cell Morphology – Microscope, Staining						12
Unit V	Preservation of animal cell lines	Variation and instability in cell lines, Preservation of cell lines, Freezing of cells, Thawing of cells, Quantification of cell viability, Cell banks						12

## **METHODOLOGY**

The course would be taught through lectures, demonstrations and practical classes.

## **BOOKS RECOMMENDED**

1. Cell and Tissue Culture: Lab Procedures in Biotechnology by Alan Doyle (ed)  
J. Bryan Griffith (ed)
2. “Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications” by R Ian Freshney
3. “Animal Cell Culture: A Practical Approach (Practical Approach Series)” by John Masters
4. “Animal Cell and Tissue Culture” by Mathur Shivangi
5. Basic Cell Culture 2nd Edition by JM Davis Oxford University Press.2002.

## **PRACTICALS:**

### **LIST OF EXPERIMENT**

1. Layout of Animal Tissue Culture laboratory
2. Washing of glasswares
3. Sterilization of glasswares
4. Preparation of culture media
5. Thawing of Animal cell lines
6. Passaging of Animal cell lines
7. Cell quantification and Cell viability
8. Cryopreservation of cell cultures

**IMMUNOLOGY (UMBTT403)**

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)
UMBTT 403	Core	Immunology	4	0	4	60	4+2=6

**Objective:**  
To introduce and familiarize the undergraduate students with overall concept of immune system, action mechanism and applications in research and biomedical field.

**Outcome:**  
The undergraduate students should be able to have basic and broad overview of immunology and its applications in the challenging fields of medicine and in basic and applied research in immunology.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Introduction to the Immune System	General properties of immune response, Components (Hematopoiesis, Cells, organs and molecules) of the Immune System, Innate Immunity; The Early Defense against Infections (Anatomic barriers).	12
Unit II	Antigen Capture and Presentation to Lymphocytes	Antigen Recognition in the Adaptive Immune System: Cell-Mediated Immunity Humoral Immunity	12
Unit III	Immunologic Tolerance and Autoimmunity	Self-Nonself Discrimination in the Immune System and Its Failure Mechanism of tolerance: Central tolerance, Peripheral tolerance Autoimmune diseases in human	12
Unit VI	Immune Responses against Tumors	Cancer: origin and malignant transformation Tumors of the immune system, tumor antigens Tumor evasion of the immune system, Cancer immunotherapy Immunity to Noninfectious Transformed and Foreign Cells	12
Unit V	Hypersensitivity Diseases	Types of hypersensitive responses: Type I, II, III, IV an overview Disorders Caused by Immune Responses	06
Unit VI	Congenital and Acquired Immunodeficiencies	Diseases Caused by Defective Immune Responses	06

## **METHODOLOGY:**

The course would be taught through lectures.

## **BOOKS RECOMMENDED:**

### **Reference Book:**

1. Immunobiology by Janeway
2. Immunology by Roitt
3. Kuby Immunology 6th Ed by Kindt, Goldsby Osborne
4. Cellular Immunology – Biotol
5. Cellular and molecular immunology 5<sup>th</sup> Ed@2005 by Abbas and Lichtman
6. Cellular and Molecular Immunology 1st South Asia Edition@2018 by Abbas., Litchman., Pillai

## **PRACTICALS:**

1. Determination of Blood Group
2. Differential counting of blood
3. Ouchterlony test
4. Coombs test: Direct
5. Coombs test: Indirect
6. WIDAL Test



**BIOINFORMATICS (UMBTT404)**

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)
UMBTT 404	Core	Bioinformatics	4	0	4	60	4+2=6
<p style="text-align: center;">Objective:</p> <p>The objective of the course is to enlighten the student with basic concepts and technique in Bioinformatics and its use in the field of Medical and health care.</p> <p style="text-align: center;">Outcome:</p> <p>Knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics existing software effectively to extract information from large databases and to use this information in computer modeling an understanding of the intersection of life and information sciences, the core of shared concepts, language and skills the ability to speak the language of structure-function relationships, information theory, gene expression, and database queries.</p>							

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Biology in the computer age: An Introduction to Bioinformatics	How Is Computing Changing Biology? Isn't Bioinformatics Just About Building Databases? What Does Informatics Mean to Biologists?? How Do I Understand Sequence Alignment Data? What Challenges Does Biology Offer Computer Scientists? What Skills Should a Bioinformatician Have? Why Should Biologists Use Computers? How Can I Configure a PC to Do Bioinformatics Research? What Information and Software Are Available? Can I Learn a Programming Language Without Classes? How Can I Use Web Information How Do I Understand Sequence Alignment Data? How Do I Write a Program to Align Two Biological Sequences? How Do I Predict Protein Structure from Sequence? What Questions Can Bioinformatics Answer?	10
Unit II	Computational approaches to biological questions.	Introduction, Computational Methods in Bioinformatics What Biologists Model, Accessing 3D Molecules through a 1D Representation, Abstractions for Modeling Protein Structure. Mathematical Modeling of Biochemical Systems. Why Biologists Model	10
Unit III	Biological research on the web	Introduction, Using Search Engines, Boolean Searching, Search Engine Algorithms, Finding Scientific Articles, Using PubMed Effectively, The Public Biological	10

Sr. No.	Topic	Detail of syllabus	Hrs.
		Databases, Data Annotation and Data Formats, 3D Molecular Structure Data, DNA, RNA, and Protein Sequence Data, Genomic Data, Biochemical Pathway Data	
Unit IV	Sequence analysis, pairwise alignment, and database searching	Introduction, Genefinders and Feature Detection in DNA, Predicting Gene Locations, Feature Detection, Pairwise Sequence Comparison, Scoring Matrices, Gap Penalties, Global Alignment, Local Alignment, Tools for local alignment, Sequence Queries against Biological Databases, Local Alignment-Based Searching Using BLAST, The BLAST algorithm	10
Unit V	Multiple sequence alignments, trees and profiles	Introduction, Taxonomy and Evolution, Concept of molecular evolution, Terms: Orthologs, paralogs and xenologs. Multiple sequence alignment: MSA by Clustal-W, Application of MSA Phylogenetic inferences, Phylogenetic trees based on neighbor joining, Software for phylogenetic analysis.	10
Unit VI	Tools for genomics and proteomics	Introduction, From Sequencing Genes to Sequencing Genomes, Analysis of Raw Sequence Data: Base calling Sequencing an Entire Genome, The shotgun approach, The clone contig approach, NCBI Genome Resources, TIGR Genome Resources, EnsEMBL, Other Sequencing Centers, Annotating and Analyzing Whole Genome Sequences, Genome Annotation, Functional Genomics: New Data Analysis Challenges, Proteomics, Tools for Proteomics Analysis.	10

## METHODOLOGY

The course would be taught through lectures, demonstrations and practical classes.

## Books Recommended:

Developing Bioinformatics computer skills – Gibas C and Jambeck P  
 Introduction to bioinformatics – T.K. Attwood and Parry-Smith D.J.  
 Introduction to Bioinformatics: Lesk, A.M. Oxford University press.  
 Developing Bioinformatics Computer Skill: Cynthia Gibbs and Per Jambeck.  
 O'Reilly & Associates.

## PRACTICAL

### LIST OF EXPERIMENTS

1. Introduction to SPDBV (deep view).
2. Basic exercise in protein structure visualization.
3. Basic exercise in protein structure visualization coloring.
4. To study the PubMed using internet.
5. To study the NCBI website using internet

## Semester V

### GENETIC ENGINEERING (UMBTT 501)

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)
UMBTT 501	Core	Genetic Engineering	4	0	4	60	4+2=6

**Objective:**

To provides a comprehensive introduction to fundamentals and applications of genetic engineering . The course is designed to give students an up-to-date understanding of a wide array of techniques that are used in genetic manipulation. This course encompasses the detailed procedure of genetic engineering so that students can become familiar with the Recombinant DNA Technology and its applications.

**OUTCOME:**

At the end of the course, the students will have sufficient scientific understanding of the subject and have good knowledge of application of Recombinant DNA techniques in Life Sciences Research.

Sr. No.	Topic	Detail of syllabus	Hrs.
<b>Unit I</b>	Introduction	Introduction to genetic engineering and recombinant DNA technology. Various steps involved in rDNA technology. Isolation of genes. Enzymes of rDNA technology - Restriction endonucleases, exonuclease, DNA modifying enzymes - Polymerase, Transferase, Kinase and Ligase.	12
<b>Unit II</b>	Different types of Vectors	Plasmids, Phage vectors, Cosmids, Phagemids, Virus vectors, Shuttle vectors and expression vectors- YAC, BAC- <i>S. cerevisiae</i> system as a model.	10
<b>Unit III</b>	Cloning Strategies	Cloning vectors for <i>E. coli.</i> , Cloning vectors for Eukaryotes. Methods of transformation- Calcium chloride, Electroporation, microinjection, and biolistic methods. Construction of genomic libraries and cDNA Libraries. Probe construction, recombinant selection and screening	12
<b>Unit IV</b>	Recombinant DNA techniques	Blotting Techniques, Autoradiography, Hybridization, Molecular Probes and Nucleic acid labelling , DNA sequencing, PCR, Mutagenesis, Analysis of gene expression , DNA fingerprinting, RAPD, RFLP, AFLP, Genetic engineering in plants: Use of <i>Agrobacterium tumefaciens</i> and Arhizogenes, Ti plasmids, Strategies for gene transfer to plant cells	16
<b>Unit V</b>	Application of rDNA Technology	Transgenic animals – Production of Insulin, Production of recombinant vaccines – Hepatitis – B, Production of GM foods and crops, Ethics and safety of GMO's	10

## **METHODOLOGY:**

The course would be taught through lectures.

## **BOOKS RECOMMENDED:**

1. Biotechnology-Fundamentals and Applications- SS Purohit
2. Principles of gene manipulation-Old and Primrose
3. Gene Biotechnology-Jogdand
4. Molecular Biology-Twyman
5. Principles of genetics-Klug
6. Molecular Biology of the gene-Watson
7. Molecular Cloning (Vol 1,2,3)-Sambrook and Russell

## **LIST OF EXPERIMENTS**

1. Isolation of chromosomal DNA from plant cells & Agarose gel Electrophoresis
2. Isolation of chromosomal DNA from *E.coli* & Agarose gel Electrophoresis
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of competent cells.
8. Demonstration of PCR
9. Demonstration of RFLP

## ENZYME TECHNOLOGY (UMBTT 502)

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)
UMBTT 502	Core	Enzyme Technology	4	0	4	60	4+2=6
<p><b>Objective:</b> To introduce and familiarize the undergraduate students with overall concept of enzyme at the interface of chemistry, biophysics, biochemistry and biotechnology as interdisciplinary approach and to underline its significance in biology.</p> <p><b>Outcome:</b> Undergraduate students should be able to have comprehensive understanding of properties, kinetics, and functioning of enzymes as well as their production, applications in research and applied fields.</p>							

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Introduction	Enzymes are mainly proteins, enzymes are classified by the reactions they catalyze.	6
Unit II	Enzyme function	Enzymes affect reaction rates not equilibria, Reaction rates and equilibria have precise thermodynamic definition, Principles behind catalytic power and specificity of enzymes, Weak interaction between enzyme and substrate are optimized in transition state, Enzyme use binding energy to provide reaction specificity and catalysis, Specific catalytic groups contribute to catalysis.	10
Unit III	Enzyme Kinetics	Kinetics and mechanism, Substrate concentration and rate of reaction, Quantitative expression of relationship between substrate concentration and rate of reaction, The meaning of $V_{max}$ and $K_m$ , Enzymes catalyzing reactions involving two or more substrate Pre-steady state kinetics can provide evidence for specific reaction.	10
Unit IV	Enzyme Inhibition	Reversible and irreversible, Effect of pH, Examples of enzymatic reactions.	8
Unit V	Regulatory enzymes	Allosteric enzymes are regulated by non-covalent binding of modulators, Allosteric organs are exceptions to many general rules, two models explain the kinetic behavior of allosteric enzymes, Other mechanisms of enzyme regulation.	8
Unit VI	Production of enzymes	Enzymes from animal and plant sources, Enzymes from microbial sources, Large scale production, Biochemical fundamentals, Genetic engineering, Recovery of enzymes, Isolation of soluble enzymes, Enzyme purification, Immobilised enzymes, Legislative and safety aspects.	09

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit VII	Synthesis of chemicals using enzymes	Hydrolytic enzymes, Chiral building blocks for synthesis, Reduction and oxidation, Use of enzymes, in sugar chemistry, Use of enzymes to make amino acids and peptides.	09

## METHODOLOGY:

The course would be taught through lectures.

## BOOKS RECOMMENDED:

### Reference Books:

1. A text of biochemistry, - A.V.S.S. Rama Rao 9th ed. (UBS Publisher's and Distributors) Ltd.)
2. Leninger: Principles of Biochemistry, 3rd Ed. – Nelson D. et al (Worth Publishers)
3. Basic Biotechnology, 2nd Ed. – Ratledge, C and Kristiansen B. (Cambridge)
4. Biochemistry, 5th, - Ed. Breg, J.M. Tymoczko J.L. and Stryer L. (W.H. Freeman & Co.)
5. Molecular Biology of the Cell, 2nd-5th Ed. – Alberts B. et al (Garland Publishing)
6. Molecular Cell Biology, 2nd -7th Ed. – Lodish et.al

## PRACTICALS:

1. Assay of chymotrypsin and trypsin.
2. Isolation and partial purification of enzymes, amylases and cellulases.
3. Localization of enzymes – mitochondrial (SDH) and cytosolic (GSH)
4. Determination of characteristics of enzyme-catalyzed reaction ( $V_{max}$  and  $K_m$ ).
5. Effect of temperature and pH on the rate of enzyme catalysed reaction.
6. Effect of inhibitors/activators on enzyme catalyzed reactions.
7. Immobilization of enzymes.
8. Characterisation of immobilised enzymes.

## INDUSTRIAL & FERMENTATION TECHNOLOGY (UMBTT 503)

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)
UMBTT 503	Core	Industrial & Fermentation Technology	4	0	4	60	4+2=6

**Objective:**

To acquaint students with technical and biological aspect of microbial utilisation of for production of metabolites

**Outcomes :**

After completion of this course, students will be able to understand:

1. Design of various reactor used in industries.
2. Criteria for selection of media for microbial growth.
3. Methos of strain improvement and preservation of culture.
4. Upsream as well as downstream processing involved in fermentation.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Introduction to fermentation technology	History, scope and development of fermentation technology, isolation and screening of industrially important microorganisms- primary and secondary screening, Maintenance of strain, strain improvement.	15
Unit II	Fermentation media	Natural and synthetic media, basic components of an media (carbon sources, nitrogen sources, vitamins, mineral, antifoaming agents ), role of buffers in media, process of aeration and agitation.	15
Unit III	Fermentor design	Basic design of fermentor, type of fermentors, scale up study and product development. Downstream processing and product recovery, regulation and safety.	12
Unit IV	Production of microbial products	Production of alcohol, organic acid- citric acid antibiotic - penicillin, amino acid – glutamic acid, vitamin – B1, single cell protein (scp)	18

**METHODOLOGY:**

The course would be taught through lectures.

**BOOKS RECOMMENDED:**

1. Peter f stanbury – principles of fermentation technology.
2. Allan Whitaker – principles of fermentation technology
3. H.j.Peppler, D.Perlman – microbial technology

**PRACTICALS:**

1. Isolation of antibiotic producing microorganisms from soil.
2. Isolation of enzyme producing microorganisms from soil.
3. Production of alcohol.

**DISSERTATION (UMBTPr 504)**

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)
UMBTPr 504	Core	Project Work	4	0	4	60	4+2=6

**B. Sc Dissertation Project:** Each candidate needs to complete a short dissertation project. Prior to proposing a project, the students must have identified a research topic and a mentor who is familiar with their prospective inquiry and who is willing to provide guidance and oversee the project.



## Semester VI

### MOLECULAR DIAGNOSTICS (UMBTT 601)

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)
UMBTT 601	Specialized	Molecular Diagnostics	4	0	4	60	4+2=6
<b>Objective:</b>							
<ul style="list-style-type: none"> <li>The objective of the course is make aware students about the various medical diagnostic techniques and their use in diagnosing various disorders in humans.</li> <li>The objectives of this course are to sensitize students about recent advances in molecular biology and various facets of molecular medicine</li> </ul>							
<b>OUTCOME:</b>							
<ul style="list-style-type: none"> <li>Students should be able to understand various facts of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.</li> </ul>							

Sr. No.	Topic	Detail of syllabus	Hrs.
<b>Unit I</b>	Introduction to Disorders	Biochemical disorders, Immune disorders Infectious disease, parasitic disease, Genetic disorders, chromosomal disorders, single cell disorders and complex traits	10
<b>Unit II</b>	Chromosomal Disorder Diagnostics	Autosomal; sex chromosomal; karyotype analysis, G-banding, in situ hybridization (FISH), and comparative genomic hybridization (CGH).	10
<b>Unit III</b>	DNA diagnostics	PCR based diagnostics; ligation chain reaction, southern blot diagnostics, array-based diagnostics, DNA sequencing, genetic profiling, single nucleotide polymorphism.	12
<b>Unit IV</b>	Biochemical Diagnostics	Inborn errors of aromatic amino acids, haemoglobinopathies, mucopolysaccharidoses, lipidoses, and glycogen storage disorders.	10
<b>Unit V</b>	Immunodiagnostics	Diagnosis of infectious diseases, respiratory diseases (influenza, etc.) Viral diseases-HIV etc., bacterial diseases, enteric diseases, parasitic diseases and mycobacterium diseases. Phage display, immunoarrays, FACs	10

## **METHODOLOGY**

The course would be taught through lectures.

## **BOOKS RECOMMENDED:**

1. Textbook: Molecular Diagnostics: Fundamentals, Methods and Clinical Applications. Authors: Lela Buckingham and Maribeth Flaws. Ph.d , Lela Buckingham Publisher: F A Davis Co
2. Molecular Diagnostics: Techniques and Applications for the Clinical Laboratory Wayne W. Grody, Robert M. Nakamura, Frederick L. Kiechle, Charles Strom, Publisher: Academic Press;

## **PRACTICALS:**

1. Isolation of Genomic DNA
2. Nucleic acid labeling and southern hybridization
3. Automated DNA sequencing (Demo)
4. RNA isolation, Pulsed Field Gel Electrophoresis, PAGE
5. PCR based diagnosis of human and plant bacterial pathogen.

## IMMUNO TECHNOLOGY & DIAGNOSTICS (UMBTT 602)

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)
UMBTT 602	Specialized	Immuno Technology & Diagnostics	4	0	4	60	4+2=6

### Objective:

The objective of this course is to provide Students with detail understanding of different cells of the immune system and their role in immune protection as well as application of immunological techniques. The course will provide knowledge about role of immune system in pathogenesis of cancer, autoimmune disease and different infectious diseases.

### Outcome:

At the end of the course students will be able to

- Apply the knowledge of immune associated mechanisms in medical biotechnology research.
- Demonstrate immunological techniques.
- Interpret association of immune system with cancer, autoimmunity, transplantation and infectious disease.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Introduction	Scope of Immunotechnology, preparation and purification of antigens, extraction of antigens from pathogens, parasites & other biological materials. Antigen fractionation & purification, preparation of synthetic antigens, recombinant antigens.	
Unit II	Production of Antibodies	Production, purification & characterization of Antibodies. Different kinds of Immunization procedures. Purification of Immunoglobulins, Characterization of Immunoglobulins.	
Unit III	Production of Hybridoma & Monoclonal Antibody	Hybridoma & Monoclonal Antibody techniques, Production of Murine Hybridoma, Production of Monoclonal Antibodies in cultures, Purification of MCABs, Characterization of MAbs & labeling of Antibodies.	
Unit IV	Immunological Methods	Cellular Immunological methods, Markers of Immunocompetent cells, separation & purification of Immunocompetent cells. Flow Cytometry and FACS, Functional test for Immunocompetent cells & Histocompatibility testing.	
Unit V	Immunological Assays & Diagnostics	Agglutination tests, Radio Immuno assays, Enzyme Immuno assays, Immunoblotting, immunofluorescence techniques, Immunodiffusion, Rocket Immuno Electrophoresis, ELISA, Western Blot Analysis.	

## **METHODOLOGY**

The course would be taught through lectures.

## **BOOKS RECOMMENDED:**

### **Reference Book:**

1. Janeway C. A. Travers P., Walport M., Immuno biology: the immune system in health and disease, Garland Science Publishing New York (2012) 8th ed.
2. Owen J. A., Punt J., Strandfold S.A, Jones P.P., Kuby- Immunology W.H. Freeman & Company (2013), 7 th ed.
3. Delves P. J., Martin J. S., Burton R. D., Roitt M. I. Roitt's Essential Immunology, Wiley Blackwell (2011) 12th ed.
4. Khan F.H. The Elements of Immunology, Pearson Education (2009)

## **PRACTICALS:**

1. Blood film preparation and identification of cells
2. Immuno-diffusion
3. Hemagglutination
4. Agglutination inhibition
5. Rocket immune-electrophoresis,
6. Western blotting
7. ELISA
8. Epitope prediction using Immuno-informatics tool
9. Isolation of Peripheral blood mononuclear cells.

## FOOD BIOTECHNOLOGY (UMBTT 603)

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)
UMBTT 603	Specialized	Food Biotechnology	4	0	4	60	4+2=6

**Objective:**  
The course will provide a broad grounding in concepts techniques & issues involved in food products & their processing.

**Outcome:**  
On completion of this course students will be able to understand - principle's involving food preservation. Via fermentation processes. Understand the principle's that make a food product safe for consumption. Understand the principles & current practices of processing techniques & the effect of processing parameter on product quality.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Introduction	Major component of foods, constituents of food, food processing, food spoilage – introduction, causes of food spoilage, food poisoning, food borne intoxication food borne infection.	08
Unit II	Food preservation & processing	Introduction, necessary, methodology, principles and methods of food preservation, Low temperature preservation-methods-chilling, refrigeration & cold storage, High temperature preservation- blanching, pasteurization, sterilization & conning,	10
Unit III	Drying, dehydration & concentration	Introduction-factors affecting rate of drying & dehydration, drying methods, concentration methods of conc., changes effect at drying dehydration & concentration on quality of foods.	08
Unit IV	Food irradiation & Food fermentation	Introduction- radiation sources, measurement of radiation dose, type of radiation, factors affecting food irradiation, effect of irradiation, Food fermentation- Introduction, method, common fermented food	10
Unit V	Preservation using sugar, salt & acids	Food preserved using sugar, Salt- introduction, antimicrobial activity of salt, food product preserved using salt. Acid- introduction, common food preserved using acid	12
Unit VI	Probiotics	History, importance, mode of action of Probiotics, characteristics of Probiotics, action of Probiotics, advantages of Probiotics, disadvantages.	12

## **METHODOLOGY**

The course would be taught through lectures.

## **BOOKS RECOMMENDED:**

### **Reference Book:**

1. Technology of food preservation – Desrosier N.W.
2. Introduction to food science & technology- Stewart G.P. & Amerine N. A.
3. Food processing handbook- Brennan J.G.
4. Food processing & preservation- B. Sivasankar
5. Essential of food science – Vickie A.N.

## **PRACTICALS:**

1. Demonstration of effect of blanching on food quality characteristics.
2. Preservation using heat
3. Preservation by low temperature
4. Preservation by high concentration of sugar (jam/ jelly syrup)
5. Preservation by using salt (pickling)
6. Drying and dehydration of fruit
7. Drying and dehydration of vegetables

## PLANT BIOTECHNOLOGY (UMBTT 604)

Course Code	Category	Course Name	L	T	P	Total Hr	Credits (T+P)	
UMBTT 604	Specialized	Plant Biotechnology	4	0	4	60	4+2=6	
<b>Objective:</b>								
The aim is to teach set of in vitro techniques, methods and strategies related to plant biotechnology. Students will learn how to create genetic variability for the improvement of crops, to improve the state of health of planted material and to increase the number of desirable germplasm.								
<b>Outcome:</b>								
At the end of the course the student will able to gain fundamental knowledge in plant biotechnology and their applications.								
Sr. No.	Topic	Detail of syllabus						Hrs.
<b>Unit I</b>	Introduction	History of PTC, Concept of Cellular Totipotency. Laboratory Organization, Sterilization Techniques, Media Preparation. Types of media – MS, Nitsh, Gamborgs. Plant growth regulators. Cytoplasmic Male Sterility.						08
<b>Unit II</b>	Micropropagation	Techniques and various steps involved in micropropagation, Production of disease free plants, Commercial aspects and limitations of micropropagation						08
<b>Unit III</b>	Production of Haploids & Embryo culture	Plant tissue culture techniques, in-vitro pollination and fertilization, embryo culture and its applications, embryogenesis and organogenesis.						08
<b>Unit IV</b>	Genetic manipulation of plants	Introduction, protoplast isolation, culture and regeneration, methods of fusing protoplasts, somatic hybridization. Genetic Engineering: <i>Agrobacterium</i> plant interaction, Ti and Ri plasmids. T-DNA transfer, Genetic Transformation: <i>Agrobacterium</i> mediated gene delivery cointegrated and binary vectors, direct gene transfer: PEG – mediated, electroporation, particle bombardment.						12
<b>Unit V</b>	Molecular markers and marker assisted selection	Molecular markers and marker assisted selection, Applications of plant transformations/ transgenics, Commercial transgenic crops.						10
<b>Unit VI</b>	Plant secondary metabolites	Primary vs secondary metabolites, Production of secondary metabolites and other compounds using plant cell culture, Hairy root culture, Immobilized cell system.						08
<b>Unit VII</b>	Molecular farming	Molecular farming of Alkaloids, Useful enzymes, Therapeutic proteins, custom- made Antibodies, Edible vaccines.						06

**METHODOLOGY**

The course would be taught through lectures.

**BOOKS RECOMMENDED:**

1. Chawla, 2003. Introduction to Plant Biotechnology (2nd edn) Oxford and IBH Publishers.
2. R.C. Dubey, A Text Book of Biotechnology. S.Chand & Co Ltd, New Delhi.
3. Chrispeel M.J, Sadava D.E, 1994. 2nd Revised edition, Plants, Genes and Agriculture, Jones and Barlett Publication, Boston. 28.
4. Satyanarayana . U, 2008, Biotechnology, Books and Allied (p) Ltd.
5. R. Keshava Chandran and K.V. Peter. Plant Biotechnology. First edition. University Press (India) Pvt Ltd, Hyderabad.
6. Plant tissue culture Theory and Practice - S.S Bhojwani and M.K. Razdan., Elsevier.
7. Plant cell and tissue culture - S. Narayanaswamy
8. Plant biotechnology - Ignacimuthu, Oxford and IBH pub
9. Plant biotechnology – J Hammond, et. al., Springer Verlag
10. Practical application of plant molecular biology – R J Henry, Chapman & Hall
11. Genetic Transformation of Plants: Jackson JF, Linskens H
12. Plant Tissue Culture Concepts and Laboratory Exercises: Robert N Trigiano, Dennis J Gray
13. Applied and fundamental Aspects of Plant Cell, Tissue, and Organ Culture: Reinert J and Bajaj.
14. Lydiane Kyte & John Kelvins (1996) Plants from test tubes. An introduction to Micropropagation (3rd Edition) Timber Press, Partland.
15. Kumar H.D (1991) A Text Book on Biotechnology (2nd Edition). Affiliated East West Press Private Ltd. New Delhi.
16. Chrispeel M.J. and Sadava D.E. (1994) Plants, Genes and Agriculture, Jones and Barlett Publishers, Boston.
17. Reinert J. and Bajaj Y.P.S (1997) Applied and Fundamental Aspects of Plant Cell, Tissue, and Organ Culture, Narosa Publishing House.

**PRACTICALS:**

1. Sterilization techniques – glasswares, media and laminar air flow chamber
2. Preparation of simple growth nutrient (Knop's medium) full strength, solid and liquid.
3. Preparation of complex nutrient medium (Murashige & Skoog's medium & B5)
4. Callus induction and sub-culturing.
5. To select, prune, sterilize and prepare an explant for culture.
6. To demonstrate various steps of Micropropagation.
7. Isolation of plant genomic DNA from the leaf sample
8. Suspension cultures and their maintenance.



*h. sharma*  
Registrar  
Pravara Institute of Medical Sciences  
(Deemed to be University)  
Loni - 413736, Tal. Rahata  
Dist. Ahmednagar (M.S. India)