

**B.ScBIOTECHNOLOGY**  
**CourseStructureandSyllabus**

(For the candidates admitted from the academic year 2022-2023 onwards)

**CHOICE BASED CREDITS SYSTEM (CBCS)**



**THANTHAI HANS ROEVER COLLEGE (AUTONOMOUS)**  
(Approved by NAAC,  
Affiliated to Bharathidasan University) ELAMBALUR, PERAM  
BALUR-621 220





Semester	Part	Course Code	Title of the Course	Ins. Hours/ Weeks	Credits	Exam Hours	CIA (Max)	ESE (Max)	Total (Max)
1	I	22UT1/22UH1	Language -1	6	3	3	25	75	100
1	II	22UE1	English -I (Communicative English-I)	6	3	3	25	75	100
1	III	22UBT1CC1	General Microbiology	6	5	3	25	75	100
1	III	22UBTIAC1	General Biochemistry	4	4	3	25	75	100
1	III	22UBT1CP1	General Microbiology, Cell Biology and Genetics(P)	3	-	-	-	-	-
1	III	22UBT2AP1	BiochemistryI&II(P)	3	-	-	-	-	-
1	IV	22UVE	Value Education	2	2	3	25	75	100
<b>Total</b>				<b>30</b>	<b>17</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>500</b>
2	I	22UT2/22UH2	Language -I	6	3	3	25	75	100
2	II	22UE2	English -II (Communicative English II)	6	3	3	25	75	100
2	III	22UBT2CC2	Cell Biology and Genetics	5	5	3	25	75	100
2	III	22UBT2AC2	Applied Biochemistry	5	5	3	25	75	100
2	III	22UBT2CP1	General Microbiology, Cell Biology and Genetics (P)	3	3	3	40	60	100
2	III	22UBT2AP1	BiochemistryI&II(P)	3	3	3	40	60	100
2	IV	22UES	Environmental Studies	2	2	3	25	75	100
<b>Total</b>				<b>30</b>	<b>24</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>700</b>
3	I	22UT3/22UH3	Language -I	6	3	3	25	75	100
3	II	22UE3	English -III (Language Through Literature and Communicative Skills.I)	6	3	3	25	75	100
3	III	22UBT3CC3	Molecular Biology	6	6	3	25	75	100
3	III	22UBT3AC3	Bioinformatics	4	4	3	25	75	100
3	III	22UBT3CP2	Molecular Biology and rDNA Technology (P)	3	-	-	-	-	-
3	IV	22UBT3AP2	Bioinformatics and Biostatistics (P)	3	-	-	-	-	-
3	IV	22UBT3NME1	Biotechnology For Human Welfare	2	2	3	25	75	100
<b>Total</b>				<b>30</b>	<b>18</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>500</b>

4	I	22UT4/UH4	Language -I	6	3	3	25	75	100
4	II	22UE4	English -IV (Language Through Literature and Communicative Skills.II)	6	3	3	25	75	100
4	III	22UBT4CC4	rDNA Technology	5	5	3	25	75	100
4	III	22UBT4AC4	Biostatistics	3	3	3	25	75	100
4	III	22UBT4CP2	Molecular Biology and rDNA Technology (P)	3	3	3	40	60	100
4	III	22UBT4AP2	Bioinformatics and Biostatistics (P)	3	3	3	40	60	100
4	IV	22UBT4NME2	Pharmaceutical Biotechnology	2	2	3	25	75	100
4	IV	22UBT4SBE1:1 22UBT4SBE1:2 22UBT4SBE1:3	1.Mushroom and Vermi technology 2.Food and Nutrition 3.Phytochemicals and Herbal Medicine	2	2	3	25	75	100
<b>Total</b>				<b>30</b>	<b>24</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>800</b>
5	III	22UBT5CC5	Plant Biotechnology	5	5	3	25	75	100
5	III	22UBT5CC6	Animal Biotechnology	5	5	3	25	75	100
5	III	22UBT5CC7	Nanotechnology	5	5	3	25	75	100
5	III	22UBT5CP3	Plant and Animal Biotechnology (P)	4	4	3	40	60	100
5	III	22UBT5MBE1:1 22UBT5MBE1:2 22UBT5MBE1:3	1.Bio Instrumentation 2.Biostatistics and Biosafety 3. Immunology	5	5	3	25	75	100
5	IV	22UBT5SBE2:1 22UBT5SBE2:2 22UBT5SBE2:3	1.Medical lab technology 2.Biofertilizer 3.Forensic Science	2	2	3	25	75	100
5	IV	22UBT5SBE3:1 22UBT5SBE3:2 22UBT5SBE3:3	1.Aquaculture 2.Apiculture 3.Sericulture	2	2	3	25	75	100
5	IV	22USSD	Soft Skill Development	2	2	3	25	75	100
<b>Total</b>				<b>30</b>	<b>30</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>800</b>
6	III	22UBT6CC8	Microbial Biotechnology	6	5	3	25	75	100
6	III	22UBT6CC9	IPR and Bioethics	6	5	3	25	75	100
6	III	22UBT6CP3	Microbial Biotechnology (P)	5	5	3	40	60	100
6	III	22UBT6MBE2:1 22UBT6MBE2:2 22UBT6MBE2:3	1.Food technology 2.Enzyme technology 3.Biodiversity and conservation	6	5	3	25	75	100
6	III	22UBT6MBE3:1	1.EnvironmentalBiotechnology	6	5	3	25	75	100

		22UBT6MBE3:2 22UBT6MBE3:3	2. Mini Project				40	60	
			3. Stem Cell Biology				25	75	
6	V		Extension Activities	-	1	-	-	-	-
6	V	22UGS	Gender Studies	1	1	3	25	75	100
<b>Total</b>				<b>30</b>	<b>27</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>600</b>
<b>Grand Total</b>				<b>180</b>	<b>140</b>				<b>3900</b>

Language Part –I	-	4
Core Paper	-	9
Core Practical	-	4
Allied Paper	-	4
Allied Practical	-	2
Non-Major Elective	-	2
Skill Based Elective	-	3
Major Based Elective	-	3
Environmental Studies	-	1
Value Education	-	1
Soft Skill Development	-	1
Gender Studies	-	1
Extension Activities	-	1

(Credit only)

\* For those who studied Tamil upto 10<sup>th</sup> +2 (Regular Stream)

+ Syllabus for other Languages should be on par with Tamil at degree level

# Those who studied Tamil upto 10<sup>th</sup> +2 but opt for other languages in degree level under Part I should study special Tamil in Part IV

\*\* Extension Activities shall be outside instruction hours

Non Major Elective I & II -for those who studied Tamil under Part I

- a) Basic Tamil I & II for other language students
- b) Special Tamil I & II for those who studied Tamil upto 10<sup>th</sup> or +2 but opt for other languages in degree programme.

**Note:**

	Internal Marks	External Marks
1.Theory	25	75
2.Practical	40	60

3. Separate passing minimum is prescribed for Internal and External marks  
For theory

## **THANTHAIHANSROEVERCOLLEGE(Autonomous)**

### **ProgrammeOutcomes(POs)**

#### **UndergraduateProgrammes**

Upon completion of the programme, the undergraduate will be able to

1. Acquire knowledge, understand concepts and apply new ideas which enable them to be employable or self-employed
2. Demonstrate motivation in advancing to higher learning programmes
3. Engage in socially responsible behaviour and have value-added education
4. Have exposure to technical proficiency, analytical capability, soft skills and life skills development
5. Develop broad understanding in the basic concepts of

Languages/Commerce/Management Studies/Physical Sciences/Computing Sciences/Biological Sciences/Life Sciences

#### **B.Sc.,Biotechnology Programme Specific Outcomes(PSOs)**

1. Acquire knowledge on the fundamentals of biotechnology, Environmental Biotechnology, Nanobiotechnology, animal and plant biotechnology, Industrial Biotechnology, genetic engineering, immunology, bioinformatics for research activities in the department research center or in collaboration with other research institutes
2. Understand the applications of biotechnology in all spheres of agriculture and develop crops with improved productivity thereby increasing farmers' income, better human health and decreased environmental pollution.
3. The objective of the Biotechnology is to equip the students to apply knowledge of molecular mechanisms of cellular processes in living systems including microbes, plants, and higher order organisms to applied aspects.
4. Interdisciplinary approach helps in providing better solutions and new ideas for the sustainable developments, recognition of the need for, and an ability to engage in life-long learning.
5. Recognize the importance of biotechnological applications as to usher next generation entrepreneurship

## SEMESTER-I

Course Code:22UBT1CC1  
InstructionHours:5  
Credits:4

ExamHours:3  
InternalMarks:25  
ExternalMarks: 75

### CORE COURSE-I GENERAL MICROBIOLOGY

#### Courseoutcomes

- The courses support to understand the microbial world in various aspects of structure, growth, classification & characterization.
- Have developed a good knowledge of the development of the discipline of Microbiology and the contributions made by prominent scientists in this field.
- Have developed a very good understanding of the properties, structure and cultivation of different types of microorganisms.
- Described the nutritional requirements of microorganism for growth.
- Have acquired a fairly good knowledge of microbial application in industry.

#### UNIT-I

Definition and scope of microbiology - History of microbiology -Classification and nomenclature of microorganism-Haeckel's three kingdom concept-Whittaker's five kingdom concept-Microscopic examination of microorganisms- Microscopy: simple, compound light microscope, Dark Field, Phase contrast and Electron Microscopy- Principles of different staining techniques like Simple, Gram staining and Capsular staining- Recent methods of microbial identification.

#### UNIT-II

Microbial association-General structure and function of microorganism -Bacteria, Fungi, Virus- Algae and Protozoa-Life cycle of *Leucothrix mucor* (Purple sulfur bacteria)-Life cycle of fungi Rhizopus and yeast (*Saccharomyces cerevisiae*)-Life cycle of algae Chlamydomonas-Life cycle of viruses Plant, animal and bacteria viruses (each with one example).

#### UNIT-III

Methods in microbial culture-Microbial Energetics-Nutritional requirements of bacteria and different media used for bacterial culture- types of Nutrition (Phototrophs, autotrophs and Chemoautotrophs) - Microbial growth curve- Aerobic and anaerobic bioenergetics and utilization of energy for

biosynthesis of important molecules-Factors affecting microbial growth, pH, light, temperatures, desiccations, osmotic pressure, radiation-pure culture techniques-pour plate, spread plate and streak plate

#### UNIT-IV

**Conditions influencing the effectiveness of antimicrobial agent activity**-Sterilization of microorganisms- Physical and chemical methods of sterilization-physical (moist heat,dry heat,filtration,pasteurization,tyndallization,radiations) and chemical (alcohols,aldehydes, phenols, halogens and hypochlorite)

#### UNIT-V

Microbes application in agriculture, Biofertilizer- Microbes as a source of protein-Single Cell Protein-Microbes in medicine; Antibiotics, Penicillin-Microbes in the production of acetic acid and Amylase.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
32	14	11	8	17	Global

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

#### Text Books

1. Prasad B.N., "A Text Book of Biotechnology", (2003) Budha Academic Enterprises, G.P.O., Box 20195, Kathmandu, Nepal.
2. Pelczar MJ, Chan ECS and Krein NR, (1993) Microbiology, Tata McGraw Hill Edition, New Delhi, India.
3. Ananthanarayanan R & Jayaram Panicker, C.K. (2005) Textbook of Microbiology, Orient Longman.

#### References

1. Prescott, L.M.J.P. Harley and C.A. Klein, Microbiology 2nd edition (1995). Wm, C. Brown publishers.
2. Talaron K, Talaron A, Casita, Pelczar and Reid. (1993) Foundations in Microbiology, W.C. Brown Publishers.
3. Michael T. Madigan John M. Martin & Jack Parker, (1984) Biology of Microorganisms Prentice Hall International, Inc., London.
4. Edward A. Birge, (1992), Modern Microbiology – Principles and application. C. Brown Publishers, Inc. U.S.A.
5. Gerard J. Tortora, Berdell R. Funke, Christine & L. Case, (2001), Microbiology-

- An Introduction. Benjamin Cummings, U.S.A.  
 6. Rajan Sand Selvi Christy R. Essentials of Microbiology, Anjana Book House, Chennai, 2011.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
I	20UBT1CC1	General Microbiology					5	4			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓		✓	✓	✓	✓	✓		
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO3	✓		✓		✓	✓	✓		✓	✓	
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓		✓	
Number of Matches (l) = 44 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

## SEMESTER-I

**Course Code:22UBC1AC1**  
**InstructionHours:5**  
**Credits:3**

**ExamHours: 3**  
**InternalMarks:25**  
**ExternalMarks: 75**

### **ALLIED COURSE -I** **GENERAL BIOCHEMISTRY**

#### **Courseoutcomes**

- Developed a very good understanding of various biomolecules which are required for development and functioning of a bacterial cell.
- Have developed how the carbohydrates make the structural and functional components such as energy generation and as storage food molecules for the bacterial cell.
- Well conversant about multifarious function of proteins and also knowledge about lipids and nucleic acids.
- To understand working principle of various instruments used in biological studies.
- Apply the recent advances in Biochemistry and Biophysical techniques in Clinical Chemistry and Life Science Research.

#### **UNIT-I**

Structure of atoms and biomolecules-Atomic theory, valency, atomic weight, molecular weight, Molarity, molality and normality, Chemical Bonding-Isomerism, anomeric form and mutarotation-Properties of Water, ionization constant, pH and buffers-Isomerism, anomeric form and mutarotation.

#### **UNIT-II**

Macromolecules-Carbohydrates, Structure, classification, properties and functions of mono, di and polysaccharides -Metabolism concepts, Glycolysis, TCA cycle, pentose phosphate shunt and Respiratory chain, ATP synthesis -Metabolic disorders associated with carbohydrates-composition and functions of peptidoglycan and agarose.

#### **UNIT-III**

Protein, Structure, Classification, properties and function-Classification, Properties and function of amino acids -Metabolism concepts, Nitrogen metabolism and urea cycle -Biosynthesis of six essential amino acids (Met,Thr,Lys,Ile,Val,Leu)and aromatic amino acids -Metabolic disorders associated with chain and aromatic amino acid

degradation--Stereoisomerism, zwitter ion in aqueous solutions, physical and chemical properties, titration of amino acids- Enzymes properties-classes of enzymes-enzyme reaction-theories of enzyme.

#### UNIT-IV

Lipids, Classification, Structure, Properties and function -Classification, properties and function of fatty acid-Biosynthesis of lipids-Vitamins, Classification, Properties and its functions

#### UNIT-V

Instrumentation pH meter colorimeter, Spectrophotometer, centrifuge- Methods for detecting radio activity GM and Scintillation counter- Principle and applications of Chromatography Paper and Column Chromatography -Electrophoretic techniques, PAGE, SDS PAGE

Total Number of Topics	Local	Regional	National	Global	Category Based on %
28	5	3	14	19	Global

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

1. mW.Passon,DennisL.Vance,(1988),PrinciplesofBiochemistry,IVedition,W.M.C.BrownPublishers, Australia.
2. Murray,R.K.A.Grannor,D.K.Mayes,P.A.andRodwellV.W.(2000)Harper’sBiochemistry,McGraw HillPvt.Ltd.,NewDelhi.
3. VoetD&VoetJ.G(1990) Biochemistry,JohnWiley&Sons,NewYork.
4. ZubayG(1998).Biochemistry2/e,McMillanPublishersNewYork,CollierMcMillanCompany,London.

## SEMESTER II

**Course Code: 22UBT2CC2**  
**Instruction Hours: 5**  
**Credits: 5**

**Exam Hours: 3**  
**Internal Marks: 25**  
**External Marks: 75**

### **CORE COURSE II** **CELL BIOLOGY AND GENETICS**

#### **Objectives**

- To study about cell, its types, cellular organelles and their functions.
- To study about cell cycle and its regulations.
- To study about basic genetic concepts.

#### **Course outcomes**

- Discuss and differentiate the basic structure and function of cell components in prokaryotes and eukaryotes cells.
- In this course the students will learn different areas of cellular biology including the structure and functions of cell, its organelles, bioenergetics; cellular communication;
- Summarize the processes of energy transduction in cells and explain their significance
- Explain classical and modern genetic concepts.
- Getting sound knowledge on mendelian laws and microbial genetics

#### Unit -I Fundamentals of cell structure

Discovery of cells-Biogenesis theory of origin of life-Basic properties of cells-Cell theory-Cell Morphology-Different classes of cells-Prokaryotic and eukaryotic cells-Cell division: Cell cycle; mitosis; meiosis-binary fission

#### Unit -II Cellular membranes and matrices

Plasma membrane-Model of plasma membrane-Chemical composition and fluidity of membranes-dynamic nature of membranes-transportation across cell membrane-membrane potentials-extracellular matrices-structure and function-cytoskeleton structure and function.

#### Unit- III Cellular organelles in metabolism

Endoplasmic reticulum-smooth & rough; function of endoplasmic reticulum-Golgi complex structure and function-Ribosomes Types, structure and function-Morphology and functions of peroxisomes and glyoxisomes-Plant cell vacuoles-endocytic pathways-endocytosis, phagocytosis-membrane trafficking-Mitochondrial structure and function-Chloroplast structure and function-Structure of nucleus nuclear membrane-nucleolus, chromatin, structure of nucleic acids.

#### Unit -IV Classical Genetics

History of Classical and Modern Genetics-Concept and organization of Genetic material in Bacteria, Plant and Animal-Structure, types, forms and functions of DNA and RNA-Genetic model organisms and their significance (E.coli, Arabidopsis thaliana, Coenorhabditis elegans).

#### Unit -V Mendelian laws and Microbial genetics

Mendelian laws of inheritance-Non Mendelian inheritance-Chromosomal theory of inheritance-Back cross and Test cross-Microbial Genetics: Methods of Gene transfer-Transformation, Transduction, Sexduction-Mapping genes by interrupted Matting-fine structure analysis of genes.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
43	3	1	4	35	Global

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### TextBooks

1. Dr. Chandrashekhar,2022.A Textbook of Cell and Molecular Biology, Everest Publishing HouseGenre: Pharmacy
2. Lewin B. 2007. Genes IX. Oxford University Press, London.
3. Ajoy Paul. 2011. Textbook of Cell and Molecular Biology. Books and Allied Ltd.
4. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. 2008. Molecular Biology of Cell. 6th Edition. Garland Science, Taylor & Francis group Publishers.
5. P S Vermaand V K Agarwal, 2016 Cell Biology,S Chand Publishing; First Edition.

### References

1. George Plopper, Diana Bebek Ivankovic, Jones & Bartlett,2021 Principles Of Cell Biology Third Edition Jones & Bartlett.
2. Veer Bala Rastogi 2021 Cell Biology, Medtech; 1st edition.
3. Bruce Alberts ,Alexander D. Johnson , Julian Lewis , David Morgan , Martin Raff , Keith Roberts 2014.Molecular Biology of the Cell, W.W. Norton; 6th edition.
4. Gerald Karp,2013,Cell Biology Wiley; Seventh Edition.
5. J.D.Watson, Tania A. Baker, Stephen P. Bell, Michael Levine and Richard Losick. 2013. Molecular Biology of the Gene. 7<sup>th</sup> Edition. Benjamin/Cummings Publ. Co., Inc.,California.
6. Benjamin Pierce 2020,Genetics: A Conceptual Approach, Wh Freeman; 7th Edition.
7. Concepts Of Genetics 2019By William S. Klug ,Michael R. Cummings ,Charlotte A. Spencer .
8. Veer Bala Rastogi ,2019, Genetics 4th Edition Medtech.
9. Bd Singh2018,Fundamentals Of Genetics Unknown Binding. Kalani Pub.
10. Gardner , Simmons , Snustad, 2006. Principles Of Genetics, Wiley; 8th Edition.

### Web Source

<https://www.nature.com/scitable/topic/cellbiology13906536/>  
<https://byjus.com/biology/genetics/>

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	22UBT2CC2	Cell Biology and Genetics					5	5			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓		✓	✓	✓	✓		✓	✓	
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓		
CO3	✓	✓	✓		✓	✓	✓		✓	✓	
CO4	✓	✓	✓	✓		✓	✓	✓	✓		
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches(✓) = 43 Relationship: High											

<b>Mapping</b>	129%	3059%	6069%	7089%	90100%
<b>Matches</b>	114	1529	3034	3544	4550
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

## SEMESTER-II

Course Code:22UBC2AC2

InstructionHours: 4

Credits:3

ExamHours:3

InternalMarks:25

ExternalMarks: 75

### ALLIED COURSE-II APPLIED BIOCHEMISTRY

#### Courseoutcomes

- To provide knowledge about the techniques used in studying biological structure and Function.
- Develop competence in handling various chromatographic techniques and apply them in isolating and characterizing different biological molecules.
- Understanding the applications of centrifugation and chromatography in biological investigations.
- Understanding the principles of Electrophoresis, Spectrophotometry and X-Ray diffraction and their applications in biological investigations/experiments.
- To provide ample opportunity for the student to specialize in instruments in centrifugation, chromatography, electrophoresis, spectroscopy and crystallography

#### UNIT-I Centrifugation

Basic principles of sedimentation - Types of centrifuges - Preparative, analytical, high speed, low speed, ultra centrifuge, differential and density gradient-Determination of molecular weight- Application of centrifuge -sedimentation velocity and sedimentation equilibrium Application of centrifuge.

#### UNIT- II Chromatography

General principle of chromatographic separation - Principle, instrumentation and applications of Partition Chromatography - Adsorption Chromatography, Paper Chromatography - TLC, HPTLC, Ion Exchange Chromatography - Gel permeation Chromatography- Affinity Chromatography - GC, GLC ,HPLC, GC,MS,LC,MS.

### UNIT- III Electrophoresis

Basic principle and types of electrophoresis, Electrophoretic mobility, Factors affecting electrophoretic migration-Application of electrophoresis-Technique and uses of agarose gel electrophoresis-PAGE, SDS,PAGE -Two dimensional electrophoresis and Isoelectric focusing.

### UNIT-IV Spectroscopy

Beer, Lambert law and its limitations, Principles of Beer Lambert law –Light absorption and transmission -Extinction coefficient- Basic design of photoelectric colorimeter and spectrophotometer - Applications of uv, visible spectroscopic techniques - Flame Photometry, Atomic absorption spectrophotometry - Circular Dichroism and Optical Rotatory Dispersion - Principle and application of NMR-ESR techniques.

### UNIT- V Crystallography

Principle, instrumentation and applications of X Ray Crystallography, Advantages and disadvantages of X Ray Crystallography- X ray diffraction-Bragg equation, Reciprocal lattice-Miller indices –Unit cell- Concept of different crystal structure -determination of crystal structure (concept of rotating crystal method, powder method).

Total Number of Topics	Local	Regional	National	Global	Category Based on %
34	15	12	7	14	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

## TextBooks

1. P.Palanivelu and M.Salihi. 2009. Analytical Biochemistry and Separation Techniques. 4<sup>th</sup> Edition, MK U, Madurai.
2. Friefelder, D.M. 1983. Physical Biochemistry: Application to Biochemistry and Molecular Biology, 2<sup>nd</sup> Revised edition. W.H. Freeman, USA.

## References

1. Upadhyay and Upadhyay Nath. 2009. Biophysical Chemistry, Principles and Techniques. Himalaya Publishing House.
2. Boyer, R.F. 2000. Modern Experimental Biochemistry, 3<sup>rd</sup> Edition, Prentice Hall publishers, USA.
3. Hammes, G.G. 2007. Physical Chemistry for the Biological Sciences, 1<sup>st</sup> Edition. Wiley-Interscience, USA.
4. Pavia, D.L., Lampman, G.M., Kriz, G.S. 2000. Introduction to Spectroscopy. 3<sup>rd</sup> Revised edition. Brooks/Cole Publishing Company, USA.
5. Wilson and Walkar. 2000. A Biologist's Guide to Principles and Techniques of Practical Biochemistry, 5<sup>th</sup> Edition, Cambridge University Press, UK.
6. P. Asokan. 2003. Analytical Biochemistry. 2<sup>nd</sup> Edition. China Publications.

### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
II	22UBC2AC2	Applied Biochemistry					4	3				
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		
CO1	✓	✓	✓	✓		✓	✓	✓		✓		
CO2	✓	✓	✓		✓	✓	✓	✓	✓	✓		
CO3	✓	✓	✓	✓		✓	✓	✓		✓		
CO4	✓	✓		✓		✓	✓	✓	✓	✓		
CO5	✓	✓	✓	✓	✓	✓	✓	✓		✓		
Number of Matches (I) = 42		Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

## SEMESTER II

Course Code: 22UBT2CP2

Instruction Hours: 3

Credits: 3

Exam Hours: 3

Internal Marks: 40

External Marks: 60

### CORE PRACTICAL II GENERAL MICROBIOLOGY , CELL BIOLOGY AND GENETICS (P)

#### Objectives

- To acquire knowledge about aseptic techniques.
- To comprehend the various methods for identification of unknown microorganisms.
- To study about cells and their enumeration by appropriate techniques.
- To study about the cell division and development.
- To know knowledge about cell identification, cell culture, cell and organelle staining.

#### Course outcomes

- This practical is designed to give an understanding about the basic techniques in Microbiology
- To know about isolation of microorganism from different sample
- The students will learn, understand & develop the skill and hands on training in fundamentals of cell biology.
- Utilize laboratory skills to enhance understanding of cell structure and function while
- Participating in a group environment
- Develop responsible conduct of laboratory skills appropriate to the field of cell biology
- Apply the cell biology techniques to biotechnological approaches
- To gain knowledge about the cell organelle separation in both Prokaryotic and Eukaryotic cells

#### General Microbiology

1. Good Laboratory Practice, Maintenance of hygienic conditions in the laboratory and legal disposal of laboratory wastes.
2. Microscope and its functions, preparation of culture media and sterilization methods.
3. Methods of staining techniques simple, grams, spore and capsular staining.
4. Bacterial culture technique -streaking, pour plate and spread plate method. Fungal culture techniques.
5. Motility of bacteria, Growth studies of bacteria

#### Cell Biology

6. Structure observation Prokaryotic & Eukaryotic cell
7. Cell count Prokaryotic & Eukaryotic cell
8. Observation -Different types of cells -parenchyma, collenchymas, sclerenchyma, epithelium
9. Cell Staining -Cytochemical methods Demonstration of Cellular and sub cellular components
10. Sub cellular fractionation, Osmosis and tonicity.
11. Microtome -Temporary & permanent slide preparation.
12. Cell division Mitotic stages Preparation of Onion Root Tip, Meiotic stages Preparation of Tradescantia Flower bud.

#### Genetics

13. Mendel's law of genetics. Mono and Dihybrid crosses.
14. Isolation of spontaneous mutant cells.
15. Identification of Barr body (Buccal epithelium smear) Polytene and diplotene chromosome -Chironomous larva.
16. Preparation of polytene chromosomes (Chironomous larvae salivary gland) squash preparation.
17. To prepare stained temporary mounts of human cheek cell

Total Number of Topics	Local	Regional	National	Global	Category Based on %
17	11	3	1	2	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

## References

1. James C Cuppicino, Chad weish 2020 Microbiology : a laboratory manual, Hoboken, N.J.: Pearson, Publishers.
2. Das.S.Microbiology Practical Manual 2020 CBS; first edition.
3. David A. Thompson. 2011. Cell and Molecular Biology Lab.Manual.
4. P.Gunasekaran. 2007. Laboratory Manual in Microbiology. New Age International.
5. D O Hall, S E Hawkins. 1974. Laboratory Manual of Cell Biology. British Society for Cell Biology, Published by Crane,Russia.
6. Mary L. Ledbetter. 1993. Cell Biology: Laboratory Manual. Edition: 2. Published by RonJon Publishing.Incorporated.
7. G. Koliantz , D.B. Szymanski.2006 Genetics A laborotary manual.
8. Gregore Koliantz , Daniel B. Szymanski .2015, Genetics A laborotary manual.

## Web Source

1. [https://webstor.srmist.edu.in/web\\_assets/downloads/2021/18BTC103Jlabmanual.pdf](https://webstor.srmist.edu.in/web_assets/downloads/2021/18BTC103Jlabmanual.pdf)
2. [https://www.bjcancer.org/Sites\\_OldFiles/Library/UserFiles/pdf/Cell\\_Biology\\_Laboratory\\_Manual.pdf](https://www.bjcancer.org/Sites_OldFiles/Library/UserFiles/pdf/Cell_Biology_Laboratory_Manual.pdf)
3. [https://academicworks.cuny.edu/cgi/viewcontent.cgi?article=1008&context=ny\\_oers](https://academicworks.cuny.edu/cgi/viewcontent.cgi?article=1008&context=ny_oers)

## Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
II	22UBT2CP2	General Microbiology, Cell Biology and Genetics (P)					3	3				
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		
CO1	✓	✓	✓		✓	✓	✓	✓	✓	✓		
CO2	✓	✓	✓	✓	✓	✓	✓	✓		✓		

<b>CO3</b>	✓	✓		✓	✓		✓	✓	✓	✓
<b>CO4</b>	✓		✓	✓	✓	✓	✓		✓	✓
<b>CO5</b>	✓	✓	✓	✓		✓	✓	✓	✓	✓
Number of Matches(✓) = 43 Relationship: High										

<b>Mapping</b>	129%	3059%	6069%	7089%	90100%
<b>Matches</b>	114	1529	3034	3544	4550
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

## SEMESTER-II

**CourseCode:22UBC2AP1**  
**InstructionHours: 3**  
**Credits:2**

**ExamHours:3**  
**InternalMarks:40**  
**ExternalMarks: 60**

### ALLIED PRACTICAL – I BIOCHEMISTRY(P)

#### Courseoutcomes

- Developed understanding of principals, and applications of different microscopic and spectrophotometric methods.
- Obtain hands-on training in basic separation techniques in biochemistry
- Developed understanding of principals, and applications of different separation techniques especially chromatographic, electrophoretic and centrifugation techniques.
- Skills in handling and use of spectrophotometer and centrifugation equipment to study/analyze various biological samples.
- Have developed a very good understanding and skills of Mitochondria and chloroplast isolation.
- To expose the student to the biophysical methods used to study the biomolecules.

1. All basic instruments -Principle & SOP(Demo)
2. Isolation of Mitochondria from rat liver.
3. Isolation of chloroplasts from spinach leaves.
4. Preparation of the sub-cellular fractions of rat liver cells.
5. Separation of amino acids/ sugars/ nucleic acids/ pigments using paper and thin layer chromatography.
6. Separation of Amino acids by Ion-Exchange Chromatography
7. SDS -PAGE analysis of proteins(Demo).
8. Gel Filtration Chromatography(Demo).
9. Separation of Blood, plasma and serum.
10. Extraction of Proteins from biological materials

## 11. Protein separation methods: Precipitation, chromatographic, electrophoretic methods

Total Number of Topics	Local	Regional	National	Global	Category Based on %
11	4	5	2	2	Regional

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### References

1. ArunRastogi, Mathur, N.B.LMathur, N.B. L.2010. AnIntroductiontoPracticalBiochemistry.AnmolPublications,India.
2. Rajan,S.2010.ExperimentalProceduresinLife Sciences.AnjanaaBookHouse.
3. Jayaraman.2011.LaboratorymanualinBiochemistry. NewageInternationalprivatelimited.
4. P.Palanivelu and M.SaliHu. 2009. Analytical biochemistry andseparationtechniques. 4<sup>th</sup>Edition,MKU,Madurai.
5. Sadasivam.SandManickamA.2009. IntroductiontoPracticalBiochemicstry. 2<sup>nd</sup>Edition.New AgeInternationalPrivate Ltd.Publishers.

RelationshipMatrixforCOs, POsandPSOs

Semester	Code	TitleoftheCourse					Hours	Credits				
II	22UBC2AP1	Biochemistry–Lab					3	2				
Course Outcomes (COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		
CO1	✓	✓		✓		✓	✓	✓	✓	✓		
CO2	✓	✓	✓		✓	✓	✓	✓		✓		
CO3	✓	✓		✓	✓	✓	✓		✓	✓		
CO4	✓	✓		✓	✓	✓	✓	✓	✓			
CO5	✓	✓	✓		✓	✓	✓	✓	✓	✓		
NumberofMatches(l)= 41Relationship:High												

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50

<b>Relationship</b>	VeryPoor	Poor	Moderate	High	VeryHigh
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## SEMESTER- III

**Course Code:22UBT3CC3**  
**InstructionHours: 5**  
**Credits:4**

**ExamHours:3**  
**InternalMarks:25**  
**ExternalMarks: 75**

### **CORECOURSE-III** **MOLECULAR BIOLOGY**

#### **Courseoutcomes**

- To understand the functional aspects of the cell at molecular level.
- This course is designed to give an understanding about the basics of molecular biology- classical genetics & molecular aspects.
- To understand the inheritance pattern at molecular level
- To explain the arrangement of Genes and their interaction.
- To describe the influence of environment on gene expression and regulation

#### **UNIT-I Nucleus & Chromosomes**

**Cytoskeleton**, Microtubules, microfilaments - associated proteins, act in, myosin and intermediate filaments-3 dimensional organization of cytoskeleton - **Nucleus**, Nucleus, nuclear envelope, nucleoplasm, chromatin and chromosomes, allele, loci, gene, Nuclear division- **Nucleolus and its role**.

#### **UNIT-II Classical genetics**

Organization of Chromosomes - Specialized chromosomes - chromosomal abnormalities and qualitative inheritance- **Mutation and its types**-Population genetics and developmental genetics using *Drosophila melanogaster* as model system- **Somatic cell genetics analysis** - Mendel's inheritance, Law's of inheritance, single & dihybrid ratio - **Linkage analysis**.

#### **UNIT-III Central dogma of Molecular Biology**

Characteristics of genetic code- **Codon and anti codon-Transcription**, Prokaryotic & Eukaryotic Transcription -Enzymes involved in Transcription, RNA polymerase - Post transcriptional processing in mRNA (5' cap), 3', end polyadenylation, splicing - **Translation**, Factors involved in translation- Mechanism of translation in Prokaryotes and Eukaryotes, initiation, elongation, termination – Translational inhibitors -Post, translational modification of Proteins -Importance of Glycosylation and Phosphorylation- **Overview of Glycosylation and Phosphorylation**.

## UNIT-IV DNA Replication & repair

Prokaryotic and Eukaryotic DNA replication - Mechanism of DNA replication-Regulation of DNA replication-Enzymes & proteins involved in DNA replication - Models of replication, Semi, conservative, unidirectional, bidirectional,rolling circle mechanism-Inhibitors of DNA replication - DNA repair, Types of DNA repair- DNA repair mechanism.

## UNIT- V Regulation of gene expression

Gene concept-In prokaryotes, lac operon, ara operon and trp operon & attenuation - In eukaryotes, gene loss, gene amplification, gene rearrangement - Regulation of synthesis of primary transcripts - transcriptional control by hormones.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
42	1	1	14	27	Global

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. AjoyPaul.2011.TextbookofCelland MolecularBiology.Booksand AlliedLtd.
2. BenjaminLewin. 2007. GeneIX.9<sup>th</sup>Edition, JonesandBarlettPublishers.
3. J.D.Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner. 2007. Molecular BiologyoftheGene.6<sup>th</sup>Edition.BenjaminCummingsPublishingCompanyInc.
4. Watson JD, Gilman M, Witkowski J, Zoller M. 1992. Recombinant DNA. Scientific AmericanBooks.

### References

1. Bruce Alberts,Alexander.Johnson.JulianLewis,David

Morgan, Martin Raff, Keith Roberts, Peter Walter. 2014. Molecular Biology of Cell. Garland Science publication.

2. Burton E. Tropp. 2012. Molecular Biology-Genes to Proteins. Jones and Bartlett Publishers.
3. George M. Malacinski. 2013. Freifelder's Essentials of Molecular Biology. Narosa Publishing House.
4. Stanely R. Maloy, Jhon E Cornan Jr, David Freifelder. 1994. Microbial genetics. 2<sup>nd</sup> Edition. Jones and Bartlett publisher.
5. Uldis N. Streips and Ronald E. Yasbin. 2002. Modern Microbial Genetics. 2<sup>nd</sup> Edition. Wiley-Blackwell.
6. Sandy B. Primrose, Richard M. Twyman and Robert W. Old. 2008. Principles of Gene Manipulation. 6<sup>th</sup> Edition. Blackwell Science.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
III	22UBT3CC3	Molecular Biology					6	4				
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
CO2	✓	✓	✓		✓	✓	✓	✓		✓		
CO3	✓		✓	✓	✓	✓	✓	✓	✓	✓		
CO4	✓	✓	✓	✓	✓	✓	✓		✓	✓		
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Number of Matches (l) =		46 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

## SEMESTER- III

Course Code:22UBI3AC3  
InstructionHours: 4  
Credits:3

ExamHours:3  
InternalMarks:25  
ExternalMarks: 75

### ALLIEDCOURSE-III BIOINFORMATICS

#### Courseoutcomes

- Describe the importance of DNA and protein sequence alignments, methods of alignment and application
- Describe bioinformatic tools to understand protein structure.
- Describe how to find a best match for a given DNA or protein sequence from the target
- Demonstrate the knowledge of various Biological databases and tools
- This course provides the details of dry lab conditions and analysis of macromolecules and genetic material.

#### UNIT-I

Biological Databases -Sequence databases -Nucleic Acid sequence Databases, Genbank -Protein Sequence Databases, Swiss Prot - Searching Sequence Databases- Non, redundant Databases –Low Annotation Databases -Specialized sequence Databases - Structural Databases, Motif Databases - Genome Databases-Proteome Databases-Applications of bioinformatics.

#### UNIT-II

Tools for Bioinformatics- Pairwise alignment - Dotplots, scoring matrices-Blosum Matrices, PAM Matrix-Gap Penalty, Alignment Algorithms-Needleman, Wunsch Global Alignment Algorithm-Smith-Waterman Local Alignment Algorithm.

#### UNIT-III

Pairwise Sequence Analysis Tools - BLAST, Steps involved in using BLAST -Interpreting BLAST results - FASTA, Alignment Scores -Multiple Alignment, Clustal W- Phylogenetic Tree, Sequence Analysis using EMBOSS.

#### UNIT-IV

Protein Structure Prediction -Secondary structure Prediction, PDB, FSSP, SCOP, CATH, Chou, Fasman- Jpred, Q3, Transmembrane protein prediction Tertiary structure prediction-Comparative Modeling-Fold recognition, Ab initio prediction -modeler, RASMOL

#### UNIT-V

Emerging areas of Bioinformatics-DNA microarrays-Structural genomics-Functional Genomics - Proteomics Comparative Genomics-Docking, Protein, Protein Interaction-Autodock vina-Auto Dock PVRX-HEX software-Protein, ligand interaction-Next generation sequence characterization..

Total Number of Topics	Local	Regional	National	Global	Category Based on %
43	4	6	20	11	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. Harshawardhan,P.(2005)Bioinformaticsprinciplesandapplication.TataMcGrawHillPublishers.New Delhi.
2. ManikandanVijayaraj,2002.Bioinformaticsforbeginners,Kalaikathir Achchagam,Coimbatore.
3. Mount,D.W.2005.BioinformaticsSequenceandgenomeanalysis(II<sup>nd</sup>edition)CBSPublishers.New Delhi.

### References

1. Hagen. J.B. (2000).Theoriginofbioinformatics.Nat.Rev.Genetics1:231-6.
2. Tyers,M.,andMann,M.2003.Fromgenomicstoproteomics.Nature422:193-7.
3. Sundarajan.S.andR.Balaji.(2005),IntroductionofBioinformatics,HimalayaPublishinghouse,Mumbai.
4. Westhead,D.R,H.J.ParishandR.M.Twyman.(2003)BioinformaticsVivabooksPrivateLtd.New Delhi.
5. J.M.Keith.Bioinformatics.Vol.1:2008Data,sequenceanalysis&evolution.HumanaPress.

### RelationshipMatrixforCOs, POsandPSOs

Semester	Code	TitleoftheCourse					Hours	Credits				
III	22UBI3AC3	Bioinformatics					4	3				
CourseOutcomes (COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
CO2	✓		✓	✓	✓	✓	✓		✓	✓		
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓		
CO4	✓	✓	✓	✓		✓	✓		✓	✓		
CO5	✓		✓	✓	✓	✓	✓	✓	✓	✓		
Number ofMatches(ℓ) =44Relationship:VeryHigh												

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	VeryPoor	Poor	3 Moderate	High	VeryHigh

## SEMESTER- III

Course Code:22UBT3NME1  
InstructionHours: 2  
Credits:2

ExamHours:3  
InternalMarks:25  
ExternalMarks: 75

### NON MAJORELECTIVE-I BIOTECHNOLOGY FOR HUMAN WELFARE

#### Courseoutcomes

- This paper provides an in-depth scope and significance of various biotechnological applications.
- The student will gain knowledge about the role of biotechnology in relation to Human welfare.
- The student will get an idea about the exploitation of readily available resources and issues associated with product development, which will be useful for developing entrepreneurship skills
- To know the basic concept and issues of environmental pollution biotechnological treatment to clean up polluted environments and to create valuable resources for the human society
- Getting the knowledge for the diagnostics and prevention and treatment of diseases.

#### UNIT-I Agricultural Biotechnology

Organic farming, Integrated farming, Vermicompost, Crop Improvement- Crop conservation

#### UNIT-II Food & Dairy Biotechnology

Microbes as food-feed Prebiotics, Probiotics, Algae-SCP, Betacarotene, Fungi as food-Mushroom, Fermented food products-Natural colours additives.

#### UNIT- III Biotechnology for disease diagnosis

Clinical diagnosis, Lab diagnosis-Microscopy, Macroscopy, Biochemical, serological & Molecular diagnosis of diseases-PCR, RT-PCR, RAPD, RFLP, Karyotyping- DNA finger printing- Applications of DNA amplification.

#### UNIT- IV Biotechnology for treatment & prevention of diseases

Treatment-Symptomatic therapy, specific therapy, antimicrobials, Prevention-Active immunization, passive immunization, combined immunization, herd immunity- Chemotherapy.

#### UNIT- V Environmental Biotechnology

Waste management-Solid, liquid, sewage, municipal waste Bioremediation, Bioleaching, Biodegradation.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
22	5	5	8	2	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. D.Balasubramanian,C.F.A.Bryce, K.Dharmalingham, J.Green andK.Jayaraman.1996.ConceptsinBiotechnology.UniversitiesPress.
2. AshokK.Chauhan.2009.ATextbookofMolecularBiotechnology.I.K.InternationalPublishinghousePvt.Ltd.
3. Chandrakant Kokate, SS Jalalpure, Pramod H.J. 2011.TextbookofPharmaceuticalBiotechnology.AdivisionofReedElsevierIndia Pvt.Ltd.

### References

1. B.C.BhattacharyyaandRintuBanerjee.2007.EnvironmentalBiotechnology.OxfordHigherEducationPublication.
2. KrishnaBGhimire.2000.Socialchangeandconservation.LondonEarthscanPubl.
3. P.J.Delves,I.S.J.Artin,,I.D.R.BurtonandII.M.Roitt.2006.Essential Immunotechnology.12<sup>th</sup>Edition.Wiley&Blackwell.

### RelationshipMatrixforCOs, POsandPSOs

Semester	Code	TitleoftheCourse					Hours	Credits			
III	22UBT3NME1	Biotechnologyfor human Welfare					2	2			
CourseOutcomes (COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓		✓	✓	✓		✓	✓	✓	

<b>CO2</b>	✓	✓	✓	✓	✓	✓	✓		✓	✓
<b>CO3</b>	✓	✓	✓		✓	✓	✓	✓	✓	✓
<b>CO4</b>	✓	✓		✓	✓	✓		✓	✓	✓
<b>CO5</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
NumberofMatches(l) =44      Relationship:High										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	VeryPoor	Poor	Moderate	High	VeryHigh

## SEMESTER-IV

Course Code:22UBT4CC4  
InstructionHours:6  
Credits:4

ExamHours:3  
InternalMarks:25  
ExternalMarks: 75

### CORE COURSE-IV rDNA TECHNOLOGY

#### Objective

- Make them understand the process of rDNA technology
- Obtain the knowledge on the basics on cloning and sequencing strategies

#### Courseoutcomes

- To understand the steps involved in recombinant DNA technology.
- Describe the mechanism of action and the use of restriction enzymes in biotechnology research and recombinant protein production.
- To explain the construction of DNA & cDNA library and their applications
- To get expertise in isolation of plasmids, cloning of gene and transformation into suitable bacteria for selection of recombinant clones.
- To enable the student to grasp of the latest advances in genetic engineering techniques and the applications in various fields of biotechnology

#### UNIT- I Introduction to rDNA Technology

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 - Holo enzyme klenow fragment- Polymerase, Transferase, Kinase and Ligase - Enzyme applications in DNA modification.

#### UNIT-II Different types of Vectors

Plasmids- Properties of plasmid- Types of plasmid- Phage vectors - Cosmids, Phagemids - Virus vectors, Shuttle vectors and expression vectors - YAC, BAC, *S.cerevisiae* system as a model.

#### UNIT-III Cloning Strategies

Cloning vectors for *E.coli* - Cloning vectors for Eukaryotes - Methods of transformation - Construction of genomic libraries and cDNA Libraries - Probe construction, recombinant selection and screening - DNA amplification using polymerase chain reaction (PCR)- *Thermus aquaticus*, thermal cycler- key concepts, Analysis of amplified products - Applications of PCR - Ligase chain reaction. RFLP, RAPD, DNA Finger printing - Principles of Southern, Northern and Western blotting techniques.

#### UNIT-IV Selection & Screening of rDNA products and Gene Sequencing

Analysis of recombinant DNA- Selection methods - antibiotics, expression basis, GUS expression- DNA sequencing method- Sequencing, chemical degradation, chain termination and automated sequence - Altered expression and engineering genes, Site, directed mutagenesis.

## UNIT-V

Application of rDNA Technology in Plants & Animals and Gene therapy -**Transgenic plants** with reference to virus and pest resistances, herbicide tolerance and stress tolerance (cold, heat and salt) - cytoplasmic male sterility - delay of fruit ripening - resistance to fungi and bacteria -Biopharmaceuticals and secondary metabolite production -**Transgenic animals**, Pharmaceutical products-insulin, Farm animal production - **Gene therapy**, Haemopoietic cells - genetically engineered bone marrow cells -skin fibroblasts, hepatocytes, myoblast and genetically modified lymphocytes -Recombinant DNA Technology in the production of vaccines.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
44	4	5	25	16	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

## Text Books

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter. 2002. Molecular Biology of the Cell, 4<sup>th</sup> Edition. Garland Sciences.
2. Stanley Maloy 1994. Microbial genetics. 2<sup>nd</sup> Edition. Jones and Bartlett publisher.
3. Udis N. Streips and Ronald E. Yasbin. 2002. Modern Microbial Genetics. 2<sup>nd</sup> Edition. Wiley-Blackwell.
4. Sandy B. Primrose, Richard M. Twyman, Robert W. Old. 2008. Principles of Gene Manipulation. 6<sup>th</sup> Edition. Blackwell Science.
5. Brown TA. 2008. Genomes. 3<sup>rd</sup> Edition. New York: Garland Publishing Co. New York: Garland Science.

## References

1. Old, R. and S. B. Primrose. 1996. Principles of Gene Manipulation: An Introduction to Genetic Engineering. 2<sup>nd</sup> Edition. Blackwell Scientific Publications, Oxford.
2. Glover, D. M. and B. D. Hames. 1995. DNA Cloning: A Practical Approach. 2<sup>nd</sup> Edition. IRL Press, Oxford.
3. Daniel L. Hartl. 2011. Analysis of Genes and Genomes. 8<sup>th</sup> edition. Maryellen Ruvolo. Laxmi Publications.
4. Keya Chaudhuri. 2012. Recombinant DNA Technology. The Energy and Resources Institute, TERI.
5. J. F. Sambrook and D. W. Russell. 2011. Molecular Cloning: A Laboratory Manual. 3<sup>rd</sup> Edition. Volume 1, 2 and 3. Cold Spring Harbor Laboratory Press.
6. T. van R. S. 1997. Recombinant Gene Expression Protocols. Humana Press Inc., Tokowa.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
IV	22UBT4CC4	rDNA Technology					6	4			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓		✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓		✓	✓		✓	✓	✓	
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓	✓	✓		✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches (l) = 46 Relationship: Very High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

## SEMESTER - IV

Course Code: 22UBT4AC4  
Instruction Hours: 3  
Credits: 3

Exam Hours: 3  
Internal Marks: 25  
External Marks: 75

### ALLIED COURSE - IV

### BIO STATISTICS

#### Objective

- To study the basic concepts of statistics and sampling design.
- To equip analytical thinking to solve biological problems

#### Course outcomes

- Explain the basic concepts of biostatistics, functions and limitations
- Classify the data and sampling design
- Compute the measures of central tendency and measures of Dispersion
- Apply the concepts of skewness, kurtosis, correlation and regression to solve the problems.
- Examine the various testing of hypothesis and also analysis of variance based on one-way classification and two-way classification

#### Unit- I

Introduction to biostatistics-Definition, statistical methods-biological measurement-kinds of biological data-functions of statistics and limitation of statistics.

#### Unit -II

Collection of data sampling and sampling design-classification and tabulation-types of representations,Graphic-bar diagrams-pie diagrams and curves.

#### Unit- III

Measures of central tendency-Mean, median, mode-geometric mean, harmonic mean.

#### Unit- IV

Measures of dispersion and variability change-Deviations-Mean Deviation-Standard Deviation-Coefficient of variation-Loren Zen's curve.

#### Unit -V

Skewness, Kurtosis-Moments, Meaning, test of skewness-characteristics of dispersion and skewness, Measures of skewness, objectives-Karl Pearson's Coefficient of skewness-Bocoley's coefficient of skewness.

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<b>Total Number of Topics</b>	<b>Local</b>	<b>Regional</b>	<b>National</b>	<b>Global</b>	<b>Category Based on %</b>
23	6	5	5	7	Global

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. Norman T. J. Bailey, 2009. Statistical methods in Biology. University press, Cambridge
2. Rastogi, V.B. 2009. Fundamentals of Biostatistics, Anne Books, India

### References

1. R.S.N. Pillai and V.Bagavathi 2016 Statistics Theory and Practice S.Chand
2. Bernard Rosner 2006 Fundamentals of Biostatistics Lengage learning
3. Stephen Bernstein & Ruth Bernstein 2005 Elements of Statistics Tata McGraw -Hill Edition
4. Veer Bala Rastogi ,2006,Fundamentals of Biostatistics Ane Books India
5. Samuel Delvin, 2007 Biostatistics ,Sarup and Sons

### Web Source

- [https://youtu.be/\\_e4mwlqCQrc](https://youtu.be/_e4mwlqCQrc)  
<https://youtu.be/AdH5vfobH5E>  
<https://youtu.be/fNLeogEjMmM>  
<https://youtu.be/0zZYBALbZgg>

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
IV	2UBT4AC4	BIOSTATISTICS					3	3			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓	✓	✓	✓		✓	✓	✓	
CO3	✓	✓		✓	✓	✓	✓		✓	✓	

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<b>CO4</b>	✓	✓		✓	✓	✓	✓	✓		✓
<b>CO5</b>	✓		✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

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## SEMESTER - IV

Course Code: 22UBT4CP4  
Instruction Hours: 3  
Credits: 3

Exam Hours: 3  
Internal Marks: 25  
External Marks: 75

### CORE PRACTICAL - IV

#### MOLECULAR BIOLOGY AND rDNA TECHNOLOGY (P)

##### Objective

- Demonstrate the genetic materials analysis process.
- Practically analyze the process of molecular biology experiments.

##### Course outcomes

- Students will be exposed to the latest techniques employed in recombinant DNA technology related to DNA manipulation in prokaryotes and eukaryotes.
- The student will be able to understand and develop the concept of recombinant DNA technique.
- To gain hands on experience in gene isolation, cloning by PCR approach, DNA on and PCR-amplification for DNA fingerprinting analysis via RAPD and restriction digestion.
- This course is planned to give hands on training in recombinant DNA technology.
- The course helps the students to understand about the recombinants from the basics to advanced techniques, giving in detail about each factor during construction of recombinants.

##### Molecular Biology

1. Isolation and purification of genomic DNA from prokaryotes.
2. Isolation and purification of genomic DNA from eukaryotes.
3. Isolation and purification of plasmid DNA.
4. Observation of DNA - Agarose gel electrophoresis.
5. Quantification of nucleic acids -DNA & RNA -Chemical and UV method.
6. Separation of protein by SDS PAGE
7. Staining of proteins - Amido black, coomassie brilliant blue & AgNO<sub>3</sub>.
8. Bacterial mutagenesis -physical & chemical.
9. Bacterial conjugation.
10. Transduction.

##### r DNA technology

1. Estimation of plasmids by agarose gel electrophoresis.
2. Different type of Restriction digestion.
3. Genetic Ligation process.
4. Preparation of competent Microbial cells.
5. Transformation of microbes with recombinant DNA.

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Total Number of Topics	Local	Regional	National	Global	Category Based on %
15	9	3	1	2	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

## References

1. Najat Abdulrazzaq Hasan,2021,Basic Molecular biology laboratory Manual, Zenodo Publisher.
2. S.K. Gakhar, Monika Miglani, Ashwani Kumar.2019.Molecular Biology: A Laboratory Manual Dreamtech Press
3. Dr. David A Thompson. 2011. Cell and Molecular Biology LabManual.
4. S. John Vennison 2009 Laboratory Manual For Genetic Engineeringphi Learning
5. J. Sambrook and D.W. Russel. 2001. Molecular Cloning: A Laboratory Manual, Vol. 1-3.CSHL.
6. Dr Hala M. Abdelmigid,2013,Genetic engineering: Laboratory Manual,CreateSpace Independent Publishing Platform; Lab Manual edition.
7. Judith W. Zyskind and Sanford I. Bernstein. 1989. Recombinant DNA Laboratory Manual.Academicpress.

## Web Source

<http://www-personal.umd.umich.edu/~poelkers/OelkersMolbiolmanualUMD2016.pdf>

[http://webstor.srmist.edu.in/web\\_assets/srm\\_mainsite/files/files/BT%200502%20-%20M\\_Tech%20r-DNA%20Technology%20lab%20manual.pdf](http://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/BT%200502%20-%20M_Tech%20r-DNA%20Technology%20lab%20manual.pdf)

## Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
IV	2UBT4CP4	Molecular Biology and rDNA Technology (P)					3	3				
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		
CO1	✓	✓	✓		✓	✓	✓	✓	✓	✓		
CO2	✓		✓	✓	✓	✓		✓	✓	✓		
CO3	✓	✓		✓	✓	✓	✓		✓	✓		

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CO4	✓	✓		✓	✓	✓	✓	✓		✓
CO5	✓		✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) = 42 Relationship: High										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

### SEMESTER - IV

**Course Code: 22UBT4AP2**  
**Instruction Hours: 3**  
**Credits: 2**

**Exam Hours: 3**  
**Internal Marks: 40**  
**External Marks: 60**

### ALLIED PRACTICAL - II BIOINFORMATICS AND BIostatISTICS (P)

#### Objective:

- Students will get good practical knowledge on biostatistics, biological databases and Structural analysis of proteins

#### Course Outcomes:

- Skill to use important biological database, use tool to retrieve data, and compare the data of the biological macromolecules.
- Good practical exposure about biological databases and tools
- Apply biological databases in advanced research
- Broad understanding about the advanced concepts and skills in biological databases
- Developing knowledge in mean, median, mode, Co-efficient of variance using
- biological materials

#### Bioinformatics and Biostatistics

1. Study of Nucleic acid sequence data banks-GenBank, NCBI, EMBL and DDBJ.
2. Pairwise sequence alignment-BLAST
3. Multiple alignment-ClustalW
4. Study of Protein Structure-PDB
5. Evaluation of protein structure by Swiss PDB viewer and RASMOL.
6. Collection of data, sampling designs, tabulation and graphic representation using biological materials.
7. To find Mean, Mode, Median, Co-efficient of variance using biological materials.
8. Tests of significance 't' test, 'chi' square, standard error and standard deviation.
9. 't' Test, chi square, statistical error, standard deviation also, to be practically done through SPSS programme [statistical Package for Social Sciences].

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Total Number of Topics	Local	Regional	National	Global	Category Based on %
9	6	1	2	2	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

## REFERENCES

1. MaicelloPagano, KimberleeGauvreau. Principles of Biostatistics, 2nd edition, Duxbury Press. 2000.
2. Roland Ennos. Statistical and Data Handling Skills in Biology, 3rd edition. Pearson. 2011.
3. S. Igancimuthu. Basic Bioinformatics Second Edition Alpha Science 2013

## Web source

<https://www.ncbi.nlm.nih.gov>

<https://www.ncbi.nlm.nih.gov/genbank>

<https://blast.ncbi.nlm.nih.gov>

## Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
III	22UBT4AP2	Bioinformatics & Biostatistics (P)					3	3				
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		

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<b>CO1</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>CO2</b>	✓	✓		✓	✓	✓		✓	✓	✓
<b>CO3</b>	✓	✓	✓		✓	✓	✓		✓	✓
<b>CO4</b>	✓	✓		✓	✓	✓	✓		✓	✓
<b>CO5</b>	✓	✓	✓	✓		✓	✓	✓	✓	✓
Number of Matches(✓) = 42      Relationship: Very High										
<b>Mapping</b>	1-29%		30-59%		60-69%		70-89%		90-100%	
<b>Matches</b>	1-14		15-29		30-34		35-44		45-50	
<b>Relationship</b>	Very Poor		Poor		Moderate		High		Very High	

## SEMESTER -IV

**Course Code:22UBT4NME2**  
**InstructionHours: 2**  
**Credits:2**

**ExamHours:3**  
**InternalMarks:25**  
**ExternalMarks: 75**

### NON MAJORELECTIVE-II PHARMACEUTICAL BIOTECHNOLOGY

#### Courseoutcomes

- To create general understanding regarding basic principles involved in modern medicinal/structuralchemistrystems.
- The student will gain knowledge in utilization of the commonly available resources for clinical application.
- The student will get an idea about the exploitation of readily available resources and issues associated with product development, which will be useful for developing entrepreneurship skills.
- Getting the knowledge for the diagnosis and treatment of diseases.
- To know about chemotherapeutic drugs.

#### **UNIT-I Introduction**

Development of Biopharmaceutical Industry -Therapeutic agents, uses and Economics- Drug development, Drug marketing, Drug desighning.

#### **UNIT-II Biologic drug Metabolism and Pharmacokinetics**

Biologic Drug metabolism -Physico Chemical principles - Pharma Kinetics, Action of drugs on human bodies.

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### UNIT- III Unit Operations in Biopharmaceutical Technology

Production of water for biopharmaceutical use, Filtration, mix-in - Drying, Freeze drying, Sterilisation- Water quality checking.

### UNIT-IV Biopharmaceuticals

Various categories of plant –animal and microbial derived therapeutics like vitamins -laxatives, analgesics, contraceptives, antibiotics, hormones and biologicals.

### UNIT- V Quality Control and Quality Assurance of Dosage Forms

Analytical methods and tests for various drugs and Pharmaceuticals-Packing, Packing, Techniques-Top pharmaceutical industries in india-Quality control-Good manufacturing Practice.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
20	5	2	9	4	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. Biotechnology and Biopharmaceutical Manufacturing, Processing, and Preservation (Drug Manufacturing Technology Series, Vol 2), by Kenneth E. Avis (Editor), Vincent L. Wu, CRC Press, 1996.
2. Remington's Pharmaceutical Sciences, Mack Publishing and Co, 1990.

### References

1. A.C. Guyton. Textbook of medical physiology, W.B. Saunders, Hong Kong 1986.
2. S.S. Purohit, Kaknani, Saleja Pharmaceutical Biotechnology.
3. N. Murugesu, A concise Text Book of Pharmacology. Sixth edition. Sathya Publishers, Madurai.

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4. R.C.Dubey, A Text Book of Biotechnology. S.Chand & Co Ltd, New Delhi.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
IV	22UBT4NME2	Pharmaceutical Biotechnology					2	2			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓		✓	✓	✓	✓	✓		✓	
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓		
CO3	✓	✓		✓	✓	✓		✓	✓	✓	
CO4	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO5	✓		✓	✓	✓	✓	✓	✓		✓	
Number of Matches (l) = 42 Relationship: High											

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

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## SEMESTER -IV

**CourseCode:22UBT4SBE1:1**  
**InstructionHours: 2**  
**Credits:2**

**ExamHours:3**  
**InternalMarks:25**  
**ExternalMarks: 75**

### SKILLBASEDELECTIVE-I MUSHROOM AND VERMITECHNOLOGY

#### Courseoutcomes

- Acquiredknowledgeaboutmushroomcultivationandvermicompostproduction
- bio
- Describeand applytheusesandloreofmanymushroomsand culturetechniques to further exploretheircultivationpotential
- AcquiredknowledgeaboutapplicationsofMushroomandVermicomposting
- Tofacilitateself-employment

#### UNIT-I Introduction of Mushroom

Edible and non edible mushroom (Historical account, most commonly cultivated mushrooms in the world, distribution and production in various countries) - Cultivation of button mushroom ,morphology raising a pure culture & spawn preparation -Cultivation of oyster and paddy straw mushroom- preparation of pure culture& spawn cultivation methods, harvest.

#### UNIT-II Cultivation

Preparation of compost & cultivation of *Agaricus bisporus*, *Pleurotus flabellus*, harvest - Pests and diseases of Edible mushrooms (Environmental, fungal, bacterial, viral, insect pests and Nematode diseases and competitor moulds).

#### UNIT-III Earthworms

Soil biota, Earthworms, Ecological classification of earthworms as Epigeics, Introduction to earthworm - biology, physical and chemical effects of earth worms on soils-Earthworm Culture-Role of earthworms in soil,classification of earthworms based on ecological strategies, Burrowing activity of earthworms - Drilospheres – Microorganisms and their relationship with earthworms, Composing, anaerobic composing, aerobic - composing, types of composing,vermicompost, earthworm species used in vermicompost production-endemic

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species,exotic species- Poisonous earthworm species.

#### UNIT- IV Vermicomposting

Vermicompost, setting up vermicompost quality N, P, K ,C, N, Microbial quality applications- vermiculture, vermiwash, role of vermicompost in organic farming, its quality and advantages over chemical inputs -Earthworms in Bio-reclamation of soil, Problems in vermiculture units, remedial suggestions-Types of vermicomposting, methods of vermicomposting.

#### UNIT-V Applications of Mushroom and Vermicomposting

Antiviral value, antibacterial effect, antifungal effect, antitumor effect, haematological value cardiovascular & renal effect, in therapeutic diets, adolescence, for aged persons & diabetes mellitus - Delicious recipies of mushroom,Economic importance of mushrooms-Vermicomposting as a tool for solid waste management, a small scale industry and it's economics, Vermic cultivation benefits - Marketing of vermiproduct.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
24	16	10	6	7	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

#### References

1. Brady, C.N,1974"TheNatureandPropertiesofsoils"MacmillanpublishingCo.NewYork,London.

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2. Edwards, C.A., and Bohlen, P.J., 1996. *Biology and Ecology of Earthworms*, Chapman and Hall, London.
- Ismail, S.A., 1997, *Vermiculture: The Biology of Earthworms* Orient Longman.
3. Chang, T.W.A. Haynes 1978. "Biology and cultivation of Mushrooms" Acad Press. N.Y.
4. Zadrazil, F. & K. Grabbe 1983 "Edible Mushroom, Biotechnology" Vol.3, Weinheim: Verlag Chemie, Berlin.
5. Kannaiyan. 2001. *Handbook of Edible Mushrooms* "TNAU Publication.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
IV	22UBT4SBE1:1	Mushroom and Vermi technology					2	2				
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		
CO1	✓	✓		✓	✓	✓		✓	✓	✓		
CO2	✓	✓	✓		✓	✓	✓	✓	✓	✓		
CO3	✓	✓		✓	✓	✓	✓	✓	✓	✓		
CO4	✓	✓	✓	✓		✓	✓		✓	✓		
CO5	✓	✓		✓	✓	✓	✓	✓	✓	✓		
Number of Matches (I) = 43		Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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**CourseCode:22UBT4SBE1:2**  
**InstructionHours:2**  
**Credits: 2**

**ExamHours:3**  
**InternalMarks: 40**  
**ExternalMarks: 60**

**SKILL BASED ELECTIVE -I**  
**FOOD AND NUTRITION**

**Courseoutcomes**

- AcquiredknowledgeofNutritionandFood Science
- AcquiredcomprehensiveknowledgeofroleofNutritioninhumanlife
- ThiscoursecomprehensiveknowledgeofCarbohydrates, Protein,VitaminsandLipids
- AcquiredcomprehensiveknowledgeofFoodpyramid
- Acquiredcomprehensiveknowledgeof nutritionaldeficiencydisorder

**UNIT-I**

**Definitions**, Food Science, Food, Nutrients, Nutrition Status - Mal-nutrition, under, Nutrition, over Nutrition, Balanced diet, Hunger, Hollow Hunger, Hidden Hunger, Appetite, Health, Meal, Menu - Balanced Diet and Food Groups, Basic four and Basic five - Nutritional Classification of foods -Energy yielding, Body Building and protective foods - Cooking Methods, Moist and Dry heat methods of cooking, merits and demerits- Fireless cooking- Advantages of cooking method.

**UNIT-II**

**Introduction to Nutrition and Food Science-Definition**, history, RDA, factors affecting RDA-Methods used for deriving RDA -Basic five food groups and the functions of food -**Food pyramid**- Food safety- Food regulations in india.

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### UNIT–III

Lipid classification,function,digestion and absorption,sources,excess and deficiency disorder- Carbohydrates classification, functions, digestion and absorption, Sources, deficiency diseases - Role of fibre in human Nutrition, Energy, units - Carbohydrate, protein, fat as a source of energy- Uses of carbohydrates.

### UNIT-IV

Protein,classification,functions, sources digestion and absorption, sources and deficiency disorders.

### UNIT-V

Vitamins , Fat soluble vitamins A, D, E & K, functions, sources, requirements deficiency diseases - Water soluble vitamins ,B like thiamine, Riboflavin, Niacin, Phridoscin, Folic acid, B2 and - Vitamin C and their functions sources requirements and deficiency diseases - Minerals ,Calcium, phosphorus,Sodium, Potassium, Iron, Iodine, Flourine and their functions, sources requirements and deficiency diseases.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
25	1	2	12	13	Global

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. Aruna Thaker

& Arlene Barton, Multicultural Handbook of Food, Nutrition and Dietetics (2012), Blackwell Publishing.

2. Michael Gibney, Hester. H. Voster & Frans.

J. Kok, Introduction to Nutrition (2002), Blackwell Publishing

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## References

1. Guthrie H.A. – Introductory Nutrition C.V. Mosby Co. St. Louis.
2. Bogert, J.G.V. Briggs, D.H. Calloway Nutrition and physical fitness (1985), 11th edition  
- W.B. Saunders Co., Philadelphia, London, Toronto.
3. Wardlaw, G.M. Insel, P.H. –  
Perspectives in Nutrition (1990) Times Mirror/Mosby College  
Publishing Co. St. Louis, Toronto, Boston.
4. William, S.R. – Nutrition and Diet Therapy (1985) 5th edition, Mosby Co. St. Louis.
5. M. Swaminathan “Principles of Nutrition and Dietetics”, 1993,  
Bappa Co 88, Mysore Road, Bangalore-560018.
6. Maurice E. Shils, James A. Olson, Moshe Shike  
“Modern Nutrition in health and disease” (1994) eighth edition, Vol. I & II Lea  
& Febiger Philadelphia, A Waverly Company.

### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
1V	22UBT4SBE1:2	Food and Nutrition					2	2			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO3	✓	✓	✓		✓	✓	✓		✓	✓	
CO4	✓	✓		✓	✓	✓	✓	✓		✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches (l) = 44		Relationship: High									

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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## SEMESTER-IV

CourseCode:22UBT4SBE1:3  
InstructionHours: 2  
Credits:2

ExamHours:3  
InternalMarks:25  
ExternalMarks: 75

### SKILLBASEDELECTIVE-I PHYTOCHEMICALS AND HERBAL MEDICINE

#### Courseoutcomes

- Acquiredknowledgeofaboutherbalmedicine,sothatonecanthinkoffarmingherbalplantsforfuture.
- AcquiredknowledgeoftissuecultureofmedicinalPlants
- Acquiredknowledgeofvarioustechniquesusedfor analysisofphytochemicals
- Acquiredknowledgeaboutmedicinalplantsinhealthcare
- Toenablethestudentstobecomeseff-employed/entrepreneur.

#### UNIT-I Crude Drugs

Crude Drugs, Scope & Importance - Classification (Taxonomical, Morphological Chemical, Pharmacological), Cultivation, Collection & processing of Crude Drugs -Indian System of medicine, Ayurveda, Siddha and Unani and its significance - Regulations of siddha medical system- Advantages of Ayurveda, Siddha and Unani.

#### UNIT- II Medicinal & Aromatic Plants

Cultivation and Utilization of Medicinal & Aromatic Plants in India - Genetics as applied to Medicinal herbs - Modern Biotechnological tools and its influence in Medical and Aromatic plant cultivation- Medical and Aromatic plant uses-Advantages of Amla, ashwagandha, mint, lemon grass, Vettiver etc.

#### UNIT-III Tissue Culture of medicinal Plants

Plant Tissue Culture as source of medicines, Secondary metabolite production in plants - Plant Tissue Culture for enhancing secondary metabolite production (*Withania somnifera*, *Rauwolfia serpentina*, *Catheranthus roseus*, *Andrographis paniculata*, *Dioscorea sp.*) - Anticancer, Anti inflammatory, Antidiabetic, Analgesic drugs, Biogenesis of Phytopharmaceuticals.

#### UNIT-IV Analysis of Phytochemicals

Methods of Drug evaluation (Morphological, Microscopic, Physical & Chemical)-Preliminary screening, Assay of Drugs, Biological evaluation/ assays, microbiological methods, Characterization of drugs - Types of Phytochemicals, Carbohydrates & derived products, Glycosides, extraction methods (Digitalis, Aloe, Mentha) - Alkaloids, extraction methods (Taxus, Papaver, Cinchona) -Flavonoids extraction methods, Resins, extraction methods, Lectins.

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## UNIT-V Applications of Phytochemicals

Application of phytochemicals in industry and healthcare - Biocides, Bio-fungicides, Bio-pesticides. Nutraceuticals and their significance.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
21	3	10	7	5	Regional

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. Pharmacognosy, C. K. Kokate, A. P. Purohit & S. B. Gokhale (1996), Nirali Prakashan, 4th Ed. School of Biotechnology and Health Sciences Department of Biotechnology (BT) Karunya University Page 626.
2. Natural Products in medicine: A Biosynthetic approach (1997), Wiley.

### References

1. Hornok, L. (ed.) (1992). Cultivation & Processing of Medicinal Plants, Chichester, U.K.: J. Wiley & Sons.
2. Trease & Evans, Pharmacognosy- William Charles Evans, 14th ed. (1989), Harcourt Brace & Company.

### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
IV	22UBT4SBE1:3	Phytochemicals and Herbal Medicine					2	2				
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		

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<b>CO2</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>CO3</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>CO4</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>CO5</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
NumberofMatches(ℓ)=45Relationship:VeryHigh										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	VeryPoor	Poor	Moderate	High	VeryHigh

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## SEMESTER-V

**Course Code:22UBT5CC5**  
**InstructionHours: 5**  
**Credits:5**

**ExamHours:3**  
**InternalMarks:25**  
**ExternalMarks: 75**

### CORECOURSE-V PLANT BIOTECHNOLOGY

#### Courseoutcomes

- Thiscourseisacquired basicknowledgeaboutplanttissueculture,transgenesisandgeneticmodificationsinagriculture.
- Design experiments for functional characterization of plant genes and to identify those suitable forcreatingagronomicallyimportanttraits.
- Conceptualizeplanttransformation,selectionofdesirablegenesforcropimprovement,designbinar yvectorandprocedureforgeneratingGMcrops.
- EvaluatecriticallythesafetyissuesofGMcropsandproductsinthesociety.
- Tounderstand theconceptsofmoderntechologypertaining tolargescaleproductionofagriculturalproducts.

#### UNIT-I

Plant tissue culture - Plant tissue culture techniques- Historical perspectives of plant tissue culture - Basic requirement for tissue culture laboratory-Establishment of plant tissue culture: Culture media , types of media- Explant: selection and preparation- *in-vitro* pollination and fertilization -embryo culture and its applications -embryogenesis and organogenesis - micropropagation -haploids and their applications - somoclonal variations and applications -Endosperm culture- production of triploids.

#### UNIT-II

Genetic manipulation of plants- Introduction, protoplast isolation,culture and regeneration -methods of fusing protoplasts -somatic hybridization -Protoplast and tissue culture manipulation for genetic manipulation of plants-Selection of somatic hybrids and cybrids.

#### UNIT-III

Applications of Plant Genetic Engineering - Genetic engineering & crop improvement - herbicide resistance - insect resistance - virus resistance -as bioreactors- Nematode Resistance-Protease inhibitors- genes for other insecticidal secondary metabolites –Stress resistance-Fungal pathogen resistance-fungal toxin resistance- Abiotic and Biotic Stress resistance.

#### UNIT-IV

Genetic modification in Agriculture - Genetic modification in food industry -background, history, controversies over risks, application, future applications - Transgenic plants - genetically modified food, application - future perspectives & ecological impact of transgenic plants-BT Cotton, Bt Brinjal and Advantages and disadvantage of GM crops.

#### UNIT-V

Organic food -Production of organic food -types of organic food -identification of organic food -organic food &preservatives -Organic Farming, Integrated Farming.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
46	10	11	30	12	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

- Gamborg O.L and Philips, G.C. 1995. Plant Cell, Tissue and organ culture - Fundamental methods. Narosa Publishing House, New Delhi. of plants. Oxford University press, USA.

### References

- Phundan Singh, 2013. Principles of Plant Biotechnology. Kalyani Publishers, India.
- V. Kumaresan, 2015. Applied Plant Biotechnology. Saras Publication, India.
- Singh, 2014. Plant Biotechnology, 2<sup>nd</sup> Revised Edition, Kalyani Publishers, India.

### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
V	22UBT5CC5	Plant Biotechnology					5	5				
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		
CO1	✓	✓	✓		✓	✓	✓	✓	✓	✓		
CO2	✓	✓	✓	✓	✓	✓	✓		✓	✓		
CO3	✓	✓		✓	✓	✓	✓	✓	✓	✓		
CO4	✓	✓	✓		✓	✓	✓	✓		✓		
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Number of Matches (I)=45		Relationship: Very High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

## SEMESTER-V

Course Code:22UBT5CC6  
InstructionHours: 5  
Credits:5

ExamHours:3  
InternalMarks:25  
ExternalMarks: 75

### CORE COURSE-VI ANIMAL BIOTECHNOLOGY

#### Courseoutcomes

- To understand the difference between stem cell types and methods for producing transgenic animals
- To improve artificial embryo transfer and nuclear transfer methods and applications.
- To learn the various types of cell morphology, stages and fertilization and transformation techniques employed in animal systems.
- The course helps the student to know about the animal cell culture techniques and applications from basics to advanced level.
- Be able to describe techniques and problems both technical and ethical in animal cloning.

#### UNIT-I

Embryology, Gametogenesis and fertilization in animals-Molecular events during fertilization- genetic regulations in embryonic development-Artificial Fertilization methods(IVF,IUF,ICSI) -*In vitro* fertilizations and embryo transfer- Superovulation - Polycystic ovarian syndrome (PVS)-Collection and preservation of embryo- culture of embryos, culture of embryonic stem cells and its applications

#### UNIT-II

Animal cell culture, Fundamentals. Facilities and Applications- Media for Animal cells- Media Composition ,Types ,Natural , Synthetic, Semisynthetic, Freezing Media - Types of cell culture: Primary cell culture, secondary culture- cell transformation, cell lines, Insect cell lines, Stem cell cultures, cell viability and cytotoxicity- Biology of cultured cells, measurement of growth, cell synchronization, senescence and apoptosis- Organ culture. Cryopreservation.

#### UNIT-III

Genetic engineering in animals- GMO (Genetically modified organism)-methods of DNA transfer in to animal cells-calcium phosphate co precipitation, microinjection,

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electroporation, Liposome encapsulation- Biological vectors- Hybridoma technology- Bacteria, Virus -Hybridoma technology –DOLLY-Sperm bank Transgenic cattles.

**UNIT-IV**

Gene therapy-mapping of human genome- Human Genome Project (HGP)-Gene silencing-RFLP and applications - DNA finger printing and Forensic Science- Molecular diagnosis of Genetic disorders -Antisense and ribozyme therapy

**UNIT-V**

Transgenics, Transgenic animals- Production and recovery of products from animal tissue culture-Humulin-cytokines, Plasminogen activators, Blood clotting factors, Growth hormones- Transgenic animals ,Merits and demerits- Ethical issues in animal biotechnology

Total Number of Topics	Local	Regional	National	Global	Category Based on %
40	9	8	10	19	Global

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

**Text Books**

1. B.Singh,SKGautam andMSChauhan. 2013. TextbookofAnimal biotechnology.TheEnergyandResearchInstitute.
2. M.K.Sateesh.2010.Biotechnology:V:(IncludingAnimalCellBiotechnology,ImmunologyandPlantBiotechnology).2<sup>nd</sup>Edition.New AgeInternational.

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## References

1. Freshney, E.D. 2000. Animal Cell Culture: A practical approach. John Wiley Pub. New York.
2. Mather, J.P. and Barnes, D. (Eds.). 1998. Animal Cell Culture Methods (Methods in Cell Biology Vol. 57). Academic Press, London.
3. Butler, M. (Ed.). 1990. Mammalian Cell Biotechnology - A Practical Approach. Oxford Univ. Press, Oxford.
4. Singer, M. and P. Berg. (Ed.). 1997. Exploring Genetic Mechanisms. University Science Books, Sausalito, CA, USA.
5. E.J. Murray (Ed). 1991. Gene Transfer and Expression Protocols - Methods in Molecular Biology Vol. 7. Humana Press, Totowa, NJ.
6. Watson, J.D., N.H. Hopkins, T.W. Roberts, J.A. Steitz and A.M. Weiner. 1987. Molecular Biology of Gene. Benjamin Cummins, San Francisco.
7. Watson, J.D., M. Gilman, J. Witkouski and M. Zoller. 1992. Recombinant DNA. Scientific American Books, New York.
8. Puller, A. (Ed). 1993. Genetic Engineering of Animals. VCH Publishers, New York.
9. Balinsky, B.I. 1975. An Introduction to Embryology. Saunders, Philadelphia.
10. Beril, N.J. 1974. Developmental Biology. Tata McGraw-Hill Publishing Company Ltd. New Delhi.

### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
V	22UBT5CC6	Animal Biotechnology					5	5				
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
CO2	✓	✓	✓	✓	✓	✓	✓		✓	✓		
CO3	✓	✓		✓	✓	✓	✓	✓	✓	✓		
CO4	✓	✓		✓	✓	✓	✓	✓		✓		
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Number of Matches (I) = 46		Relationship: Very High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50

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<b>Relationship</b>	VeryPoor	Poor	Moderate	High	VeryHigh
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## SEMESTER - V

Course Code: 22UBT5CC7

Instruction Hours: 5

Credits: 5

Exam Hours: 3

Internal Marks: 25

External Marks: 75

### CORE COURSE -VII NANO TECHNOLOGY

#### Objectives

- Obtain the knowledge on the basics on nanomaterials and their properties based on size.
- Make them understand the process of synthesizing nanoparticles with different source/materials.

#### Course outcomes

- To introduces the learners to the basic concepts and applications of nanotechnology.
- Students to understand the various nanomaterial, their construction and biological approach of in medical field.
- Gain an understanding of producing novel nano biologics and Nanopharmaceuticals
- Expand their knowledge on Ethical, Safety and regulatory issues of Nanomedicine.
- Gain an understanding of producing novel environmental Nano Remediation Technology

#### UNIT-I

**Basic Concepts of Nanoscience** Scientific Revolution- Feynman's Vision , Nanoscience -Introduction, Scope and Overview-Length scales- Nanomaterials definitions - Classification of Nanomaterials - dimensions, confinement, Surface to volume ratio, Energy at bulk and nano scale - Nature Nanophenomena - Size dependent variation in Mechanical, Physical, Chemical, electronics, reaction, catalytic properties -Importance of Nanoscale and technology- History of Nanotechnology- Future of Nanotechnology- Nanotechnology Revolution-Silicon based Technology.

#### UNIT-II

Synthesis of semiconducting nano structured materials by co precipitation technique and to calculate the absorption coefficient-optical bandgap using UV Vis spectrometer-Nanoparticles, Introduction- Types of Nanoparticles, Pure Metal, Gold, Silicon, Silver, Cobalt, Metal Oxides, Silica, Zinc oxide, Iron oxide, Alumina, Titania- Techniques to Synthesize Nanoparticle- Characterization of Nanoparticle, Nanocomposite.

#### UNIT-III

Applications of nanotechnology- Recent trends in nanomaterials-Nanosensors - types and its applications- Nano carriers for Drug Delivery, Polymeric Nanoparticles as Drug Carrier-Micelles for Drug Deliver-Nanomedicine- Nanotechnology for Cancer Research and Therapy- Nanocomposite materials for

therapy and food packaging, Functional graphen, carbon nanotube and polymer composite applications in defence and aerospace-Nanobots-Nanodevice

#### UNIT-IV

Environmental Nano Remediation Technology, Thermal, Physico, Chemical, and Biological methods-Nano Filtration for the Treatment of Wastes, Removal of Organics, Inorganics and Pathogen, Nanotechnology for Water Purification- Green synthesis of silver & iron nanoparticles.

#### UNIT-V

Nature Nanophenomena Size dependent variation in Mechanical, Physical, Chemical, electronics reaction catalytic properties- Ethical issues in nanotechnology: Introduction, Socio-economic Challenges, with special Reference to Nanomedicine -Social and Ethical Issues- Economic Impacts.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
37	12	10	29	20	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

#### Text Books

- Christef M. Niemeyer, C. A. Mirkin. 2004. Nanobiotechnology: Concepts, Application and Properties. Wiley -VCH Publishers, New York.
- Tuan Vo-Dinh.2007. Nanotechnology in Biology and Medicine: Methods, Devices and Applications.

#### References

- Ratner M, Ratner D, “Nanotechnology: A Gentle Introduction to the next Big idea”
- Prentice Hall, 2005.
- H.S. Nalwa,“Encyclopedia of Nanoscience & Nanotechnology”, McGraw Hill, 2004.
- CNR Rao, “The chemistry of Nanomaterials: Synthesis, Properties & Application”,
- Springer 2006.
- Viola Vogel, “Nanomedicine & Nanotechnology”, John Willey & Sons Ltd, 2008.
- Goodshell, “ Nanobiotechnology”, John Willey & Sons Ltd,3rd edition, 2004.
- Ralph S. Greco, “Nanoscale Technology in Biological systems”, CRC Press, 2005.

#### Web Source

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits						
V	22UBT5CC7	Nanotechnology	5	5						
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓		✓	✓	✓		✓	✓	✓
CO3	✓	✓	✓		✓	✓	✓		✓	✓
CO4	✓	✓	✓	✓		✓	✓	✓		✓
CO5	✓		✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) = 43 Relationship: High										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

**SEMESTER - V**

**Course Code: 22UBT5CP5**  
**Instruction Hours: 4**  
**Credits: 4**

**Exam Hours: 3**  
**Internal Marks: 25**  
**External Marks: 75**

**CORE PRACTICAL - V**

**PLANT AND ANIMAL BIOTECHNOLOGY (P)**

**Objective**

- Demonstrate the experiments of plant biotechnology.
- Practically analyze the process of animal biotechnology.

**Course outcomes**

- This course is to give hands on training on plant & animal tissue culture and biotechnology
- Explain the basis for formulation of plant tissue culture medium for growth and differentiation of plants
- Discuss the importance and applications of different techniques employed in tissue culture and storage of plant germplasm
- Illustrate the preparation of mesophyll protoplasts and analyze their fusing using PEG.
- To know Animal cell culture and different type of cell culture and application of cell culture.

**Plant Biotechnology**

1. Introduction to Safety Practices for plant cell culture laboratory(Theory&Demo).
2. Aseptic culture techniques for establishment and maintenance of cultures (Handson).
3. Tissue culture media preparation: Preparation of stock solutions of Murashige Skoog

- basal medium and plant growth regulator stocks (Handson).
4. Protoplast isolation–1.Mechanical 2.Enzymatic
  5. Protoplast culture (Handson).
  6. Isolation of plant genomic DNA(Handson).
  7. Size analysis of DNA by Agarose Electrophoresis (Handson).
  8. Photoperiodism.
  9. Micropropagation method in banana.
  10. Propagation of embryos
  11. Transformation of leaf discs with *Agrobacterium*(Handson).
  12. Expression of foreign genes in to plant cells: use of *Agrobacterium tumefaciens* (Theory).
  13. Morphogenesis in tobacco leaf tissue(Handson).
  14. Regeneration of the Shoot Apical Meristem (SAM).
  15. Preparation of chloroplast from pea (Handson).

### Animal Biotechnology

16. Isolation of DNA from Animal liver
17. Isolation of DNA from human cheek cells
18. Isolation of DNA from blood
19. Quantification of DNA by spectrophotometric method
20. Size analysis of DNA by Agarose gell electrophoresis
21. Animal cell culture-Preparation of media
22. Types of Animal cell culture-Primary,secondary&established.
23. Identification of stages during chick embryo development.
24. Establishment of Primary culture
25. Establishment of Secondary culture
26. Visit to Animal Cell Culture Lab.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
26	11	7	8	1	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### References

1. S S Purohit, 2006,A Laboratory Manual of Plant Biotechnology,Agrobios (India).
2. Chawla, 2008,Plant Biotechnology: Laboratory Manual For Plant Biotechnology Oxford & Ibh Publishing Company Pvt. Ltd.
3. Ss.Purohit 2010,A Laboratory Manual Of Plant Biotechnology, Agrobios (India).

4. Amit Gupta, 2019, Immunology And Animal Biotechnology - A Laboratory Manual , Lap Lambert Academic Publishing.
5. Sunil D Purohit & Neelu Joshi,2017, Molecular Biology & Biotechnology (A Practical Manual) Agrobios (India).

Web Source

[https://www.academia.edu/21781061/Lab\\_in\\_Industrial\\_Plant\\_and\\_Animal\\_Biotechnology\\_Students\\_Manual](https://www.academia.edu/21781061/Lab_in_Industrial_Plant_and_Animal_Biotechnology_Students_Manual)

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
V	22UBT5CP5	Plant and Animal Biotechnology (P)					4	4			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO3	✓		✓	✓	✓	✓	✓		✓	✓	
CO4	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches(✓) = 46 Relationship: Very High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

## SEMESTER - V

Course Code: 22UBT5MBE1:1

Instruction Hours: 5

Credits: 5

Exam Hours: 3

Internal Marks: 25

External Marks: 75

### BIO INSTRUMENTATION

#### Objectives.

- Categorize and explain the role of biological instruments.
- Compare and contrast the functions of the various instrumental process.

#### Course outcomes

- To provide better understanding of various analytical techniques using in research area
- This course will give an understanding about the working principles, construction and applications of the instruments often used in the studies related to various disciplines of Biological Sciences
- Outline the principle, types and applications of Spectroscopy.
- Summarize the principle, types and applications of Centrifugation and chromatography.
- Demonstrate the various electrophoretic techniques and its applications

#### UNIT- I Basic Instruments

Principles, operation protocol & applications of the following instruments - Weighing balance - pH meter - Polarography - Radioactivity - ECG - FTIR.

#### UNIT- II Microscopy

Observation of different microbes, Light, Bright & Dark field; Phase contrast- Inverted Phase contrast; Fluorescent, Electron-TEM & SEM; Confocal -Application of Microscope.

#### UNIT- III Spectroscopy

Colorimeter - Spectrometer –UV visible spectrometer -X - ray spectrometer –ELISA reader – Atomic absorption spectrometer –Flame photometer -Fluorimeter& Spectro fluorimeter- Application of spectrophotometer

#### UNIT-IV Separation Techniques

Centrifugation, Principle, operation, types & application - Chromatography, Principle, operation & applications - Paper, ascending, descending & Circular, TLC, HPTLC, GC, HPLC- Column Chromatography, Ion Exchange & Affinity Chromatography, LC,MS.

#### UNIT- V Electrophoresis

Native & denatured, zone, iso-electrofocusing & isotachopheresis - 1D&2D.PCR, MoldiT-- Agarose gel electrophoresis-PAGE-SDS PAGE.

<b>Total Number of Topics</b>	<b>Local</b>	<b>Regional</b>	<b>National</b>	<b>Global</b>	<b>Category Based on %</b>
27	12	13	8	4	<b>Regional</b>

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Book

1. Veerakumar2011,Bioinstrumentation,Mjp Publishers
2. Natarajan R. Ananda,2012,Biomedical Instrumentation and Measurements ,PHI Publishers

### References

1. Dr. G.Rajagobal., Dr. B.D.Toora. 2001. Practical Biochemistry. 1<sup>st</sup> Edition. Ahuja Book CompanyPvt.Ltd.
2. J.Jayaraman. 2000. Laboratory Manual in Biochemistry. New Age International(p).
3. Webster, 2007,Bioinstrumentation,Wiley Publisher.
4. Rajgopal Shenoy K And Anitha Nileshwar,2012,Manipal Manual Of Instruments, CBJ Publication
5. Veerakumari L,2017,Bioinstrumentation, MJP Publisher.
6. M.J. Reilly, 2018 ,Bioinstrumentation, CBJ Publishers

### Web Source

[https://sist.sathyabama.ac.in/sist\\_coursematerial/uploads/SMB2103.pdf](https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SMB2103.pdf).

### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
V	22UBT5MBE1:1	Bio Instrumentation					5	5			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓		✓	✓	✓		✓	✓	✓	
CO3	✓		✓	✓	✓	✓	✓		✓	✓	
CO4	✓	✓		✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓		✓	✓	✓	✓	✓	
Number of Matches(✓) = 44 Relationship: High											

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

## SEMESTER - V

Course Code: 22UBT5MBE1:2  
Instruction Hours: 5  
Credits: 5

Exam Hours: 3  
Internal Marks: 25  
External Marks: 75

### MAJOR BASED ELECTIVE - I

### BIOSTATISTICS AND BIOSAFETY

#### Objective

- Criticize and relate to the concept of Biostatistics.
- Describe the applications of Biosafety measures.

#### Course outcomes

- To Know basic concepts of probability and statistics and be able to describe statistical methods and probability distributions relevant for molecular biology data
- To know the applications and limitations of different biostatistical methods.
- Know basic bioethics to be followed during any scientific writing or experimentation.
- This part of the syllabus helps the students to understand the ethical, social, legal aspects in biology and bio containment.
- This course is designed to give knowledge on Biosafety guidelines and regulation

#### UNIT-I

Biostatistics, Concepts of statistics - basic principles -History of Bio statistics-Recent trends in biostatistics- Variables, measurements, functions and limitation - Data, types of data-biological measurement - kind of biological data- functions of statistics and limitation of statistics- methods of collection of data -merits and demerits, tabulation and -representation of data by frequency distribution diagram (Simple/ Multiple/ Subdivided bar diagram, Pie diagram) - Graphs (Histogram, polygon, curve) - Stem and leaf diagram - Sampling design essentials of sampling, census methods, sampling methods - statistical laws, statistical error- test of reliability of sample.

#### UNIT-II Measures of central tendency

Mean, median, mode and geometric mean - Measures of dispersion - range, mean deviations, standard deviation, Variance, Skewness, Kurtosis, quartile deviation merits and demerits - coefficient of variations - Correlation, types and methods of correlation - Regression, simple regression equation -fitting prediction, similarities and dissimilarities of correlation and regression.

#### UNIT-III Inferential statistics

Hypothesis, definition, types (one tailed, two tailed) - Sampling distribution and errors - Statistical Tests of significance, 't' test, Chi-square and goodness of fit-'F' test Analysis of variance - (ANOVA), One, way & Two, way.

#### UNIT-IV Biosafety

Introduction, biosafety issues in biotechnology - historical background- Introduction to Biological Safety Cabinets -Primary Containment for Biohazards -Biosafety Levels -Biosafety Levels of Specific Microorganisms - Recommended Biosafety Levels for Infectious Agents and

## Infected Animals.

### UNIT-V Biosafety Guidelines

Biosafety guidelines and regulations (National and International) - operation of biosafety guidelines and regulations of Government of India - Definition of GMOs & LMOs - Roles of Institutional Biosafety Committee - RCGM, GEAC etc, for GMO applications in food and agriculture - Environmental release of GMOs, Risk Analysis, Risk Assessment, risk management and communication - Overview of National Regulations - relevant International Agreements including Cartagena Protocol.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
43	2	11	22	11	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. Norman T. J. Bailey, 2009. Statistical methods in Biology. University press, Cambridge Rastogi, V.B. 2009. Fundamentals of Biostatistics, Anne Books,India.
2. Sateesh,M.K.,2008.Bioethics and Biosafety, I.K.International Pvt. Ltd, New Delhi,India.
3. Senthil Kumar Sadhasivam and Mohammed, Jaabir. 2008. IPR, Biosafety and Biotechnology Management. Jasen Publications, Tiruchirapalli,India.

### References

1. Zar, J.H. 2003. Biostatistical Analysis. Pearson Education (Singapore) Pvt. Ltd., Indian Branch, NewDelhi.
2. Rao S 2012 Introduction to Biostatistics and Research Methods, PHI Learning Pvt. Ltd.
3. Wayne W. Daniel, Chad L. Cross, 2014,Biostatistics: Basic Concepts and Methodology for the Health Sciences, Wiley Publisher.
4. Kulkarni A.P.2010,Basics of Biostatistics CBS Publishers & Distributors.
5. Sharma Suresh, 2016,Research Methodology and Biostatistics: A Comprehensive Guide for Health Care Professionals, Elsevier India

### Web Source

<https://www.who.int/csr/resources/publications/biosafety/Biosafety7.pdf>

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Relationship Matrix for COs, POs and PSOs

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Semester	Code	Title of the Course			Hours	Credits				
V	22UBT5MBE1:2	Biostatistics and Biosafety			5	5				
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓		✓	✓		✓	✓	✓
CO4	✓	✓		✓	✓	✓	✓	✓		✓
CO5	✓	✓	✓		✓	✓	✓	✓	✓	✓
Number of Matches(✓) = 44 Relationship: High										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

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## SEMESTER-V

**Course Code:22UBT5MBE1:1**  
**InstructionHours: 5**  
**Credits:3**

**ExamHours:3**  
**InternalMarks:25**  
**ExternalMarks: 75**

### MAJOR BASED ELECTIVE -I

#### IMMUNOLOGY

##### Courseoutcomes

- To understand the immune system, its components and their functions
- To comprehend the different types of cells, organs and mechanisms involved in immune system and their contributions in elucidating immune response.
- To impart knowledge of immune responses to various pathogens
- To understand the various components and the techniques associated with the specific immunological reactions.
- Gain knowledge about vaccine preparation

##### UNIT-I Fundamental Concepts and Anatomy of the Immune System

Terminology, Antigen, immunogen, hapten, allergen, tolerogen, super antigens, antibody, immunoglobulin, antigenicity, immunogenicity - Self & nonself, innate & acquired immunity - Haematopoiesis - Organs, tissues, cells and mediators of immune system - primary lymphoid organs, secondary lymphoid tissues, lymphocytes, mediators - Lymphatic system - lymphocyte circulation and lymphocyte homing -Principles of cell signaling.

##### UNIT- II Non specific Immunity

Natural built in barriers, skin, semen, saliva, tears, enzymes - Mediators of immune system - lymphokines, cytokines, interferon, tumor necrosis factor - Complement components - natural killer cells, macrophages - phagocytosis, pinocytosis - Inflammatory response - Mucosal and Gut associated lymphoid tissue (MALT&GALT) and mucosal immunity.

##### UNIT- III Specific Immunity

Antigen recognition and response - Major Histo compatibility Complex - MHC genes - MHC in immune responsiveness and disease susceptibility -HLA typing -Kinetics of immune response and memory - CMI

response - T cell development, mutation activation and differentiation - T cell receptor and determinant - T cell sub sets, TCR complex -Antigen processing and presentation - HI response , B cell, B cell development, maturation, activation and differentiation - B cell receptor and determinants -B cell sub sets -Immuno globulins, basic structure, classes & subclasses of immune globulins - antigenic determinants - Generation of antibody diversity - Unresponsiveness, tolerance, suppression and potentiation.

**UNIT-IV Vaccinology**

Historical aspects of vaccination - Active, passive and combined immunization - Live, killed, attenuated, plasma derived, subunit, recombinant DNA, protein based, plant, based, peptide, anti, idio typic and conjugate vaccines, production & applications- Role and properties of adjuvants & ISCOMS.

**UNIT- V Clinical Immunology**

Immunity to infection, Bacteria, viral, fungal and parasitic Hypersensitivity -Ebola infection causative treatment -H1N1 viral infection causative treatment-Type I, II, III and IV. Autoimmunity Transplantation immunology -Tumor & Cancer immunology and immune therapy Immuno deficiency-HIV infection, AIDS treatment.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
44	2	3	5	37	Global

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

**Text Books**

1. E.Riot.2011. Essential Immunology 12<sup>th</sup> Edition. Wiley & Blackwell.
2. Janeway et al. 1999. Immunobiology. 4<sup>th</sup> Edition. J Current Biology publications.
3. D.M. Weir, John Stewart. 1997. Immunology. 8<sup>th</sup> Edition. Churchill Livingstone.
4. P.J. Delves, IS.J. Artin, ID.R. Burton and II.M. Roitt. 2006. Essential Immunotechnology. 12<sup>th</sup> Edition

n. Wiley&Blackwell.

- RichardM.Hyde.2012.MicrobiologyandImmunology.3<sup>rd</sup>Edition.SpringerScience&BusinessMedia.

## References

- BrostoffJ,SeaddinJK,MaleD,RoittIM.,2002.ClinicalImmunology.6<sup>th</sup>Edition.GowerMedicalPublishing.
- Paul.1999.FundamentalofImmunology.4<sup>th</sup>Edition.LippencottRaven.

RelationshipMatrixforCOs, POsandPSOs

Semester	Code	TitleoftheCourse					Hours	Credits			
V	22UBT5MBE1:1	Immunology					5	3			
Course Outcomes (COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓		✓	✓	✓	✓	✓		✓	
CO3	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO4	✓	✓	✓		✓	✓	✓		✓	✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
NumberofMatches(ℓ)=45		Relationship:VeryHigh									

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	VeryPoor	Poor	Moderate	High	VeryHigh

## SEMESTER-V

**Course Code: 22UBT5SBE2:1**  
**Instruction Hours: 2**  
**Credits: 2**

**Exam Hours: 3**  
**Internal Marks: 25**  
**External Marks: 75**

### SKILL BASED ELECTIVE – II MEDICAL LAB TECHNOLOGY

#### Course outcomes

- The course provides knowledge about medical lab management and various techniques in medical field.
- The course provides knowledge about Histopathological techniques and skills required to diagnose various disorders
- The course provides knowledge about hematological specimens and blood bank management
- Acquired knowledge about the role of pathology in applied or experimental medical research.
- To facilitate self-employment

#### UNIT-I

Medical lab management-Laboratory management and planning- reception and recording of specimen- knowledge of maintenance and use of the following: microscope, hot plates, refrigerators, cryostat, blood bank refrigerators, walking coolers, refrigerated centrifuge, incubator, oven, autoclave- Equipments for Hematology-Advantages of MLT

#### UNIT-II

Histopathology- Tissue processing, details of paraffin embedding, vacuum embedding, decalcification- section cutting and different types of microtomes- frozen section uses and techniques- Staining procedures in Histopathology, Museum methods, mounting of specimens, preparation of mounting medium- Parts of photometer, types of photometry, colorimetry, spectrophotometry-Ethical aspects of Histopathological work.

#### UNIT-III

Hematology, Blood, Collection of haematological specimens, Equipments for Hematology- Parts of photometer, types of photometry colorimetry, spectrophotometry-Different methods of estimation of hemoglobin - Staining procedures in haematology, Peripheral blood smears- Salient features and investigations for iron deficiency anemia, megaloblastic anaemia and haemolytic anaemia, Leukaemias, Haemorrhagic disorders-Hemostasis: Definition, Basic concept and principle, Basic steps involved in Hemostasis.

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#### UNIT-IV

Body fluids and excretory products- Examination of stool, Urine its formation- normal and abnormal constituents -Examination of sputum- Examination of body fluids pleural, pericardial, ascetic, cerebrospinal fluid and semen examination-Bone marrow: Techniques of aspiration, preparation and staining of films, Bone marrow biopsy.

#### UNIT-V

Hemostasis: Definition, Basic concept and principle, Basic steps involved in Hemastosis-Blood bank management: Blood bank management and planning the receiving and recording of blood samples, indexing- Inheritance and nomenclature of ABO and Rh blood group systems, other blood group systems- transfusion reactions, recognition and investigations- Criteria used while selecting a blood donor-Blood Components, Blood Transfusion Reactions.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
31	13	8	22	12	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

#### Text Books

1. RajanS. MedicalMicrobiology.MJPPublishers, Chennai.2007.
2. RajanS.Parasitology.SRSPublications,Chennai.2007.

#### References

1. K.L. Mukherjee,  
“MedicalLaboratoryTechnology”Vol.I,II&III,TataMcGrawHillPublishingcompany,N  
ew Delhi,2008.

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2. C.R.Maity,“MedicalLaboratoryTechnology”,NewCentralBookAgencyPvtLtd.Kolkata,2005.
3. AlanHGowenlock,“Varley’sPracticalClinicalBiochemistry”,CBSPublications&Distributors,NewDelhi,2009.
4. Monica Cheesbrough, “District Laboratory Practice” in Tropical Countries Part -1 & 2Cambridge Low-PriceEdn.2000.

RelationshipMatrixforCOs, POsandPSOs

Semester	Code	TitleoftheCourse					Hours	Credits				
V	22UBT5SBE2:1	Medicallabtechnology					2	2				
CourseOutcomes (COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
CO2	✓		✓	✓	✓	✓	✓	✓	✓	✓		
CO3	✓	✓		✓	✓	✓	✓		✓	✓		
CO4	✓	✓	✓		✓	✓	✓	✓	✓	✓		
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
NumberofMatches(ℓ) =46Relationship:High												

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	VeryPoor	Poor	Moderate	High	VeryHigh

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## SEMESTER-V

**CourseCode: 22UBT5SBE2:2**  
**Instruction Hours: 2**  
**Credits:2**

**ExamHours:3**  
**InternalMarks:25**  
**ExternalMarks: 75**

### SKILL BASED ELECTIVE-II BIO FERTILIZER

#### Courseoutcomes

- To give adequate knowledge on biofertilizer production and to train the students for self-employment
- To ensure imparting the knowledge of biofertilizer based agriculture.
- The course provides knowledge about the application of biofertilizer and organic farming.
- The course provides knowledge about Biofertilizers Production and quality control
- Acquired knowledge about economic importance and reduce hazards in environment

#### UNIT-I Microbes and Agriculture

Importance of Carbon, Nitrogen and Phosphorus cycles - Benefits of Biofertilizers - strain selection, seed pelleting, Inoculant and inoculants carriers- Nitrogen fixing Bacteria (*Azotobacter*, *Beijerinckia*, *Clostridium*, *Cyanobacter*) -Media for *Azotobacter*, *Azospirillum* and phosphate solubilizer - New nitrogen fixers, 'Nif' genes (Hybrid *E.coli*)-Economic importance of Nitrogen fixing microbes.

#### UNIT-II Blue Green algae as Bio fertilizers

Mass cultivation of Cyanobacteria (*Anabaena*, *Cylindrospermum*) - Mass cultivation of *Azolla*, *Azolla* - *Anabaena* complex, Algal inoculants - methods of production (Trough method, Pit method, Field scale) application- Benefits of Blue Green algae.

#### UNIT- III Microbial Symbiotic association

*Rhizobium*, Taxonomy, physiology, Host-*Rhizobium* interaction, mass cultivation, carrier and base inoculants - Nod gene and factor- Vermiculture, Earthworms and microorganisms-Microbial enzymes, Bioprocessing.

#### UNIT- IV Mycorrhiza

Types of mycorrhizal associations - VAM mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield - collection of VAM-VAM life cycle-isolation, stock plants and inoculums production of VAM.

#### UNIT- V Production and quality control in Bio fertilizers

Isolation and identification of different nitrogen fixing ability of different strains under controlled and field conditions - direct and indirect methods, culture production, fermenter, storage of culture, carrier, packing, quality control -ISI Standards, inoculums requirements, packing, marketing and storage - inoculums requirements methods of application.

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Total Number of Topics	Local	Regional	National	Global	Category Based on %
27	4	13	8	8	Regional

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. S.G. Borkar, 2015. Microbes as Bio-fertilizers and their Production Technology, Woodhead Publishing India Agriculture, India.
2. RShankaraReddy, 2012. Biofertilizer Technology, Adhyayan Publishers, India.

### References

1. Moshrafuddin Ahmed and Basumatary, S.K. 2006. Applied Microbiology, M.J.P. Publishers, Chennai.
2. Dubey, R.C. 2003. A text book of Biotechnology. S. Chand & company, New Delhi.

### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
V	22UBT5SBE2:2	Biofertilizer					2	2			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓		✓	✓	
CO2	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO3	✓		✓	✓	✓	✓		✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓	✓	✓		✓	
CO5	✓		✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches (ll) = 44		Relationship: High									

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

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## SEMESTER - V

Course Code: 22UBT5SBE2:3  
Instruction Hours: 2  
Credits: 2

Exam Hours: 3  
Internal Marks: 25  
External Marks: 75

### SKILL BASED ELECTIVE - II FORENSIC SCIENCE

#### Objectives

- To understand the basic concepts in Forensic science
- To familiarise with analytical tools and sample preparation methods.
- testing To apply the DNA fingerprinting technique to solve various research and real life

#### Course outcomes

- Understand the basis of Crime scenario.
- Demonstrate the sample preparation and processing from various specimens
- Familiarise with the available analytical tools and techniques for Forensic science.
- Analyse various case studies based on Personal identification techniques.
- Apply the knowledge in various problem solving aspects

#### Unit-I:

Crime Scenario in India-Introduction to crime and history-Sociological aspects of crime and criminals in society-Types of crime and its causes-property crimes, public order crimes-violent crimes, cyber-crimes.

#### Unit-II:

Forensic Examination of Body and Semen Fluids-Molecular mechanisms for identification of the evidences from the criminal.

#### Unit-III:

Forensic Examination of Hair and Tissue-Molecular mechanisms for identification of the evidences from the criminal.

#### Unit -IV:

Personal Identification-Personal identification techniques as somatoscopy, somatometry-osteometry and craniometry their importance in determination of age and sex.

#### Unit -V:

Techniques and Applications-New and future technologies -DNA chips-SNPs and limitations of DNA profiling-Application of Molecular techniques to Forensic. Case study based on DNA fingerprinting-Disputed property, paternity, criminal identification.

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Total Number of Topics	Local	Regional	National	Global	Category Based on %
20	3	4	3	10	Global

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text book

1. Dr. Rukmani Krishnamurthy. Introduction to Forensic Science in Crime Investigation. Selective and scientific books publishers and distributors, New Delhi. (2005).
2. Kirby, LT. DNA Fingerprinting Technology. Palgrave Macmillan UK. (2009).

### References

1. Kelly M. Pyrek ,2017.Pioneers In Forensic Science: Innovations And Issues In Practice, CRC Press.
2. Phill Jones,2012.Forensic Science For Writers, Createspace Independent Pub
3. Jo -Anne Bright and Michael Coble Forensic DNA Profiling: A practical guide to assigning likelihood Rarios CRC Press 2019
4. Pankaj Shrivastava, HirakRanjann Dash, Forensic DNA typing: Principles, Applications and Advancements Springer 2020.
5. Sara costontokis, 2017.,World Of Forensic Science,Gale Virtual Reference Library.

### Web Source

<https://microbenotes.com/dna-fingerprinting-principle-methods-applications/>  
<https://www.vedantu.com/biology/dna-fingerprinting>

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
V	22UBT5SBE2:3	Forensic Science					2	2			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO2	✓		✓	✓	✓	✓	✓		✓	✓	
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO4	✓	✓		✓	✓	✓	✓		✓	✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches(✓) = 45 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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## SEMESTER-V

**Course Code:22UBT5SBE3:1**  
**InstructionHours: 2**  
**Credits:2**

**ExamHours:3**  
**InternalMarks:25**  
**ExternalMarks: 75**

### SKILLBASEDELECTIVE- III AQUA CULTURE

#### Courseoutcomes

- The students acquired knowledge about Preparation and Management of Ponds
- The students acquired knowledge about Concept of different systems of aquaculture.
- The students acquired knowledge about Disease management & Product export
- To have the ability to manufacture of aquaculture feeds
- To facilitate self-employment

#### UNIT-I Introduction

History, definition, scope and significance of aquaculture - comparison of aquaculture with agriculture - and commercial fisheries - Different aquaculture systems - Aquaculture, Global and Indian Scenario - General characters of fishes, and shell fishes - Criteria for the selection of species - Fresh water and marine cultivable fishes and their biology.

#### UNIT-II Aquaculture ponds

Preparation and Management of Ponds - Types of ponds, Nursery ponds, Rearing ponds, grow out ponds  
Prestocking management - Liming of ponds, Fertilization of ponds - Control of algal blooms, weed control - Water quality management.

#### UNIT- III Systems of aquaculture

Concept of different systems of aquaculture - Monoculture, Polyculture, Composite culture - Monosex culture, Mixed culture, Pen, Cage and raft culture - Extensive, Semi-intensive, Intensive aquaculture - Integrated fish farming, Shellfish, culture of prawns and molluscs.

#### Unit IV

Fish feed and its importance- Economical importance of prawn- Prawn culture and hosting- Prawn feed production - Factors affecting feed design - production and feeding - Manufacture of aquaculture feeds - Feed types, selection of ingredients and additives, Formulation of feeds and storage - Feed techniques, Manual and Mechanical.

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## UNIT-V Disease management & Product export

Introduction to fish diseases - Diseases in aquaculture - bacterial, viral and fungal pathogens of fish - Methods for disease control and management -Environment management, chemotherapeutic agents,vaccines and probiotics -Export of fishery products from India-major countries, important products.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
35	7	6	19	8	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. S.Ayyappan,J.K.Jena,A.Gopalakrishnan,Dr.A.K.Pandey.2010.Handbook of FisheriesandAquaculture.IndianCouncilofAgriculturalResearch.New Delhi.
2. K.K.Balachandran.2001.PostharvestTechnologyinFishandFisheryProducts.DayaPublishingHouse.New Delhi.
3. JhingranV.G.1985.FishandFisheriesofIndia.3rdEdition.HindustanPubl.Crop.India.Ltd.NewDelhi.
4. T.V.R.PillayandM.N.Kutty.2005.AquaculturePrinciplesandPractices.WielyBlack-Well

### References

1. AlineW.1980.Fishdiseases.SpringerVerlag.
2. MidlenA.BandReddingT.A.1998.EnvironmentalManagementforAquaculture.6thEdition.London:Chapman&Hall.
3. WedmeyerG.MeyerF.P.andSmithL.1999.EnvironmentalStress andFishDiseases.NarendraPubl.House.
4. WooP.T.KandBrunoD.W.1999.FishDiseasesandDisorders.Vol.3Viral,BacterialandFungalInfection.CenterforAgricultureandBiosciencesInternational.
- 5.FelixS.RijiJohnK,PrinceJeyaseelanM.J.andSundararajV.2001.FishDiseaseDiagnosis andHealthManagement.

RelationshipMatrixforCOs, POsandPSOs

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Semester	Code	TitleoftheCourse					Hours	Credits			
V	22UBT5SBE3:1	Aquaculture					2	2			
Course Outcomes (COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓		✓	✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓	✓		✓		✓	✓	✓	
CO3	✓		✓	✓	✓	✓	✓	✓		✓	
CO4	✓	✓	✓		✓	✓		✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
NumberofMatches(l)=43		Relationship:High									

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	VeryPoor	Poor	Moderate	High	VeryHigh

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## SEMESTER-V

**CourseCode:22UBT5SBE3:2**  
**InstructionHours: 2**  
**Credits:2**

**ExamHours:3**  
**InternalMarks:25**  
**ExternalMarks: 75**

### SKILLBASEDELECTIVE-III API CULTURE

#### Courseoutcomes

- The students acquired knowledge about honey bees, its lifestyle, the social behavior and colonization.
- The students acquired knowledge about Concept Apiary Management.
- To know about nutritional value and economic importance of honey
- The students acquired knowledge about Honey extraction & Product export
- To facilitate self-employment

#### UNIT-I

History and scope of Bee keeping -Present status of Apiculture in India -Honey bee, Systematic position, Species of Honey bees- Morphology and Life history, Stinging apparatus and bee poisoning.

#### UNIT-II

Bee colony, Castes- natural colonies and their yield -Bee foraging, Pollen and nectar yielding plants, Honey bee, behaviour, swarming, Pheromones.

#### UNIT-III

Apiary Management- Artificial beehives, types, construction of space frames, Selection of sites, Handling, Maintenance- Recent trends in apiculture-Instruments employed in Apiary and International markets for Honey and Wax - Natural enemies and diseases of honey bees and their control measure

#### UNIT-IV

Honey, Composition, Honey extraction, seasonal maintenance, uses -Bee wax and its uses, National control measure-Medicinal uses of Honey.

#### UNIT-V

Apiculture as Self,employment venture- Apiculture marketing-financial assistance and funding agencies – Economics of Apiculture and Management.

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Total Number of Topics	Local	Regional	National	Global	Category Based on %
20	2	9	6	6	Regional

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. Abrol,D.P.1997.BeesandBeekeepinginIndia.KalyaniPublishers,Ludhiana.
2. Rare,S.1998,IntroductiontoBeekeeping, VikasPublishinghouse.

### Reference

1. Cherian,R.&K.R.Ramanathan,1992–BeekeepinginIndia
2. Singh, S.1982–BeeKeeping –ICAR
3. Mishra,R.C. 1995.HoneyBeesandTheirManagementinIndia.ICAR,NewDelhi.
4. Sharma,P.andSinghL. 1987–Handbookofbeekeeping, ControllerPrintingandStationery,
5. Shukla,G.S andUpadhyay,V.B.1997.Economic Zoology.RastogiPublications,Meerut.
6. Arumugam,N.,Murugan,T.,JohnsonRajeshwar,J.andRamPrabhu,R.2009.AppliedZoology.SarasPublication,Nagercoil.
7. Amsath,A.andMarimuthuGovindarajan,2013.Apiculture.LambertAcademicPublishing.

### RelationshipMatrixforCOs, POsandPSOs

Semester	Code	Title of theCourse					Hours	Credits			
V	22UBT5SBE3:2	Apiculture					2	2			
CourseOutcomes (COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓		✓		✓	✓	✓	
CO2	✓		✓	✓	✓	✓	✓	✓	✓	✓	
CO3	✓	✓	✓		✓	✓	✓		✓	✓	
CO4	✓		✓	✓	✓	✓	✓	✓		✓	

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<b>CO5</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
NumberofMatches(l)=43		Relationship:High								

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	VeryPoor	Poor	Moderate	High	VeryHigh

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## SEMESTER-V

**CourseCode:22UBT5SBE3:3**  
**InstructionHours: 2**  
**Credits:2**

**ExamHours:3**  
**InternalMarks:25**  
**ExternalMarks: 75**

### SKILLBASEDELECTIVE-III SERICULTURE

#### Courseoutcomes

- The students acquired knowledge about the technique of silk worm rearing, cocoon production and silk reeling from sericulture.
- The students acquired knowledge about types of silk worms, distribution of races.
- The students acquired knowledge about mulberry cultivation
- Describes silk worm rearing house and appliances
- To kindle the young mind to become self-employers.

#### UNIT-I

Introduction, Sericulture, Definition, history and present status, silk route. - Prospects of Sericulture in India, Sericulture industry in different states of India-Employment potential in mulberry and non-mulberry sericulture - Mulberry, Classification, distribution and common varieties of mulberry used in India- Mulberry import and export-Mulberry cultivation skills, Moriculture.

#### UNIT-II

Types of silk worms, distribution of races- Silk worm rearing-Silk reeling-exotic and indigenous races - Commercial races, Multivoltine, bivoltine and hybrid races used in India - Morphology and Life cycle of Bombyx mori - Structure of silk gland and secretion of silk- Chemical composition of silk- Silk marketing.

#### UNIT-III

Silk worm rearing house and appliances -Rearing house, Early age rearing and Late age rearing - Appliances, Rearing trays, ant, wells, rearing stands and racks, paraffin papers, rubber foam pads, net, chopsticks, feathers-Types of mountages, Spinning, harvesting and storage of cocoons.

#### UNIT-IV

Pests of silk worm, uzifly, dermistid beetle, control and preventive measures -Silk worm diseases, protozoan viral fungal and bacterial diseases and their control and preventive methods.

#### UNIT-V

Sericulture organizations in India, Silk Industry - commercial classification of silk and silk thread wastes and their marketing-By-products of sericulture used as compost, animal feed, in Biogas plants and in pharmaceutical products.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
24	4	1	18	1	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. Ganga,G.andSulochanaChetty,J.2003. AnIntroductiontoSericulture(2ndEdition). OxfordandIBHPublishingco.Pvt-Ltd.,NewDelhi.
2. Taxima,Y. 1972.Hand BookofSilkwormRearing.FujiPublication,Tokyo.

### References

2. Ullal,  
S.R.andNarasimhanna,M.N.1979.HandbookofPracticalSericulture.CentralSilkBoard,Bombay.1.Jo  
lly,M.S.(Ed)AppropriatesericulturalTechniques,CSR&TI,Mysore.
3. Narasimhanna,M.N.1988. Manualofsilkwormeggproduction. CSB, Bangalore
4. Wupang-chunandda-chung. 1988.Silkwormrearing, pub.ByFAO, Rome
5. SenguptaK.1989.Aguideforbivoltinesericulture:, Director, CSR&TI,Mysore
6. Krishnaswamy,1986.Improvedmethodofrearingyoungagesilkworm:S.reprintedCSB,Bangalore.
7. Shukla,G.S.andUpadhyay,V.B. 1997.EconomicZoology. RastogiPublications, Meerut.
8. Tomar,B.SandN.Singh. ATextBookofAppliedZoology. 2007. Emkaypublications. Delhi.

### RelationshipMatrixforCOs, POsandPSOs

Semester	Code	TitleoftheCourse					Hours	Credits			
V	22UBT5SBE3:3	Sericulture					2	2			
CourseO utcomes( COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓		✓	✓	✓	✓		✓	✓	✓	
CO2	✓	✓	✓		✓	✓	✓	✓	✓	✓	

<b>CO3</b>	✓		✓	✓	✓	✓	✓	✓	✓	✓
<b>CO4</b>	✓	✓	✓	✓		✓		✓	✓	✓
<b>CO5</b>	✓	✓		✓	✓	✓	✓	✓	✓	✓
NumberofMatches(l)=43      Relationship:High										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	VeryPoor	Poor	Moderate	High	VeryHigh
		*	**		

## SEMESTER-VI

**Course Code:22UBT6CC8**  
**Instruction Hours: 6**  
**Credits:6**

**ExamHours:3**  
**InternalMarks:25**  
**ExternalMarks: 75**

### **CORECOURSE –VIII** **MICROBIAL BIOTECHNOLOGY**

#### **Courseoutcomes**

- The students will be able to demonstrate a familiarity with the wide diversity of microbes, and their potential for use in microbial biotechnology
- The students will be able to understand screening methods for industrial microbes
- Have acquired a detailed knowledge of number of products which are produced by industrial fermentation processes
- The students will be able to understand Biology of Industrial Microorganisms
- The students will be able to know the Industrial production of various products

#### **UNIT-I**

Basic principle of Biochemical engineering - Isolation, screening and maintenance of industrially important microbes - Microbial growth and death kinetics with reference to industrially useful microorganisms - Strain improvement for increased yield and other desirable characteristics-Industrially important microbe's types- By products of industrially important microbes.

#### **UNIT- II Concepts of basic mode of fermentation processes**

Bioreactor designs and types of fermentation and fermentors - Concepts & basic modes of fermentation- Batch, fed batch and continuous fermentation - Conventional fermentation versus biotransformation - Solid substrate, surface and submerged fermentation -Fermentation economics and fermentation media - Fermenter design - mechanically agitated, pneumatic and hydrodynamic fermenters. - Large scale animal and plant cell cultivation and air sterilization.

#### **UNIT- III Up stream processing**

Media formulation - sterilization, aeration and agitation -Measurement and control of bioprocess parameters -scale up and scale down process.

#### UNIT-IV Down stream processing

Bio-separation, filtration, centrifugation, sedimentation, flocculation, microfiltration, sonication - Cell disruption, enzymatic lysis and liquid, liquid extraction - Purification by precipitation (ammonium sulfate, solvent electrophoresis and crystallization) - Extraction (solvent, aqueous two phase, supercritical) and chromatographic techniques - Reverse osmosis and ultra filtration - Drying, crystallization - storage and packaging - Treatment of effluent and its disposal.

#### UNIT-V Applications of Microbes in food processing and production

Fermented foods and beverages - Commercial products of fermentation, Application of fermentation-food ingredients and additives used in fermentation and their purification - Fermentation in preparing and preserving foods- Microbes and their use in pickling - producing colours and flavours, alcoholic beverages and other products - Process wastes, whey, molasses, starch substrates and other food wastes for bioconversion to useful products - Bacteriocins from lactic acid bacteria - Ethanol production- Importance of biodiesel- production and applications in food preservation.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
41	7	9	19	4	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

#### Text Books

1. Jackson AT. 1991. Bioprocess Engineering in Biotechnology. Prentice Hall, Englewood Cliffs.
2. Shuler ML and Kargi F. 2002. Bioprocess Engineering: Basic concepts, 2<sup>nd</sup> Edition. Prentice Hall, Englewood Cliffs.

#### References

1. Young M.M., Reed. 2004. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine. Vol 1, 2, 3 and 4. Elsevier India Private Ltd, India.
2. Mansi EMTEL, Bryle CFA. 2007. Fermentation Microbiology and Biotechnology. 2<sup>nd</sup> Edition. Taylor & Francis Ltd,

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
VI	22UBT6CC8	Microbial Biotechnology					6	6			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓	✓	✓	✓	✓	✓		✓	
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO4	✓	✓		✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓		✓	✓	✓	✓	✓	
Number of Matches (l)=46		Relationship: Very High									

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

## SEMESTER-VI

**Course Code:22UBT6CC9**  
**InstructionHours:6**  
**Credits:6**

**ExamHours:3**  
**InternalMarks:25**  
**ExternalMarks: 75**

### CORECOURSE-IX IPR AND BIOETHICS

#### Courseoutcomes

- Exposuretolegalandsocioeconomicimpactsofbiotechnology.TounderstandtheethicalimplicationsinBiotechnologicalapplications.
- Exposuretoethicalconcernsofbiotechnologyresearch
- Tounderstandtheethical,social,legalaspects inbiologyandbiocontainment.
- TounderstandtheethicalimplicationsinBiotechnologicalapplications.
- Tounderstandtheintellectualpropertyrights,biosafetyofgeneticallyengineeredproductsandguidelines inIndia.

#### UNIT-I

Introduction to Intellectual Property -Types of IP:Patents,Trademarks,Copyright & Related Rights - Design, Draft design - **Agmark and its uses** -Traditional Knowledge - Geographical Indications- importance of IPR- **Applications of IPR-** patentable and non patentables –patenting life, legal protection of biotechnological inventions - world intellectual property rights organization(WIPO)- IP rights in India-IPs of relevance to Biotechnology few Case Studies- **Advantages of IPR.**

#### UNIT- II

**PatentFilingProcedures** - **National&PCTfilingprocedure** - **Timeframeandcost** - **Statusofthepatentapplicationsfiled** - **Precautions while patenting** - **disclosure/nondisclosure-Legal rights for products-Financial assistance for patenting,I n troductionto existing schemes Patent licensing-agreement Patent infringement- meaning, scope, litigation, case studies.**

#### UNIT-III

**IPR Agreements and Treaties -History of GATT-TRIPS Agreement –Madrid Agreement; Hague Agreement –WIPO Treaties; Budapest Treaty -PCT; Indian Patent Act 1970 & recent amendments - Patent and copyright Infringement -Patent and copyright misappropriation and enforcement, Important IP associations in india- Copyrights case studies-Trade secret- Trade secret case studies.**

#### UNIT-IV

**Bioethics, Introduction to ethics/ bioethics -framework for ethical decision making - purpose and principles of bioethics - Bioethics in medical - drug testing, non maleficence - Informed consent and human cloning - Bioethics on religious rules and guidelines- Medicines and its crime studies.**

## UNIT-V

Biotechnology and ethics -Benefits and risks of genetic engineering -ethical aspects of genetic testing -ethical aspects relating to use of genetic information-genetic engineering and biowarfare –Ethical implications of cloning -Reproductive cloning- therapeutic cloning - Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research -GM crops and GMO's -biotechnology and biopiracy –Ethical implications of human genome project.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
56	4	1	39	19	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. Bioethics- byEllenFrankelPaul, FredD.Miller, JeffreyPaul, FredDycusMillerCambridgeUniversityPress,2002.
2. Bioethics&Science,JohnA.Bryant,LindaBaggottlaVelle,JohnF.Searle.a2002.

### References

1. JoseB. Cibelli,RobertP.Lanza,KeithH.S. Campbell,MichaelD.West. 2002.PrinciplesofCloning,AcademicPress,SanDiego,Gurdon.
2. Hoosetti,B.B.2002. GlimpsesofBiodiversity.Daya,NewDelhi.
3. Martin.M.W.andSchinzinger.R. 2003.Ethics inengineering. 3<sup>rd</sup>Edition, TataMcGraw-Hill,New Delhi.
4. BAREACT. 2007.IndianPatentAct1970Acts&Rules.UniversalLawPublishingCo.Pvt.Ltd.
5. Kankanala,K.C. 2007.GeneticPatentLaw&Strategy.1<sup>st</sup>Edition. ManupatraInformationSolutionPvt.Ltd.Noida,India.
6. SenthilKumarSadhasivamandMohammed, Jaabir.2008.IPR,BiosafetyandBiotechnologyManagement.JasenPublications,Tiruchirapalli,India.
7. <http://www.cbd.int/biosafety/backgrounds.html>
8. <http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html>.

RelationshipMatrixforCOs, POsandPSOs

Semester	Code	TitleoftheCourse	Hours	Credits
VI	22UBT6CC9	IPRandBioethics	6	6
CourseO	ProgrammeOutcomes(POs)		ProgrammeSpecificOutcomes(PSOs)	

utcomes (COs)	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓		✓	✓	✓		✓	✓	✓
CO3	✓	✓	✓	✓		✓	✓		✓	✓
CO4	✓	✓	✓		✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓		✓	✓	✓	✓	✓
NumberofMatches(ℓ)=44 Relationship:High										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	VeryPoor	Poor	Moderate	High	VeryHigh

## SEMESTER-VI

**CourseCode:22UBT6CP6**  
**InstructionHours: 5**  
**Credits:4**

**ExamHours:3**  
**InternalMarks:25**  
**ExternalMarks: 75**

### **COREPRACTICAL-VI MICROBIAL BIOTECHNOLOGY (P)**

#### **Courseoutcomes**

- This course the students will get hands on exposure on strain selection, fermentation, upstream & downstream the product.
- Acquired knowledge about isolation of industrial important microorganism and various industrial production
- To understand the various downstream processing methods and production of industrially significant products in fermentation.
- Acquired knowledge about immobilization methods
- Acquired knowledge about various techniques
  1. Isolation of industrially important microorganisms.
  2. Selective isolation of actinomycetes –study their growth characteristics.
  3. Isolation and enumeration of lactic acid bacteria.
  4. Ethanol production by yeast.
  5. Estimation of alcohol content by colorimetric method and GLC.
  6. Wine production by yeast–setting up a lab experiment.
  7. Wine production by various methods.
  8. Enzyme production–amylase production.
  9. Enzyme production–Protease production.
  10. Biopolymer production
  11. Biofilm production
  12. Production of organic acids-Citric acid production by solid state fermentation.
  13. Antibiotic production by different strains of microbes(Theory).
  14. Test for sensitivity of microorganisms.
  15. Down stream processes of enzymes–dialysis.
  16. Immobilization of yeast cell by alginate beads
  17. Isolation & identification microbes from spoiled food.
  18. Production of yogurt, butter.
  19. Visit to Distillery unit; alcohol production and pharmacological industries. Pasteur Institute (Field

Visit)

Total Number of Topics	Local	Regional	National	Global	Category Based on %
19	3	3	10	3	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

## References

1. E.Mans,E.M.T.andC.F.A.Bryce,Taylorand Francis,UK.2002.FermentationtechnologyandBiotechnology.
2. Ghose,T.KandP.Ghose. 2003.Biotechnologyin India.SpringerPublishers,India.
3. Glazer,A.NandH.Nikaido.1995.MicrobialBiotechnology. W.H.FreemanandCo.,NewYork.
4. Stanbury,P.F.,A.WhitakerandS.J.Hall.1995.PrinciplesoffermentationTechnology, Pergamon,UK.
5. Wolf.Cruzer andAnnaliseCruzer.2000.BiotechnologyTextBookofIndustrialMicrobiology.Panima PublishingHouse,NewDelhi.
7. Patel,A.H.2001.IndustrialMicrobiology.MacmillanIndiaLtd.

## RelationshipMatrixforCOs, POsandPSOs

Semester	Code	TitleoftheCourse					Hours	Credits			
VI	22UBT6CP6	MicrobialBiotechnology-Lab					5	4			
CourseO utcomes (COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO2	✓		✓	✓	✓	✓	✓		✓	✓	
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓	✓		✓	✓	

<b>CO5</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
NumberofMatches(ℓ)=46Relationship:VeryHigh										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	VeryPoor	Poor	Moderate	High	VeryHigh

## SEMESTER-VI

**Course Code:22UBT6MBE2:1**  
**InstructionHours: 6**  
**Credits:5**

**ExamHours:3**  
**InternalMarks:25**  
**ExternalMarks: 75**

### MAJORBASEDELECTIVE- II FOOD TECHNOLOGY

#### Courseoutcomes

- To gain knowledge on the basic principles of food processing and the various methods used to process foods
- To be aware of the processed food products available in the market.
- To know about Foodborne diseases.
- To help the students to understand about the industrial food process and consumer safety
- To understand the basic principles of processing and the unit operation employed in a food processing plant.

#### UNIT-I

Introduction to Food Biotechnology-Microorganisms associated with food, bacteria, fungi and yeast- Principle of Fermentation process-Enzymes in food preparation-Food contaminations - Food preservation -Food carcinogens & mutagen-N nitrosamines, Acrylamide - their mode of action- Application in Food Industries, Pharmaceuticals, Agriculture, and Waste Utilisation-Food colours-Natural and artificial food colours-Effects of food colours.

#### UNIT-II

Food processing and preservation-Food borne diseases-Food Allergens-Antioxidants-Food colors (natural & artificial food colourants)- Food flavoring agents- Properties & function of Emulsifiers & Stabilizers in food- Food Sweeteners, Saccharine, Acesulfane, Aspartame & Sucrose.

#### UNIT-III

Production of food products , Bread, Dairy, Confectionery and Beverages -General principle,

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plant design, construction, functionality of building, Plant layout- Pest proofing/ fumigation methods- Water supply to food processing unit.

**UNIT- IV**

Food engineering operations -Characteristics of food raw materials, preparative operations in food industry, cleaning of food raw materials, sorting of foods, grading of foods- Sensory evaluation of food quality- quality factors for consumer safety. FSSA, HACCPFD- Food waste management-

**UNIT-V**

Cleaning and sanitation of process plants- Classification & Characterization of waste from food industry- Treatment methods for solid & liquid waste- Genetically Modified Food ,Bovine somatotropin, alpha lactalbumin& lactoferrin in milk- Edible vaccine (Cholera vaccine , potatoes & Hepatitis B vaccine & maize).

Total Number of Topics	Local	Regional	National	Global	Category Based on %
34	11	6	26	12	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

**Text Books**

1. B.Siva2011.FoodProcessing&Preservation–PHILearningPvtLtd.

**References**

1. D.G. Rao,2010.FundamentalsofFoodEngineering –PHI LearningPvtLtd.
2. Narang,FoodMicrobiology.
3. MichaelP.Doyle,Larry.R.FoodMicrobiology –Fundamentals&Frontiers
4. Frazier,FoodMicrobiology.
5. YiuHui&G.Khachatourians,FoodBiotechnology.
6. Ibek,Laramie&Bhunia, FundamentalsofFoodMicrobiology,CRCPress.

RelationshipMatrixforCOs, POsandPSOs

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Semester	Code	TitleoftheCourse					Hours	Credits			
VI	22UBT6MBE2:1	Foodtechnology					6	5			
Course Outcomes (COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓		✓	✓	✓		✓	✓	✓	
CO2	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO4	✓		✓	✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓		✓	✓	✓	✓	✓	
NumberofMatches(ℓ)=45		Relationship:VeryHigh									

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	VeryPoor	Poor	Moderate	High	VeryHigh

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## SEMESTER-VI

**Course Code:22UBT6MBE2:2**  
**InstructionHours: 6**  
**Credits:5**

**ExamHours:3**  
**InternalMarks: 25**  
**ExternalMarks: 75**

### MAJORBASEDELECTIVE- II

#### ENZYME TECHNOLOGY

##### Courseoutcomes

- Acquiretheknowledgeabouthistory,classification,purificationandseparationofenzymes
- Describethemechanismofenzymeactionandconstructtheknowledgeonenzymeregulation.
- To enable the learner to realize the importance of enzymes in daily life, the properties ofenzymes, the use of enzymes in industry, research and human health, and methods for thediscoveryofnovelenzymes willbethoroughlyexplored
- Tocreateabasicunderstandingoftheimportanceofenzymesascellularcatalysts.
- Appraiseaboutthetechniquesofimmobilizationandapplicationinenzymes inindustries.

##### UNIT- I Enzyme Introduction

Enzyme Introduction-Classification, nomenclature & general properties-factors, affecting enzyme action pH, Temp, ions, substrate concentration, enzyme concentration - inhibitors, extraction, assay and purification of enzymes -units of activity and kinetics of enzyme catalysed reactions-The transition state-Factors affecting enzyme activity-Evolution of enzymes.

##### UNIT-II Steady statekinetics

Steady state kinetics-Bi substrate and multi substrate reaction - enzyme catalyzed Reaction –different types of inhibitors and activators-Michaelis Menton (MM equations) line weaver and burke equation,  $k_m$ ,  $k_{cat}$  and  $k_i$  value, enzyme specificity-absolute and rigid Specificity-nucleophilic and electrophilic attack.

##### UNIT-III Role of coenzyme in enzyme catalysis

Role of coenzyme in enzyme catalysis - Coenzyme regeneration, mechanism of enzyme action, e.g.Lysozyme, chymotrypsin, DNA polymerase, ribonuclease, LDH and Zymogen -Enzyme activation - allosteric enzymes and metabolic regulations -Clinical and industrial uses of enzymes.

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UNIT-IV Techniques of enzyme immobilization and their applications

Techniques of enzyme immobilization and their applications - Medical, food, leather, Textile and paper industries -Enzyme Engineering- Biosensors-types and its application.

UNIT- V Industrial utilization of enzymes

Industrial utilization of enzymes- Applications of industrial enzymes- Enzyme production mechanism- Use of soluble enzymes-enzyme reactors, membrane reactors, continuous flow - packed bed reactors- large scale application of microbial enzymes in food and allied industries -Enzyme therapy.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
31	9	6	12	18	Global

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. RenugaHarekrishnanBiomoleculesandEnzymes,
2. ThomasMDevlin.TextbookofBiochemistrywithClinicalCorrelations,7thedition,Wileypublis her.2010.
3. AlbertLLehninger, DavidLNelsonandMichaelMCox.  
LehningerPrinciplesofBiochemistry,2ndedition,Wileypublisher.2010.
4. SathanarayanaUandChakrapaniU.Biochemistry,4thedition,Elsevierpublishers. 2013.

### References

1. Blazej,a.&Zemek,j.1987.InterBiotech,87,Enzymetechnologies,Elsevier.
2. Murraymoo-  
Young.1988.Bioreactorimmobilizedenzymeandcells.Fundamentalsandapplications,elseyl er,appliedscience.
3. Rehm,h.jandYeed,g.1988.Biotechnology,Vol.7a,Enzymetechnology,Elsevier.
4. William,b.Jakoby,1984.MethodsinEnzymology,vol.104,enzyme purificationandrelatedtechni ques.

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5. Charlotte W Pratt and Kathleen Comely. Essential Biochemistry, 3rd edition Wiley publisher. 2013.
6. Deb AC. Fundamentals of Biochemistry, 10th edition, New Central Book Agency (p) Ltd, London. 2011.
7. Rajagopal G. Concise text book of Biochemistry, 2nd edition, Ahuja Publishing House. 2010.
8. Reginald H Garrett and Charles M Grisham, 5th edition. Biochemistry, Brooks Cole publishers. 2012.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
VI	22UBT6MBE2:2	Enzyme technology					6	5			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓		✓	✓	✓	✓		✓	✓	✓	
CO2	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO3	✓		✓	✓	✓	✓	✓	✓		✓	
CO4	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches (I)=44		Relationship: High									

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

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## SEMESTER-VI

**Course Code:22UBT6MBE2:3**  
**InstructionHours: 6**  
**Credits:5**

**ExamHours:3**  
**InternalMarks: 25**  
**ExternalMarks: 75**

### **MAJOR BASED ELECTIVE -II** **BIODIVERSITY AND CONSERVATION**

#### **Courseoutcomes**

- Toacquireknowledgewithrespecttobiodiversity,its threatsanditsconservationandappreciatethe conceptofinterdependence.
- Tobeawareofthenationalandinternationalconcernforprotectingtheenvironment.
- Toobservetheorganization,functionalmorphologyanddiversityofrepresentativePlant andanimal.
- Tostudythefundamentalknowledgeaboutendangeredplantand animals
- Improvethenewdiscoveryandcommercializationofnewproductsbasedonbiologicalresources.

#### UNIT-I Biodiversity

Biodiversity, **Definition**, Types-Diversity of Genes (genetic diversity) species (species diversity) and ecosystems (ecosystem diversity) - Genetic diversity, Nature and origin of genetic variation - The need for preservation of wild relatives of domestic animals - Centres of origin of domesticated animals - Species diversity- Measurement, concepts, richness and turn over - Species-area relationships - Global distribution of richness -Centres of species diversity - Mega diversity centres - Hot spot analysis.

#### UNIT-II Loss of biodiversity

Ecosystem service - Measuring biodiversity - The holocene extinction -Loss of biodiversity-Species extinction-Fundamental causes- Deterministic and stochastic processes - Current and future extinction rates -Methods of estimating loss of biodiversity - Threatened species -The IUCN threat categories (Extinct, Endangered, Vulnerable, Rare, Intermediate, and Insufficiently known), The threat factors (Habitat loss, Over exploitation for uses, introduction of exotics, Diseases Habitat fragmentation etc.), Common threat animal taxa of India-Red data books.

#### UNIT-III Uses and values of Biodiversity

Uses and values of Biodiversity-Uses of bio resources- animal uses; food animals (terrestrial and aquatic)- non food uses of animals, domestic livestock, Values of Biodiversity - Instrumental (Goods, Services, Information and Psycho spiritual values), inherent or intrinsic values, ethical and aesthetic values -An outline account on methods of valuing biodiversity.

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## UNIT-IV Conservation and sustainable management

Conservation and sustainable management of Biodiversity and Bioresources-National policies and instrument relating the production of the wild / domesticated fauna as well as habitats-International policies and Instruments - A general account on multilateral treaties-the role of CBD, IUCN, IBPGR, NBPGR, WWF, FAO, UNESCO AND CITES -Bioresources - Biotechnology and intellectual Property Rights - An elementary account on WTO, GATT and TRIPs, Bioprospecting and IKS-Bio privacy rights of farmers, breeders and indigenous people - An elementary account on biodiversity/ bio resources data.

## UNIT-V Conservation of biodiversity

Conservation of biodiversity, Current practices in conservation-Habitat ecosystem approaches-Biodiversity research- Species protection areas in india and global-Species based approaches, Social approaches, Chipkomovement- *In situ*(Afforestation, Social forestry, Agro forestry, Zoos, Biosphere reserves, National parks, Sanctuaries), *exsitu*(Cryopreservation, Genebanks, Sperm banks, DNA banks, Tissue culture and Biotechnological strategies )-Ecorestoration, environmental and biodiversity laws, environmental education.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
57	9	12	25	11	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. Gaston, K.J. 1996. Biodiversity: Biology of numbers and Difference. Blackwell

### References

1. Primack, R. B. 1993. Essentials of Conservation Biology, Sinauer Associates, USA

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2. Meffe, G.K. and C.R. Carroll. 1994. Principles of Conservation Biology, Sinauer Associates, USA.
3. Groombridge, B. 1992. Global Biodiversity: Status of the Earth's Living Resources. Chapman and Hall, London.
4. Mittermeier, R.A., Meyers, P.R. Gil and C. G. Mittermeier 2000. Hotspots: Earth
5. Biologically richest and most endangered Terrestrial Ecoregions. Cemex/Conservation International, USA.
6. Soule, M.E. 1986. Conservation Biology: The Science of Scarcity and Diversity, Sinauer Associates Inc., USA.
7. Reaka-Kudla, M.L., D. E. Wilson and E.O. Wilson 1997. Biodiversity II: Understanding and Protecting our Biological Resources. Joseph Henry Press, Washington, DC.
8. Clark, T.W., R.P. Reading and A.L. Clarke 1994. Endangered Species Recovery: Finding the Lessons, Improving the process. Island Press, Washington, DC.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
VI	22UBT6MBE2:3	Biodiversity and conservation					6	5			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓		✓	✓	✓	✓	✓	✓	✓	
CO3	✓	✓	✓		✓	✓	✓	✓	✓		
CO4	✓		✓	✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches (M) = 46		Relationship: Very High									

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

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## SEMESTER-VI

**Course Code:22UBT6MBE3:1**  
**InstructionHours: 6**  
**Credits:5**

**ExamHours:3**  
**InternalMarks: 25**  
**ExternalMarks: 75**

### MAJOR BASED ELECTIVE -II ENVIRONMENTAL BIOTECHNOLOGY

#### Courseoutcomes

- To understand the treatment of wastewater and solid waste management.
- To acquire knowledge about environmental pollution- sources, effects and control measures of environmental pollution.
- To know the basic concept and issues of environmental pollution biotechnological treatment to clean up polluted environments and to create valuable resources for the human society.
- To gain knowledge on the importance of environmental education and ecosystem.
- To be aware of the national and international concern for protecting the environment.

#### UNIT-I

Basic components of environment, Definition, concept and scope of ecosystem, abiotic and biotic components- Basic Concepts, Interactions between environment and biota- Concept of habitat and ecological niches- Limiting factor; Ecosystem dynamics and management: Stability and complexity of ecosystem-Energy flow, food chain, food web and trophic level- Ecological pyramids, Population ecology - recycling, biotic community - concept, structure, dominance, fluctuation and succession; N.P.C and S cycles in nature.- Population ecology - community structure - Principles of conservation; Speciation and extinctions Conservation strategies; sustainable development. - Environmental impact assessment

#### UNIT-II

Environmental Pollution - Effects and control of Water pollution- Water Pollution: Sources of pollution. Industrial effluents, Domestic wastes, Agrochemical, Heavy metals - Bhopal disaster, Chernobyl tragedy-Water pollution analysis and monitoring - prevention and control of water pollution- Soil pollution, sources, effects and its control- Air pollution, sources, air pollutants, effects and control measures- Ozone depletion and global warming- Air pollution analysis and monitoring- Noise

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pollution, Radioactive pollution- Thermal pollution and their Sources, effects, prevention and control measures.

### UNIT-III

Bioremediation and Bio leaching,-Types of bioremediation-Environmental impact of pollution and measurement methods-Microbial bioremediation of oil spills and toxic metal ions- Phytoremediation-Microbial leaching of ores, direct and indirect mechanisms- Genetic Engineering in Environmental Biotechnology-Oil spills-Superbug- Role of Genetically engineered microorganisms in environment. Waste water treatment-sewage treatment and common industrial effluent treatment; Concepts of bioremediation (in situ and ex situ), Bioremediation of toxic metal ions - biosorption and bioaccumulation principles, Concepts of phytoremediation. Microbial biotransformation of pesticides and xenobiotics; Microbial leaching of ores - direct and indirect mechanisms.

### UNIT-IV

Biomass energy , Biomass waste as renewable source of energy- Conversion of Solid Waste to Methane (Biogas production)- solid waste management and Industrial waste water management-Management of Sludge and Solid waste treatment -Land filling, Composting and Vermi Composting.

### UNIT-V

Biodiversity Definition, Types- Diversity of Genes (genetic diversity) species (speciesdiversity) and ecosystems (ecosystem diversity)- Conservation of biodiversity, Current practicesin conservation.- Biodiversity reserve - *In situ* (Afforestation, Social forestry, Agro forestry, Zoos, Biosphere reserves, National parks, Sanctuaries)-*ex situ* (Cryopreservation, Gene banks, Sperm banks, DNA banks,Tissue culture and Biotechnological strategies)- Eco restoration, environmental and biodiversity laws, environmental education.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
48	16	28	16	25	Regional

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

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### Text Books

1. JogdandSN.EnvironmentalBiotechnology.2010.HimalayaPublishingHouse.NewDelhi.
2. Gaston, K.J.1996.Biodiversity:BiologynumbersandDifference. Blackwell.
3. Prescott,Harley,Klein.2003.Microbiology.5thEdition.McGrawHillPublication.

### References

1. AlanScragg.1999.EnvironmentalBiotechnology.PearsonEducationLimited,England.
2. Jogdand,S.N.1995.EnvironmentalBiotechnology.HimalayaPublishingHouse,Bombay.
3. Chatterji AK. Introduction to Environmental Biotechnology. Prentice-Hall of IndiaPrivate Limited.2005.
4. Primack,R. B.1993.EssentialsofConservationBiology, SinauerAssociates,USA
5. Reaka-Kudla,M.L.,D.E.WilsonandE.O.Wilson1997.BiodiversityII:Understandingand

### RelationshipMatrixforCOs, POsandPSOs

Semester	Code	TitleoftheCourse					Hours	Credits				
VI	22UBT6MBE3:1	EnvironmentalBiotechnology					6	5				
Course Outcomes (COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
CO2	✓	✓		✓	✓	✓	✓	✓	✓	✓		
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓		
CO4	✓	✓	✓	✓		✓	✓	✓		✓		
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
NumberofMatches(ℓ)=46		Relationship:VeryHigh										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	VeryPoor	Poor	Moderate	High	VeryHigh

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## SEMESTER-VI

Course Code:22UBT6MBE3:3  
InstructionHours: 6  
Credits:5

ExamHours:3  
InternalMarks: 25  
ExternalMarks: 75

### MAJOR BASED ELECTIVE-III STEM CELL BIOLOGY

#### Courseoutcomes

- To strengthen the knowledge of students on Stem cell basics and their applications for the benefit of mankind
- To acquire knowledge about Embryonic Stem Cells and Adult stem cell
- To impart knowledge about stem cell culturing and stem cell signaling
- To know about Stem cell policy, ethics and stem cell research.
- To acquire knowledge about Gene therapy

#### UNIT-I Stem Cells

Introduction- Tissue organization - Stem cells Sources - Unique properties of stem cells classification - Embryonic stem cells adult stem cells - Prenatal stem cells-Induced pluripotent stem cells - similarities and differences between adult and embryonic stem cells -Functional characterization - Stem cell preservation methods.

#### UNIT- II Embryonic Stem Cells

Stem cells and their developmental potential - In vitro fertilization, culturing of embryos - Recent trends in stem cell development - Blastocyst inner cell mass-isolation and growing ES cells in lab, Identification - characterization of human ES cells- Cloning and controlled differentiation of human embryonic stem cells- Applications of Embryonic stem cells -Gene knock in, Gene knock out, Ethical issues.

#### UNIT-III Adult Stem Cells

Somatic stem cells -test for identification of adult stem cells, adult stem cell differentiation - transdifferentiation plasticity- different types of adult stem cells- liver stem cells - skeletal muscle stem cells -bone marrow derived stem cells- Stem cell specific transcription factors- Induced pluripotent cells.

#### UNIT-IV Cancer Stem Cell Signaling

**Introduction:** Tumor stem cells, Breast Cancer Stem Cells- Identification, Signaling pathways -Notch signaling- Wnt signaling in stem cells, cancer cells.

UNIT-V Stem Cells In Tissue Engineering

Introduction -Biomaterials -Cell and biomaterial interactions –Haematopoietic Stem Cells, Mesenchymal stem cells - Bone tissue engineering-Cartilage tissue engineering, Cardiovascular tissue engineering, Neural tissue engineering- Therapeutic applications.

<b>Total Number of Topics</b>	<b>Local</b>	<b>Regional</b>	<b>National</b>	<b>Global</b>	<b>Category Based on %</b>
48	20	11	11	6	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

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**M.Sc BIOTECHNOLOGY**

**Course Structure and Syllabus**

(For the candidates admitted from the academic year 2022-2023 onwards)

**CHOICE BASED CREDIT SYSTEM (CBCS)**



**THANTHAI HANS ROEVER COLLEGE(AUTONOMOUS)**

**(Approved by NAAC, Affiliated to Bharathidasan University)**

**ELAMBALUR, PERAMBALUR – 621 220**





## M.Sc., BIOTECHNOLOGY–Course Structure Under CBCS



(For the candidates admitted from the academic year 2022-2023 onwards)

Semester	Course Code	Title of the Course	Ins. Hours/ Weeks	Credits	Exam Hours	CIA (Max)	ESE (Max)	Total (Max)
1	22PBT1CC1	Cell and Molecular biology	6	5	3	25	75	100
1	22PBT1CC2	General Microbiology	6	5	3	25	75	100
1	22P BT1CCC1:1 22P BT1CCC1:2	1. General Biochemistry (Or) 2. Enzyme technology	6	5	3	25	75	100
1	22PBT1CP1	Cell Biology, Microbiology, Biochemistry & Molecular Biology (P)	6	3	6	40	60	100
1	22PBT1EC1:1 22PBT1EC1:2	1.Nanobiotechnology(Or) 2. Cancer biology	6	4	3	25	75	100
	22VABT1:1 22VABT1:2	1. Biofertilizer (Or) 2. Phytochemicals and Herbal Medicine	-	2*	3	25	75	100*
<b>Total</b>			<b>30</b>	<b>22</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>500</b>
2	22PBT2CC3	rDNA Technology	6	5	3	25	75	100
2	22PBT2CC4	Immuno technology	5	5	3	25	75	100
2	22PBT2CCC2:1 22PBT2CCC2:2	1.BioInformatics& Biostatistics (Or) 2. Genomics and Proteomics	5	5	3	25	75	100
2	22PBT2CP2	rDNA Technology & Immuno technology (P)	6	3	6	40	60	100
2	22PBT2EC2:1 22PBT2EC2:2	1. IPR,Biosaftey and Bioethics (Or) 2. Pharmaceutical Biotechnology	5	4	3	25	75	100
	22PBT2NME1:1 22PBT2NME1:2	1. MushroomTechnology (Or) 2. Vermicomposting	3	2	3	25	75	100

		technology						
	22PBT2OC	SWAYAM/NPTEL Online Course		2**				
<b>Total</b>			<b>30</b>	<b>24</b>	-	-	-	<b>500</b>
3	22PBT3CC5	Plant Biotechnology	6	5	3	25	75	100
3	22PBT3CC6	Animal Biotechnology	6	5	3	25	75	100
3	22PBT3CCC3:1 22PBT3CCC3:2	1.EnvironmentalBiotechnology (Or) 2. Marine Biotechnology	6	5	3	25	75	100
3	22PBT3CP3	Plant and Animal Biotechnology (P)	6	3	6	40	60	100
3	22PBT3EC3:1 22PBT3EC3:2	1. Stem Cell Basics and Application (Or) 2. Developmental Biology	6	4	3	25	75	100
	22VABT2:1 22VABT2:2	1. Food and Nutrition (Or) 2. Quality Control and Hygienic Practices	-	2*	3	25	75	100*
<b>Total</b>			<b>30</b>	<b>22</b>	-	-	-	<b>500</b>
4	22PBT4CC7	Bioprocess Technology	6	5	3	25	75	100
4	22PBT4CC8	Food Biotechnology	6	5	3	25	75	100
4	22PBT4E/ 22PBT4IBC	Biotechnology for Entrepreneurs	6	5	3	25	75	100
4	22PBT4NME2:1 22PBT4NME2:2	1.Forensic Science (Or) 2. Human Anatomy and Physiology	3	2	3	25	75	100
4	22PBT4PW	Project Work	9	5	3	Evaluation-80 Viva-Voce-20	100	
<b>Total</b>			<b>30</b>	<b>22</b>	-	-	-	<b>600</b>
<b>Grand Total</b>			<b>120</b>	<b>90</b>	-	-	-	<b>2100</b>

**Note:**

Project : 100 Marks  
Dissertation : 80 Marks  
Viva Voce : 20 Marks

Core Papers - 10  
Core Practical - 4  
Elective Papers - 5  
Project - 1

1. Theory Internal 25 marks External 75 marks
2. Practical " 40 marks " 60 marks
3. Separate passing minimum is prescribed for Internal and External
  - a) The passing minimum for CIA shall be 40% out of 25 marks (i.e. 10 marks)
  - b) The passing minimum for University Examinations shall be 40% out of 75 marks (i.e. 50 marks)
  - c) The passing minimum not less than 50% in the aggregate.

**PROJECT WORK**

**Objectives**

The student can get the knowledge to prepare the document, to implement tools for the specific problem and learn the industrial need programs for their placement.

S.No.	Work Description	Maximum Marks
1	Dissertation	80
2	Viva voce	20
<b>Total</b>		<b>100</b>

**Note:**

**PASSING MINIMUM – 50 MARKS**

**I Review –December last week**

- Confirmation letter from the company
- Project type & title
- Company profile
- Synopsis
- Contact number &mail d of the external guide
- S/w selection

**II Review – January3<sup>rd</sup> week**

- Data or System flow diagram
- Documentation of first three chapters

- Database design
- Input design – Forms
- Output design – Reports

### **III Review – February 3<sup>rd</sup> week**

- Complete coding
- Test plan with demo
- Rough documentation of the entire project

### **IV Review – March 1<sup>st</sup> week**

- Corrected rough draft
- Explanation of the entire project
- Execution of Implementation Work

- Attending all the review is compulsory
- PPT and necessary Documentation should be brought for each Review
- Font size in documentation has to be 12, Times New Roman, Space 1.5
- Document should be neatly aligned and justified
- No change can be made in the review marks later
- Internal mark will be submitted at the same day of review to controller section.

## **THANTHAI HANS ROEVER COLLEGE (Autonomous)**

### **Programme Outcomes (POs)**

#### **Postgraduate Programmes**

Upon completion of the programme, the postgraduate will be able to

1. Gain advanced knowledge resulting in entrepreneurship; innovation and newer opportunities for being employable in public and private sectors, research and development organizations
2. Apply enhanced new techniques and adopt new technologies needed in the respective disciplines
3. Appreciate the diversity of behaviour in professional practice and act in accordance with the core values of chosen profession.
4. Demonstrate the knowledge, values and skills to be critical consumer of research practice and possess investigative skills to evaluate the practice
5. Engage in lifelong learning process, have the ability to communicate the findings of Languages Commerce Management Studies Social Work/Computing Sciences/Physical Sciences/Biological Sciences/Life Sciences with the current knowledge

#### **M.Sc., Biotechnology - Programme Specific Outcomes (PSO's)**

1. Basics and current updates in the areas of Biochemistry, Molecular biology, Plant tissue culture, Genetic Engineering, Bioinformatics rDNA, Industrial Biotechnology, Fermentation Technology, Agriculture

&Environmental Biotechnology are included to train the students and also sensitize them to scope for research.

2. The Masters in Biotechnology Programme will address the increasing need for skilled scientific manpower with an understanding of research ethics involving animals and humans to contribute to application, advancement, and impartment of knowledge in the field of biotechnology globally.

3. An ability to conduct experiments, as well as to analyze data, understood the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life.

4. An ability to acquire the skills in handling scientific instruments, planning and performing in laboratory experiments to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability in biotechnology.

5. Graduates will exhibit contemporary knowledge in Biotechnology and will be eligible for doing jobs in pharmaceutical and biotechnological Industry and also graduates who attain professional leadership role.

## SEMESTER 1

Course Code: 22PBT1CC1  
Instruction Hours: 6  
Credits: 5

Exam Hours: 3  
Internal Marks: 25  
External Marks: 75

### CORE COURSE –1 CELL AND MOLECULAR BIOLOGY

#### Objective

- To study about cell, its types, cellular organelles and their functions.
- To study about the chromosomes, genes and their functions.
- To study about the central dogma of molecular biology.

#### Course outcomes

- Extend the knowledge of the structure and functions of genetic materials.
- Focus on genome organization, transcription and translation process in prokaryotes.
- Acquire elaborate knowledge on nucleic acids and replication.
- Illustrate the reactions that comprise energy metabolism.
- Acquired knowledge of gene, their expression and regulation of expression.

#### UNIT- I CELL STRUCTURE

Prokaryotic and eukaryotic cell- Difference between plant and animal cell- Chemical Composition of Membranes- Membrane Lipids, the Asymmetry of Membrane Lipids- Membrane Carbohydrate- Structure and Functions of Membrane Proteins, Integral Membrane Proteins, Peripheral Membrane Proteins, Lipid-Anchored Membrane Proteins- Membrane Lipids and Membrane Fluidity; Importance of Membrane Fluidity, Maintaining Membrane Fluidity, Lipid Rafts- Movement of Substances across Cell Membranes; the Energetic of Solute Movement, Diffusion of Substances through Membranes, Facilitated Diffusion, Active Transport.

#### UNIT- II STRUCTURE AND FUNCTIONS OF CELL ORGANELLE

Mitochondria: structure, origin and evolution, organization of respiratory chain complexes, Mitochondrial Genome- Structure and function of peroxisome- Structure and function of micro bodies, Golgi apparatus, lysosomes and Endoplasmic reticulum- Overview of cellular cytoskeleton- Organization and role of microtubules and microfilaments, Intermediate filaments, Cellular motility, Molecular motors- Nucleus: structure and function of nuclear envelope, lamina and nucleolus; Chromatin organization and packaging.

#### UNIT -III NUCLEIC ACIDS, DNA REPLICATION AND DNA REPAIR:

DNA structure, different forms- RNA structure, classes and functions- Models of DNA replication: Semi conservative DNA replication, semi discontinuous DNA Replication, unidirectional and bidirectional DNA replication- Mechanism of DNA replication in prokaryotes, DNA replication in eukaryotes- The structure and functions of DNA polymerase, Replication in Eukaryotic cells- DNA Repair: Nucleotide excision repair, Base excision repair, Mismatch repair, Double strand Breakage Repair- Recombination: double strand break model or recombination.

## UNIT -IV GENE EXPRESSION: TRANSCRIPTION AND TRANSLATION:

**Transcription** –Codon and Anticodon -Prokaryotic transcription, transcription unit, promoters constitutive and inducible, operators and regulatory elements, Initiation,elongation,termination-Rho-dependent and independent and antitermination- Posttranscriptional modifications –Processing of hnRNA,tRNA, rRNA,5' cap formation, 3' end processing and polyadenylation -Splicing, RNA editing-nuclear export of mRNA – mRNA stability and catalytic RNA -**Translation:** Translation machinery, ribosomes, composition and assembly -Universal genetic code, degeneracy of codons and termination codons –isoaccepting tRNA and Wobble hypothesis –Mechanism of initiation, elongation and termination -Co and post translational modifications –Transport of proteins and molecular chaperones -Protein stability, protein turn over and degradation.

## UNIT -V REGULATION OF GENE EXPRESSION AND MUTATION:

Operon systems: Lactose operon - induction & repression. Tryptophan operon - Repression & attenuation, Arabinose operon. Mutation -Types - Non sense mutation, missense mutation and point mutations-intragenic and intergenic suppression and frame shift mutations -Physical, chemical and biological mutagens -Transposition, mechanisms of transposition and role of transposons in mutation -Gene as unit of mutation and recombination -Molecular nature of mutation -mutagen and origin of spontaneous mutations - Gene transfer mechanisms -transformation, transduction, conjugation, transfection and their applications.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
52	21	23	11	11	Regional

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### TEXT BOOKS

1. Ajoy Paul. 2011. Textbook of Cell and Molecular Biology. Books and Allied Ltd.
2. Benjamin Lewin. 2007. Gene IX. 9th Edition, Jones and Barlett Publishers.
3. J.D.Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner. 2007. Molecular Biology of the Gene. 6th Edition. Benjamin Cummings Publishing Company Inc.

### REFERENCES:

1. Freifelder D.2004. Molecular Biology, Narosa Publishing House. New Delhi.
2. Lewin B. 2018. Genes XII. Oxford University Press, London.

3. Karp, G., Iwasa, J., & Marshall, W. (2018). Karp's Cell Biology. John Wiley & Sons.
4. Alberts, B., Bray, D., Hopkin, K., Johnson, A. D., Lewis, J., Raff, M., & Walter, P. (2019). Essential cell biology. Fifth edition, Garland Science.
6. Lodish, H., Berk, A., Kaiser, C. A., Kaiser, C., Krieger, M., Scott, M. P.0 &
7. Matsudaira, P. (2008). Molecular cell biology. Macmillan.
8. Thomas D. Pollard & William C. Earnshaw & Graham T. Johnson. 2016. Cell
9. Biology. 3rd Edition. Elsevier Health Sciences.
10. Blackburn GM and Gait MJ. 2022. Nucleic Acids in Chemistry and Biology 4th
11. edition. Oxford University Press.

**Web source**

1. <https://geneticcertificate.stanford.edu/courses/genetic-engineering-and-biotechnology>
2. [https://study.com/articles/Genetic\\_Engineering\\_Courses\\_and\\_Classes\\_Overview.html](https://study.com/articles/Genetic_Engineering_Courses_and_Classes_Overview.html)
3. <https://www.edx.org/learn/genetic-engineering>
4. [https://nptel.ac.in/content/syllabus\\_pdf/102103013.pdf](https://nptel.ac.in/content/syllabus_pdf/102103013.pdf)

**Relationship Matrix for COs, POs and PSOs**

Semester	Code	Title of the Course					Hours	Credits			
I	22PBT1CC1	Cell and Molecular Biology					6	5			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO2	✓	✓	✓	✓	✓	✓	✓		✓	✓	
CO3	✓		✓	✓	✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓		✓	✓	✓		✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches(✓) = 46 Relationship: Very High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

## SEMESTER 1

Course Code: 22PBT1CC1  
Instruction Hours: 6  
Credits: 5

Exam Hours: 3  
Internal Marks: 25  
External Marks: 75

### CORE COURSE –II GENERAL MICROBIOLOGY

#### OBJECTIVES

- To acquire knowledge about aseptic techniques.
- To comprehend the various methods for identification of unknown microorganisms.

#### COURSE OUTCOMES

- To enable the students to understand the basic knowledge in Microbiology
- Receive a fundamental knowledge on morphology and functions of microbes
- To impart the knowledge on microbial classification and taxonomy
- Imparting ideas on cultivation methods of microbes
- Obtaining knowledge about preservation methods of microbes

#### UNIT- I Ultrastructure and function

Bacteria: Morphological types - cell wall – cell walls of Gram negative, Gram positive, halophiles L-forms -Bacterial virulent enzymes -Archaeobacteria, Cell wall synthesis, cell membrane, capsule type's composition and function - Structure and function of flagella, fimbriae and pili, gas vesicles, chlorosomes, carboxysomes, magnetosomes and phycobilisomes - Reserve food materials polyhydroxy butyrate, polyphosphates, cyanophycin and sulphur inclusions. Nuclear material - bacterial chromosomes and bacterial plasmids.

#### UNIT-II Microbial Classification

Microbial Taxonomy-Definition and systematics - Nomenclature and identification .Haeckel's three kingdom classification - Whittaker's five kingdom approach - Three domain classification; Taxon, species, strain, type culture - Major characteristics used in taxonomy - morphological, physiological, metabolic, serological and molecular - Phylogenetic relationships - Cladogram, Dendrogram; Classification and salient features of bacteria according to Bergey's Manual of Determinative Bacteriology(9th edition).

UNIT- III Fungi and Viruses:Fungi: Classification of fungi based on Alexopoulos system.

Characteristics of Fungi - Filamentous, non filamentous and dimorphic fungi - Morphology, structure and life cycle of *Aspergillus niger* and *Saccharomyces cerevisiae* - Parasitism, mutualism and symbiosis with plants and animals - Industrial uses of yeast and moulds - Viruses: ICTV system of classification, General properties, Morphology and ultra-structure of virus -capsid and their arrangements - types of envelopes and their composition - viral culture method- Antiviral treatment-

viral genome(RNA,DNA);Viroids, Prions - structure and importance- Black fungus-Mucormycosis ,Pathogenesis- SARS virus with special reference to Covid 19, Omicron and Delmicron

### UNIT- IV Algae and Protozoans

Classification of Algae based on Fritsch system - General characters of Blue green Algae (Cyanobacteria) Macroalgae – Biological and Economic importance of algae. Protozoa - structural characteristics, classification and reproduction-General characteristics of microalgae - Habit, Habitat, Biological and Economic importance of microalgae- Morphology, structure, life cycle of Chlorella and Dunaliella.

### UNIT-V Cultivation methods of microbes

Isolation of different types of bacteria - Fungi , Actinomycetes ,Cyanobacteria – Protozoa - Physical and Chemical requirements for growth - Pure culture methods - Anaerobic culture techniques - Preservation methods of microbes - Type of culture collections - Physical and chemical methods of controlling microorganisms.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
49	12	16	13	10	Regional

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. Alcamo E. Fundamentals of Microbiology. 6th Ed., Jones and Bartlett Publishers, New Delhi. 2001.
2. Dubey RC and Maheswari DK. A Text Book of Microbiology. S Chand, NewDelhi. 2010.
3. Dube HC. Introduction to Fungi. Vikas publishing pvt. Ltd. New Delhi 2009.
4. Johri RM, Snehlatha, Sandhya Shrama. A Textbook of Algae. Wisdom Press, New Delhi. 2010.
5. Kanika Sharma. Textbook of Microbiology – Tools and Techniques. 1st edition, Ane Books Pvt. Ltd., New Delhi. 2011.
6. Pelczar TR, Chan ECS and Kreig NR .Microbiology. 5th Edition, Tata McGraw – Hill, New Delhi.2006.

### References

- Alexopoulos CJ, Mims CW and Blackwell M. Introductory Mycology. Fifth edition John Wiley and Sons. Chichester. 2000.
- Holt JS, Kreig NR, Sneath PHA and Williams ST. Bergey's Manual of Determinative Bacteriology (9th Edition), Williams and Wilkins, Baltimore. 1994.
- Madigan MT, Martinko JM, Dunlap PV and Clark DP. Brock Biology of Microorganisms. 12th Ed. Pearson/ Prentice Hall. 2008.
- Prescott LM, Harley JP and Klein DA. Microbiology. 7th edition, McGraw Hill, New York. 2008.
- Schlegel HG. General Microbiology, Cambridge University Press, UK. 2008.

#### Web Source

- [https://webstor.srmist.edu.in/web\\_assets/downloads/2021/18BTC103J-lab-manual.pdf](https://webstor.srmist.edu.in/web_assets/downloads/2021/18BTC103J-lab-manual.pdf)

#### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
I	22PBT1CC2	General Microbiology					6	5				
Course Outcomes (COs)	Programme Outcomes(Pos)					Programme Specific Outcomes(PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		
CO1	✓	✓	✓	✓		✓	✓	✓	✓	✓		
CO2	✓	✓	✓	✓	✓	✓	✓		✓	✓		
CO3	✓		✓	✓	✓	✓	✓	✓	✓	✓		
CO4	✓	✓	✓	✓		✓	✓	✓		✓		
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Number of Matches(✓) = 45 Relationship: Very High												

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

### SEMESTER 1

**Course Code: 22PBT1CCC1**

**Instruction Hours: 5**

**Credits: 5**

**Exam Hours: 3**

**Internal Marks: 25**

**External Marks: 75**

### CORE CHOICE COURSE –I GENERAL BIOCHEMISTRY

#### Objectives

- To make the students understand the basics of biomolecules.
- To study structural and functional properties of carbohydrates, proteins, lipids and nucleic acids.
- To make the students learn the disorders of metabolic pathways.

#### Course Outcomes

- To provide the knowledge on structure and functions of the cell.
- Attaining the fundamental concepts of Carbohydrates and its Metabolism.
- To learn about the lipids and its role.
- Understanding the types and biosynthesis of Protein.
- Acquire knowledge about biosynthesis of Nucleic acids.

## UNIT-I

Cell and its function –Composition of living matter -Cell types and chemistry-Biochemistry of bacterial, animal and plant cell -Free energy and entropy- Phosphoryl group transfers and ATP- Enzymes involved in redox reactions- The electron transport chain-organization and role in electron capture-Electron transfer reactions in mitochondria- Oxidative phosphorylation- F1/F0 ATPase structure and mechanism of action-The chemiosmotic theory- Inhibitors of respiratory chain and Oxidative phosphorylation - uncouplers, ionophores- Regulation of oxidative phosphorylation.

## UNIT-II

Carbohydrate-Classification, Structure and Isomerism- Monosaccharides, Oligosaccharides, Polysaccharides- Structure and Properties- Metabolism of Carbohydrates- Glycolysis-Mechanism of pyruvate Dehydrogenase-Citric acid cycle- HMP shunt, Glucuronic acid Gluconeogenesis, Glycogenesis, Glycogenolysis, Glyoxylate cycle- Metabolic disorders associated with carbohydrate metabolism- CSDB (Carbohydrate Structure Database, Glycome DB, Calvin cycle).

## UNIT-III

Lipid classification and its role-Fattyacid types and its functions-Biosynthesis of fatty acid and its regulation, biosynthesis of triacylglycerol, phospholipids and cholesterol. Metabolism of triacylglycerol during stress.  $\alpha$ ,  $\beta$ ,  $\gamma$ , Oxidation of fatty acids- Role of carnitine cycle in the regulation of  $\beta$  -oxidation. Ketogenesis and its control. Lipoprotein types and its functions. Metabolic disorders associated with lipid metabolism, LMSD (Lipid Maps Structure Database), Lipid Bank.

## UNIT-IV

Protein classification and function-Biosynthesis of nonessential amino acids- amino acid transamination-deamination,-ammonia formation-urea cycle-Catabolism of carbon skeletons of amino acids- Protein classification, types, characteristics and structures- PDB (Protein DataBank)- Ramachandran plot- PROCHECK Solid state synthesis of peptides, Sequence determination.

## UNIT-V

Nucleic acids types and synthesis -Digestion and absorption of nucleoproteins, Fractionation, sequencing and chemical synthesis of oligo nucleotides. Metabolism of purines- de novo and salvage pathways for purine biosynthesis, regulation of biosynthesis of nucleotides-Purine catabolic pathway- Metabolism of pyrimidines - biosynthesis and catabolism- Disorders of purine and pyrimidine metabolism, intermediary metabolism and KEGG pathway.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
50	17	11	19	7	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. Jain, J.L., Jain, S and Jain, N., Fundamentals of Biochemistry, S.Chand & Company. New Delhi 2016.
2. Sathyanarayana U and Chakrapani U. Biochemistry, 4th edition, Elsevier Publishers. 2013.
3. Michael Cox., David. L. Nelson, (2004). Lehninger, Principles of Biochemistry, Kalyani Publishers, New Delhi.
4. H.S. Srivastava (2006). Elements of Biochemistry, Rastogi Publications, Meerut.
5. Biophysical chemistry – Upadhyay, Himalaya Publication, edition 3, 2005.

### References

1. Lehninger's, McMillan, Worth, Principles of Biochemistry. 7th ed, Nelson Cox.,2013.
2. David E Metzler and Carol M Metzler. Biochemistry -The chemical reactions of living cells- Vol.1and2.2nd edition. Harcourt/Academic press, Newyork. 2001.
3. Lehninger, Albert L, David L Nelson and Michael M Cox. Lehninger Principles of Biochemistry. New York: Worth Publishers. 2000.
4. Jeremy M Berg, John L Tymoczko and Lubert stryer. Biochemistry.5<sup>th</sup> edition.W.H.Freeman and company, Newyork.2002.
5. Stryer L Berg JM and Tymoczko JL. Biochemistry. 5th edition. New York:W. H. Freeman. 2002.

### Web Source

<https://www.uwyo.edu/molecbio/courses/molb-3610/files/3610%20chpts%201-2%20notes.pdf/>

### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
I	22PBT1CCC1	General Biochemistry					5	5			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO2	✓		✓	✓	✓	✓		✓	✓	✓	
CO3	✓	✓		✓	✓	✓	✓		✓	✓	
CO4	✓	✓	✓		✓	✓	✓	✓		✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches(✓) = 44 Relationship: High											

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

## SEMESTER I

**Course Code: 22PBT1CCC1:2**  
**Instruction Hours: 6**  
**Credits: 5**

**Exam Hours: 3**  
**Internal Marks: 25**  
**External Marks: 75**

### **CORE CHOICE COURSE –I** **ENZYME TECHNOLOGY**

#### **Objective**

- Criticize and relate to the concept of enzyme technology
- Describe the applications enzymes.

#### **Course outcomes**

- Acquire the knowledge about history, classification, purification and separation of enzymes
- Describe the mechanism of enzyme action and construct the knowledge on enzyme regulation.
- To understand the Enzymes activity and kinetics.
- To create a basic understanding of the importance of enzymes as cellular catalysts.
- Appraise about the techniques of immobilization and application in enzymes in industries.

#### **UNIT-I Historical aspects of enzymology**

History, nomenclature and classification of enzymes-according to IUB EC 1964. Intracellular localization of enzymes, isolation and fractionation of enzymes -classical methods of purification and crystallization-criteria of purity, units of enzyme activity-Turn over number, specific activity -Active site definition-organization and determination of active sites.

#### **UNIT-II Kinetics of catalyzed reaction**

Single substrate reactions, bisubstrate reactions -Concept and derivation of Michaelis-Menten equation-Lineweaver burk plot, Briggs Haldane relationship -Determination and significance of kinetic constants-Limitations of Michaelis-Menten Kinetics. Inhibition kinetics-competitive, non competitive and uncompetitive-Allosteric inhibition, cooperative, cumulative, feed back inhibition.

#### **UNIT-III Mechanism of enzyme catalysis**

Collision & transition state theories -specificity of enzymes -Proximity and orientation effects, general acid-base catalysis-covalent and electrostatic catalysis-nucleophilic and electrophilic attacks, catalysis by distortion-metal ion catalysis-Theories on mechanism of catalysis-Coenzymes - structure and function, Mechanism of enzymes action-mechanism of action of lysozyme and chymotrypsin-Isoenzymes.

**UNIT-IV Enzyme Regulation**

General mechanisms of enzyme regulation-Reversible (glutamine synthase&phosphorylase)and irreversible (proteases) covalent modifications of enzymes -Mono cyclic and multicyclic cascade systems with specific examples-Allosteric enzymes, qualitative description of “concerted” & “sequential” models for allosteric enzymes. Protein ligand binding measurement-analysis of binding isotherms.

**UNIT-V Applications of enzymes in Industry**

Immobilization and Immobilized enzymes-Variou methods of immobilization-ionic bonding, adsorption, covalent bonding (based on R groups of amino acids)-microencapsulation and gel entrapment- Applications of immobilized enzymes. Biosensors-glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors-Abzymes and Ribozymes-Enzymes of clinical importance-diagnostic significance and therapeutic effects –Enzyme Engineering.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
43	10	13	12	17	Global

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

## Text Books

1. Thomas M Devlin. Textbook of Biochemistry with Clinical Correlations, 7th edition, Wiley publisher. 2010.
2. Sathyanarayana U and Chakrapani U. Biochemistry, 4th edition, Elsevier publishers. 2013.
3. Zubay, Principles of Biochemistry - 4th ed, William C. Brown Publication 1998.
4. Palmer. Understanding enzymes. Prentice Hall. 2004.

## References

1. William, B. Jakoby, 2014. Methods in Enzymology, vol. 104, enzyme purification and related techniques.
2. Charlotte W Pratt and Kathleen Comely. Essential Biochemistry, 3rd edition Wiley publisher. 2013.
3. Deb AC. Fundamentals of Biochemistry, 10th edition, New Central Book Agency (p) Ltd, London. 2011.
4. Rajagopal. G. Concise textbook of Biochemistry, 2nd edition, Abuja Publishing House. 2010.
5. Reginald. H Garrett and Charles M Grisham, 5th edition. Biochemistry, Brooks Cole publishers. 2012.

## Web source

<https://microbenotes.com/enzyme-technology/>

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
I	22PBT1CCC1:2	Enzyme technology					6	5			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓		✓	✓	✓	✓		✓	✓	
CO2	✓	✓	✓		✓	✓		✓	✓	✓	
CO3	✓		✓	✓	✓	✓	✓		✓	✓	
CO4		✓	✓	✓	✓	✓	✓	✓		✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches(✓) = 42 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

## SEMESTER I

**Course Code: 22PBT1CP1**  
**Instruction Hours: 6**  
**Credits: 3**

**Exam Hours: 6**  
**Internal Marks: 40**  
**External Marks: 60**

### **CORE CHOICE COURSE –I** **CELLBIOLOGY,MICROBIOLOGY,BIOCHEMISTRYANDMOLECULAR BIOLOGY(P)**

#### **Objectives**

- To develop skills pertaining to Molecular Biology.
- To impart the students with hands on skills related to biochemical techniques.
- To acquire knowledge about aseptic techniques.

#### **Course outcomes**

- Students will get hands on experience in Cell Biology, Microbiology and Biochemistry & Molecular Biology Techniques.
- To learn about characteristics of cells, cell organelles and cell division and total & differential count of human bloodcells
- Are able to perform basic experiments to grow and study microorganisms in the laboratory.
- Has acquired a fairly good knowledge of the tools and the laboratory skill for estimation of biomolecules.
- Students can perform isolation of DNA, amplification of any gene by PCR and its analysis by gel electrophoresis.

#### **CellBiology**

1. **Microtomy–(Demo).**
2. **Prokaryotic & eukaryotic cell-structure observation.**
3. **Cell count- prokaryotic & eukaryotic.**
4. **Types of cells - parenchyma, collenchyma, sclerenchyma,columnar epithelium, squamous epithelium.**
5. **Leishman staining**
6. **Giemsa staining**
7. **Total (WBC,RBC) &differential count of human blood cells.**
8. **Separation of Peripheral Blood Mononuclear Cells from blood.**
9. **Osmosis and Tonicity.**
10. **Cell Division-Cytological preparations of tissues (onion)for mitosis.**
11. **Cell Division-Cytological preparations of tissues(Tradescantia)for meiosis.**
12. **Cell Division-Binary fission of yeast**
13. **Polytene and diplotene chromosomes.**
14. **Temporary and permanent slide preparation.**

## 15. Sub-cellular fractionation.

### Microbiology

16. Microscopy- Observation of different microbes.
17. Sterilization techniques–physical,chemical,filtration and irradiation techniques.
18. Preparation of media –simple media and complex media.
19. Isolation of microorganisms from air,soil & water- spreadplate,pour plate,streak plate techniques
20. Staining methods–simple, differential, acid- fast & negative
21. Identification-Macroscopic, microscopic,biochemical,serological&genericlevel.
22. Bacterial growth curve-colony counting,cell counting, spectrophotometric method.
23. Preservation & maintenance.
24. Antibiotic sensitivity test–Kirby- Bauer method.

### Biochemistry

25. Preparation of solutions–Molar, Normal, Percentage, Stock,Workingetc.
26. Preparation of buffers– PBS, Tris and Acetate buffer.
27. Identification of sugars- reducing &non-reducing sugars.
28. Estimation of monosaccharine(glucose) byNelson, Somogi method &polysaccharide(starch)by iodine method.
29. Estimation of aminoacid by Ninhydrin method.
30. Estimation of protein by Lowry’s method and Barford Method
31. Estimation of nucleic acids by absorbance at 260 nm and hyperchromic effect.
32. Enzyme assay:Estimation of salivary amylase from saliva&phosphatase from potato
33. Estimation of DNA by diphenylamine and RNA by orcinol method.
34. Estimation of lipids- cholesterol, PUFA&steroid.
35. Estimation of vitamins–ascorbic acid, $\alpha$ -tocopherol& $\beta$ -carotenoids.

### Molecular Biology

36. Isolation and purification of genomic DNA from prokaryotes.
37. Isolation and purification of genomic DNA from eukaryotes.
38. Isolation and purification of plasmid DNA.
39. Observation of DNA –Agarosegel electrophoresis.
40. Quantification of nucleic acids–DNA &RNA–Chemical and UV method.
41. Separation of protein by SDS PAGE
42. Protein staining techniques. Amido black,coomossive brilliant blue&AgNO<sub>3</sub>.
43. Transfer of protein-Western blot.
44. Observation of transferred protein–staining (Indianink),immune blot.
45. Bacterial mutagenesis–physical&chemical.
46. Preparation of *E. coli* competent cells.
47. Transformation of bacteria–CaCl<sub>2</sub> method.
48. Bacterial conjugation.
49. Transduction.
50. Yeast Binary fission

Total Number of Topics	Local	Regional	National	Global	Category Based on %
50	25	18	4	3	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

## References

1. S.Sadasivam.A.Manickam.1996.Biochemical Methods.2nd Edition. New Age International (p) Ltd, Publishers.
2. Dr. G.Rajagobal., Dr.B.D.Toora. 2001. Practical Biochemistry. 1st Edition. Ahuja Book Company Pvt.Ltd.
3. J.Jayaraman. 2000. Laboratory Manual in Biochemistry. New Age International Publishers.
4. Plummer Mu, David T.Plummer. 1988. Introduction to Practical Biochemistry. Tata McGraw-Hill Education.
5. Gunasekaran,P.2009. Laboratory Manual in Microbiology.1st Edition.New Age International Publishers. Reprint 2009.
6. Dr. T. Sundararaj. Microbiology Laboratory Manual. Dr.A.L. MPGIBMS, University of Madras, Taramani, Chennai – 600 113.
7. Arnold L. Demain & Julian E. Davies. 1999. Manual of Industrial Microbiology and Biotechnology. 2nd Edition. ASM press.
8. M. Mooyoung. 1985. Comprehensive Biotechnology. Vol. 2, 3 & 4. Pergamon press.
9. Dr. David A Thompson. 2011. Cell and Molecular Biology LabManual.

## Web Source

<http://www-personal.umd.umich.edu/~poelkers/OelkersMolbiolmanualUMD2016.pdf>  
<https://tkk.elte.hu/dstore/document/871/book.pdf>

## Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
I	22PBT1CP1	Cell Biology, Microbiology, Biochemistry & Molecular Biology (P)					6	3			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓		✓	✓	✓	✓	✓		✓	✓	
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO4	✓	✓		✓	✓	✓	✓	✓		✓	

<b>CO5</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) = 45    Relationship: Very High										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

## SEMESTER I

Course Code: 22PBT1EC1:1  
Instruction Hours: 6  
Credits: 4

Exam Hours: 3  
Internal Marks: 25  
External Marks: 75

### ELECTIVE COURSE –I NANO BIOTECHNOLOGY

#### Objectives

- Obtain the knowledge on the basics on Nanomaterials and their properties based on size.
- Make them understand the process of synthesizing nanoparticles with different source/materials.

#### Course outcomes

- To introduces the learners to the basic concepts and applications of Nanotechnology.
- Students to understand the various Nanomaterial, their construction and biological approach in medical field.
- Gain an understanding of Nanotechnological deduction system.
- Expand their knowledge on Nanomedicine and Nanomedical system.
- Gain an understanding of producing novel environmental and food technology.

#### UNIT I INTRODUCTION AND HISTORY

Introduction Scope and Overview of Nanobiotechnology- Length scales-Importance of Nanoscale and technology- History of Nanotechnology- Nanomaterials definitions- Classification of Nanomaterials- chemical bonds in nanotechnology-Scales at the bionano interface-Basic capabilities of nanobiotechnology and nanomedicine-Biological tradition and mechanical tradition biotechnology- Applications in biotechnology.

#### UNIT II SYNTHESIS AND CHARACTERIZATION OF NANOMATERIALS

Nanomaterials for Biotechnological Applications Carbon Nanotubes-Nanowires-Synthesizing Nanoparticles -Green Synthesis of Nanoparticles -Nanoparticle synthesis of Fungi -Green Synthesis of Nanoparticles (Plant metabolites)-A few examples of production of metal nanoparticles using plant-Characterization of Nanomaterials- Structural and functional principles of nanobiotechnology- Types of Nanoparticles- Pure Metal, Gold, Silicon, Silver, Cobalt, Metal Oxides, Silica, Zinc oxide, Iron oxide, Alumina, titania-Techniques to Synthesize Nanoparticles- Characterization of Nanoparticles.

#### UNIT III NANOBIOTECHNOLOGICAL DETECTION SYSTEMS

Various types of transducing elements and their applications in bio-nanotechnology-Electrochemical transducer-Optical transducers-Biosensors in nanotechnology-Quantum dots-gold nanoparticles as biosensors-DNA detection-Small scale systems for drug delivery.

#### UNIT IV NANOBIOTECHNOLOGY IN CHRONIC AND INFECTIOUS DISEASES

Application of Nanobiotechnology in the treatment Infectious Diseases-viral infectious diseases-fungal infectious diseases-Applications of Nanotechnology in Chronic Diseases-Cardiovascular Diseases-Chronic Disease-Hypertension-Nanotechnology Applications in Cancer Diagnosis and Therapy- Pancreatic Cancer-Targeted delivery of anticancer drugs-Gold Nanoparticles in Drug Delivery Applications-Functionalized gold nanoparticles for protein delivery

## UNIT V NANOBIO TECHNOLOGY IN ENVIRONMENT AND FOOD SCIENCES

Nanobiotechnology in environment-Environmental remediation-Carbon nanotube-Applications of nanobiotechnology in food contaminant detection-Detection of pathogens in food-Opportunities for nanobiotechnology in food industry-Nanobiotechnology in food preservation-Risk analysis of the use of nanotechnology in food industry-Applications of biotechnology in waste water treatment.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
54	9	20	28	16	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

- Christef M. Niemeyer, C. A. Mirkin. 2004. Nanobiotechnology: Concepts, Application and Properties. Wiley – VCH Publishers, New York.
- Tuan Vo-Dinh.2007. Nanotechnology in Biology and Medicine: Methods, Devices and Applications.

### References

- Ratner M, Ratner D, “Nanotechnology: A Gentle Introduction to the next Big idea” Prentice Hall, 2005.
- H.S. Nalwa, “Encyclopedia of Nanoscience & Nanotechnology”, McGraw Hill, 2004.
- CNR Rao, “The chemistry of Nanomaterials: Synthesis, Properties & Application”, Springer 2006.
- Viola Vogel, “Nanomedicine & Nanotechnology”, John Willey & Sons Ltd, 2008.
- Goodshell, “ Nanobiotechnology”, John Willey & Sons Ltd,3rd edition, 2004.
- Ralph S. Greco, “Nanoscale Technology in Biological systems”, CRC Press, 2005.

### Web Source

<https://lecturenotes.in/subject/563/introduction-to-nanotechnology>

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits
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I	22UBT1EC1:1	Nanobiotechnology				6	4			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓		✓	✓	✓		✓	✓	✓
CO3	✓	✓	✓		✓	✓	✓		✓	✓
CO4	✓	✓	✓	✓		✓	✓	✓		✓
CO5	✓		✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) = 43 Relationship: High										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

## SEMESTER I

Course Code: 22PBT1EC1:2

Instruction Hours: 6

Credits: 4

Exam Hours: 3

Internal Marks: 25

External Marks: 75

## ELECTIVE COURSE –II CANCER BIOLOGY

### OBJECTIVES

- Comprehend the mechanism of cancer treatment.
- Criticize and relate to the concept of cancer biology.

### COURSE OUTCOMES

- Gain a deep understanding of the fundamental processes related to cancer, growth, causes, and differentiation.
- Understand the multistep genetic alterations which enable the transformation of a normal cell into cancer.
- Describe the Molecular genetics of Oncogenes and Tumour Suppressor genes
- Acquire the knowledge of Apoptosis and its signalling
- Gain knowledge of cancer-related diseases and their treatment.

### UNIT - I CHARACTERISTICS OF CANCER

Definition, Description of cancer- Basic facts about cancer- cancer is clonal in origin-, Hallmarks of Cancer- general classification of human cancers- microscopic and macroscopic features of neoplasm's, Grade and stage of neoplasm - Histologic grade of malignancy and tumor staging.

### UNIT - II CAUSES OF CANCER

Theory of HITS- Chemical carcinogenesis - metabolic activation of chemical carcinogens (donors of simple alkyl group- cytochrome P 450 mediated activation)- Mechanism of tumor initiation, promotion and progression- Irradiation carcinogenesis and viral carcinogenesis (Epstein Barr virus and Hepatitis virus).

### UNIT - III MOLECULAR GENETICS OF CANCER

Oncogenes- Oncogene families- cell transforming ability of onc gene, functional classes of oncogenes- Characteristics of individual oncogene (ras and erbA). Tumor suppressor genes - suppressor genes (rb and p53)- Cancer diagnosis -categories of tumor markers (nucleic acid based markers and gene expression microarray).

### UNIT -IV CANCER DIAGNOSIS

Methods in cancer cytogenetics (Karyotyping, FISH)- Tumor markers, genetic markers of cancer predisposition (Tumor suppressor genes as diagnostic tool)- Strategies of anticancer drug therapy- Chemotherapy (Cdk inhibitors as target of chemotherapeutic agents and ubiquitination in cancer, classification of cytotoxic drugs: Alkylating agents, Platinum drugs, Topoisomerase inhibitors)-gene therapy- Immunotherapy and Radiotherapy - Stem Cells and Cancer - Personalized medicine in cancer.

### UNIT -V TUMOR PREVENTION

Bcl2 family proteins- Caspases, Apoptotic signaling pathway (Intrinsic and extrinsic pathway- Telomeres and immortality-Molecular mechanism of tumor metastasis - WHO classification- Tumor staging and grading- VEGF signaling, Angiogenesis- Diet and cancer prevention -Chemoprevention- Molecular targets of chemoprevention -Immunotherapy –Radiation therapy: Advantages and limitation.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
40	19	6	12	6	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. Maly B.W.J .Virology: A Practical approach IRL Press, Oxford, 2007.

### References

2. Margaret A. Knowles, Peter J Selby, An Introduction to Cellular and Molecular Biology of Cancer, 4th Edition, Oxford Medical Publication, 2012.
3. Dunmock N.J and Primrose S.B; Introduction to Modern Virology, Blackwell Scientific publication, Oxford, 2017.
4. Devita V.T.2021,Cancer: Principles And Practice Of Oncology Primer Of Molecular Biology In Cancer, Blackwell Scientific Publication.
5. Mcintosh JR, 2019.Understanding Cancer An Introduction To The Biology Medicine And Societal Implications Of This Disease, Taylor And Francis Publishers.
6. Sarkar Amita,2019,Biology of Cancer, Discovery Publishing Pvt.Ltd.

### Web Source

<https://www.biologydiscussion.com/cancer/study-notes-on-cancer/27314>

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	22PBT2EC2:2	Cancer Biology					6	5			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓		✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓		✓	✓	✓		✓	✓	
CO3	✓	✓		✓	✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓		✓	✓		✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches(✓) = 44 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

## SEMESTER I

Course Code: 22VABT1:1

Credits: 2

Exam Hours: 3  
Internal Marks: 25  
External Marks: 75

### VALUE ADDED COURSE –I BIOFERTILIZER

#### Objectives

- Make them understand the process of biofertilizer production
- Obtain the knowledge on the basics on biofertilizer based agriculture

#### Course outcomes

- To give adequate knowledge on biofertilizer production and to train the students for self employment
- To ensure imparting the knowledge of biofertilizer based agriculture.
- The course provides knowledge about the application of biofertilizer and organic farming.
- The course provides knowledge about Biofertilizers Production and quality control
- Acquired knowledge about economic importance and reduce hazards in environment

#### UNIT - I Microbes and Agriculture

Importance of Carbon, Nitrogen and Phosphorus cycles- Benefits of Biofertilizers-strain selection seed pelleting, Inoculant and inoculant carriers -Nitrogen fixing Bacteria (Azotobacter, Beijerinckia, Clostridium, Cyanobacter)- Media for Azotobacter, Azospirillum and phosphate solubilizer - New nitrogen fixers 'Nif' genes (Hybrid E.coli)- **Economical importance of Nitrogen fixing microbes.**

#### UNIT - II Blue Green algae as Biofertilizers

Mass cultivation of Cyanobacteria (Anabaena, Cylandropermum) -Mass cultivation of Azolla, Azolla - Anabaena complex Algal inoculants- methods of production (Trough method, Pit method, Field scale,) application- **Benefits of Blue Green algae.**

#### UNIT - III Microbial Symbiotic association

Rhizobium Taxonomy, physiology, Host-Rhizobium interaction, mass cultivation, carrier and base inoculants- Nod gene and factor-Vermiculture Earth worms and micro organisms - Microbial enzymes Bioprocessing.

#### UNIT - IV Mycorrhiza

Types of mycorrhizal associations- VAM mycorrhizal association: taxonomy, occurrence-distribution, phosphorus nutrition, growth and yield- collection of VAM- VAM life cycle- isolation, stock plants and inoculums production of VAM.

#### UNIT - V Production and quality control in Biofertilizers

Isolation and identification of different nitrogen fixing ability of different strains under controlled and field conditions- direct and indirect methods- culture production, fermenter, storage of culture, carrier, packing, quality control- ISI Standards- inoculums requirements-packing- marketing and storage-inoculums requirements methods of application.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
31	6	16	2	9	Regional

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. S.G. Borkar, 2015. Microbes as Bio-fertilizers and their Production Technology, Woodhead Publishing India in Agriculture, India.
2. R Shankara Reddy, 2012. Biofertilizer Technology, Adhyayan Publishers, India.

### References

1. Moshrafuddin Ahmed and Basumatary, S.K.2006. Applied Microbiology, M.J.P. Publishers, Chennai.
2. Dubey, R.C.2003. A text book of Biotechnology. S. Chand & company, New Delhi.

### Web Source

<https://egyankosh.ac.in/bitstream/123456789/8896/1/Unit-3.pdf>

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
I	22VABT1:1	Biofertilizer					3	2				
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		
CO1	✓	✓	✓	✓	✓	✓	✓		✓	✓		
CO2	✓	✓	✓		✓	✓	✓	✓	✓	✓		
CO3	✓		✓	✓	✓	✓		✓	✓	✓		
CO4	✓	✓	✓	✓	✓	✓	✓	✓		✓		
CO5	✓		✓	✓	✓	✓	✓	✓	✓	✓		
Number of Matches(✓) = 44      Relationship: High												

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

## SEMESTER I

Course Code: 22VABT1:2

Credits: 2

Exam Hours: 3  
Internal Marks: 25  
External Marks: 75

### VALUE ADDED COURSE –I PHYTOCHEMICALS AND HERBAL MEDICINE

#### Objectives

- Obtain the knowledge on the basics on phytochemicals.
- Make them understand the process of synthesizing herbal medicine

#### Course outcomes

- Acquired knowledge of about herbal medicine, so that one can think of farming herbal plants for future.
- Acquired knowledge of tissue culture of medicinal plants
- Acquired knowledge of various techniques used for analysis of phytochemicals
- Acquired knowledge about medicinal plants in healthcare
- To enable the student to become self-employed/entrepreneur.

#### UNIT - I Crude Drugs

Crude Drugs ,Scope & Importance-Classification (Taxonomical, Morphological Chemical, Pharmacological); Cultivation, Collection & processing of Crude Drugs- Indian System of medicine: Ayurveda, Siddha and Unani and its significance- Regulations of siddha medical system- Advantages of Ayurveda, Siddha and Unani.

#### UNIT- II Medicinal & Aromatic Plants

Cultivation and Utilization of Medicinal & Aromatic Plants in India- Genetics as applied to Medicinal herbs-Modern Biotechnological tools and its influence in Medical and Aromatic plant cultivation- Medical and Aromatic plant uses-Advantages of Amla, ashwagandha, mint, lemon grass, Vetiver etc.

#### UNIT - III Tissue Culture of medicinal Plants

Plant Tissue Culture as source of medicines, Secondary metabolite production in plant- Plant Tissue Culture for enhancing secondary metabolite production (Withania somnifera, Rauwolfia serpentina, Catharanthus roseus, Andrographis paniculata, Dioscorea sp.)- Anticancer, Anti inflammatory, Antidiabetic, Analgesic drugs, Biogenesis of Phyto pharmaceuticals.

#### UNIT - IV Analysis of Phytochemicals

Methods of Drug evaluation (Morphological, Microscopic, Physical & Chemical). Preliminary screening- Assay of Drugs- Biological evaluation / assays, microbiological methods- Characterization of drugs- Types of Phytochemicals- Carbohydrates & derived products; Glycosides ,extraction methods (Digitalis, Aloe, Mentha)- Alkaloids extraction methods (Taxus, Papaver, Cinchona)- Flavonoids extraction methods, Resins- extraction methods; Lectins.

#### UNIT - V Applications of Phytochemicals

Application of phytochemicals in industry and healthcare-Biocides, Biofungicides, Biopesticides. Nutraceuticals and their significance.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
24	4	7	11	2	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

**Text Books**

1. Pharmacognosy, C. K. Kokate, A. P. Purohit & S. B. Gokhale (1996), Nirali Prakashan, 4th Ed. School of Biotechnology and Health Sciences Department of Biotechnology (BT) Karunya University Page 626.
2. Natural Products in medicine: A Biosynthetic approach (1997), Wiley.

**References**

3. Hornok, L. (ed.) (1992). Cultivation & Processing of Medicinal Plants, Chichester, U.K.: J. Wiley & Sons.
4. Trease & Evans, Pharmacognosy- William Charles Evans, 14th ed. (1989), Harcourt Brace & Company.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
I	20VABT1:2	Phytochemicals and Herbal Medicine					2	2			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓		✓	✓	
CO2	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO3	✓		✓	✓	✓	✓		✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓	✓	✓		✓	
CO5	✓		✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches (✓) = 45 Relationship: Very High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
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<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	VeryPoor	Poor	Moderate	High	VeryHigh

## SEMESTER II

Course Code: 22PBT2CC1  
Instruction Hours: 6  
Credits: 5

Exam Hours: 3  
Internal Marks: 25  
External Marks: 75

### CORECOURSE –III rDNA TECHNOLOGY

#### Objective

- To study about the chromosomes, genes and their functions.
- To study about the DNA damage and repair mechanism.
- To study about the central dogma of molecular biology.

#### Course outcomes

- To understand the steps involved in recombinant DNA technology.
- Describe the mechanism of action and the use of restriction enzymes in biotechnology research.
- To get expertise in isolation of plasmids, cloning of gene and transformation into suitable bacteria for Selection of recombinant clones.
- To conduct gene amplification experiments by PCR analysis and Sequencing Methods
- To get insight in applications or recombinant DNA technology in agriculture, production of therapeutic proteins.

#### UNIT-I Basics Concepts

DNA structure and properties - Restriction enzymes - DNA ligase, klenow enzyme - T4 DNA polymerase, polynucleotide kinase - alkaline phosphatase, cohesive and blunt end ligation - linkers, adaptors and homopolymeric tailing - Labeling of DNA - nick translation, random priming, radioactive and non radioactive probes - hybridization techniques - northern, southern and colony hybridization, fluorescence *insitu* hybridization - chromatin immuno-precipitation - DNA-protein interactions, electromobility shift assay - DNeI foot printing and methyl interference assay - Holo enzyme

#### UNIT-II Cloning Vectors

Plasmids, bacteriophages, M13 mp vectors, PUC19 and blue script vectors - Phagemids, lambdaphage vectors, insertion and replacement vectors - EMBL, cosmids, artificial chromosome vectors (YAC, BAC) - animal virus derived vectors - SV40 - vaccinia/ bacculo & retroviral vectors - Expression vectors - pMal, GST and pET based vectors - Protein purification. His tag, GST tag, MBPtag etc. intein based vectors, inclusion bodies - methodology of formation of inclusion bodies - baculovirus and pichia vectors system - plant based vectors - Ti and Ri as vectors, yeast vectors and shuttle vectors - Types of Plasmid, PBR322.

#### UNIT-III Cloning Methodologies

Insertion of foreign DNA into host cells - transformation, construction of libraries - isolation of mRNA and total RNA - cDNA and genomic libraries - cDNA and genomic cloning - expression cloning and protein-protein interactive cloning - Yeast two hybrid system - phage display and principles in maximizing gene expression - Gene Cloning strategy.

#### UNIT-IV PCR and its Applications

History of PCR - Primer design, fidelity of thermo stable enzymes - History of PCR DNA polymerases - types of PCR - multiplex - nested reverse transcriptase, realtime, touchdown, hot

start, and colony - Cloning of PCR products - T vectors, proof reading enzymes - PCR in gene recombination, deletion, addition, overlap extension, and site specific mutagenesis - PCR in molecular diagnostics, viral and bacterial detection - PCR based mutagenesis, mutation detection - SSCP, DGGE, RFLP, oligoligation assay (OLA) - Mismatch Chemical Cleavage (MCC) -Allele-Specific Amplification (ASA) and Protein Truncation Test(PTT).

#### UNIT -V Sequencing Methods

DNA sequencing - Enzymatic, chemical & automated DNA sequencing and RNA sequencing - Chemical synthesis of oligo nucleotides - introduction of DNA in to mammalian cells, and transfection techniques - Gene silencing techniques-Antisense RNA technology-Recent trends in RNA vaccine production-Recombinant vaccine production-Vaccine marketing -introduction to siRNA, siRNA technology, micro RNA - construction of siRNA vectors - principle and application of gene silencing - Gene knockouts and gene therapy - creation of knockout mice, disease model, somatic and germ linetherapy - *in vivo* and *ex vivo*,suicide gene therapy - gene replacement and gene targeting -Transgenics, cDNA and intragenic arrays - differential gene expression and protein array-Maxam Gilbert method, Sanger method.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
74	16	23	34	46	Global

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

#### Text Books

- 1.S.B.Primrose, R.M. Twyman and R.W.Old.2001. Principles of Gene Manipulation. 6<sup>th</sup> Edition. S.B.UniversityPress.
- 2.J.D.Watson, N.H. Hopkins, J.W. Roberts, J.A. Seitz &A.M. Weiner. 2007. Molecular Biology of the Gene. 6<sup>th</sup> Edition. Benjamin Cummings Publishing CompanyInc.

#### References

- 1.Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. 2002. Molecular Biology of the Cell, 4<sup>th</sup> Edition. Garland Sciences.
- 2.Stanley Maloy 1994. Microbial genetics. 2<sup>nd</sup> Edition. Jones and Bartlett publisher.
- 3.Uldis N. Streips and Ronald E. Yasbin. 2002. Modern Microbial Genetics. 2<sup>nd</sup> Edition.Wiley-Blackwell.
- 4.Sandy B. Primrose, Richard M. Twyman, Robert W. Old. 2008. Principles of Gene Manipulation. 6<sup>th</sup> Edition. BlackwellScience.
- 5.Brown. TA.2008.*Genomes*. 3<sup>rd</sup> Edition. New York:Garland Publishing Co. New York:

GarlandScience.

**Web source**

<https://microbenotes.com/category/molecular-biology/>

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	22PBT2CC1	rDNA Technology					6	5			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓		
CO2	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓	
CO4	✓	✓		✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches(✓) = 46 Relationship: Very High											

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

## SEMESTER II

Course Code: 22PBT2CC2  
Instruction Hours: 5  
Credits: 5

Exam Hours: 3  
Internal Marks: 25  
External Marks: 75

### CORECOURSE –IV IMMUNOTECHNOLOGY

#### Objective

- Categorize and explain the role of the major components of the immune system at the organ, cellular and molecular levels.
- Compare and contrast the functions of the various immune components with respect to their role in the two major types of immune responses.

#### Course outcomes

- Describe the function of the major components and mechanism of the immune system to protect the body from the pathogens
- Familiar with the immunologic responses involved in preventing, combating infections and the concepts of nonspecific and specific immunity.
- Resourceful in the structure, function and characteristics of immunoglobulins.
- Intellectual literacy in the common immune diseases in terms of the underlying basic principles and preventive measures.
- Familiar in the modern techniques that aids human protection

#### UNIT-I Components of Immune system:

Immunity: innate immunity-factors, acquired immunity-types, comparison of active and passive acquired immunity- Haematopoiesis-, Cells of the immune system and their role - lymphoid cells (T and B lymphocytes, NK cells)- Macrophages, Dendritic cells, Eosinophils, Basophils, Neutrophils, Mast cells, Antigen presenting cells and Platelets- Organs of the immune system - Primary and secondary lymphoid organs.

#### UNIT- II Antigens, and Antibodies

Antigens- structure, Types of antigens - factors of antigenicity- T cell and B cell epitopes- haptens- adjuvants and super antigens-T dependent and independent antigens- antigenic determinants- Immunogens and chemical nature-Antibodies: Ultra structure of immunoglobulin- types and functions- Monoclonal and polyclonal antibodies and its application- Antibody receptors- T cell receptors (TCR)- B cell receptor (BCR).

#### UNIT- III Immune response of B cells and T cells

B cell - Activation, humoral immune response- T cell Activation and Cell mediated response- Antigen processing and presentation pathway- Induction of immune response-Cytokines- lymphokines and chemokines- Clonal Selection Theory and process - Complement activation - classical and alternative pathways.

#### UNIT-IV Immunity to infectious diseases

Bacterial, viral Auto immunity: Classification and mechanisms of autoimmune diseases- Structure and functions of class I and class II MHC molecules- Transplantation immunology: types, allograft rejection-Graft versus host reactions- application of transplantation immunology- Principles of tumour immunology: Tumour antigens- immune response to tumour and immunotherapy of malignancy- Vaccines: classification - inactivated, live attenuated, subunit, synthetic and DNA vaccine and its importance.

## UNIT-V Immunology based techniques and technology

Clinical methods for detection of antigens and antibodies- Immuno diffusion- Ouchterlony analysis (Single radial diffusion)- Double immune diffusion- Immuno electrophoresis: Immuno contraception. Binder- Ligand assays: RIA, ELISA, Western blot- Histocompatibility testing: HLA typing- Hepatitis B virus test- Immune complex detection- Rosettes Forming Array- Plaque Forming Array.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
54	16	5	7	30	Global

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books:

1. R. A. Goldsby, T. J. Kindt, B. A. Osborne, J. Kuby. Immunology, 5th Edition, W.H. Freeman and Company, New York, 2003.
2. A. K. Abbas, A. H. Lichtman, S. Pillai. Cellular and Molecular Immunology, 7th Edition, Elsevier Health Sciences., 2011
3. P. M. Latha. A Text Book of Immunology, 1st Edition, S.Chand & Company Ltd, New Delhi, 2003.

### References:

1. Roitt. Essential Immunology, 10th Edition. Blackwell Scientific Publication, 2002.
2. M. R. Pandian and B. S. Kumar. Immunology and Immunotechnology, Panima Publishing Corporation, New Delhi, 2007.
3. D. M. Weir and J. Stewart. Immunology, 10th Edition. Churchill Livingstone, New York, 2000.
4. Janis Kuby, Immunology, W.H. Freeman & company, New York. 1997
5. Ivan M. Roitt et al., Essential Immunology, XII Edition, Wiley- Blackwell Publishers, UK, 2010.

### Web Source

<https://www.immunology.org/public-information/what-is-immunology>  
<https://en.wikipedia.org/wiki/Immunology>  
<https://www.nature.com/subjects/immunology>  
<https://www.immunology.org/public-information/bitesized-immunology>

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits
II	22PBT2CC2	Immuno technology	5	5

Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓		✓	✓		✓	✓		✓
CO2	✓				✓		✓	✓	✓	✓
CO3	✓		✓	✓	✓		✓	✓	✓	✓
CO4	✓	✓	✓		✓	✓	✓	✓	✓	✓
CO5	✓	✓		✓		✓	✓	✓	✓	✓
Number of Matches(✓) = 45 Relationship: Very High										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

## SEMESTER II

**Course Code: 22PBT2CCC2:1**  
**Instruction Hours: 5**  
**Credits: 5**

**Exam Hours: 3**  
**Internal Marks: 25**  
**External Marks: 75**

### CORE CHOICE COURSE –II **BIOINFORMATICS AND BIostatISTICS**

#### Objective

- Obtain the knowledge on the basics on bioinformatics tools.
- Criticize and relate to the concept of Biostatistics

#### Course outcomes

- Identify the scope of Computational Biology and Bioinformatics.
- Gain the knowledge Major sequence alignment and Information.
- The Study of understanding biological information. Retrieval methods for DNA sequence.
- To Know basic concepts of probability and statistics and be able to describe statistical methods and probability distributions relevant for molecular biology data
- To know the applications and limitations of different biostatistical methods.

#### UNIT-I

**Bioinformatic scope and history**-factors determining primary, secondary, tertiary and quaternary structure of proteins - protein information resources- biological databases, primary sequence databases, secondary database- Composite protein sequence database- Bioinformatics tools and Resources -free online tools, downloadable free tools, software packages, internet -Bioinformatics books and Journal -Bioinformatics web-portals.

#### UNIT-II

Pair wise sequence alignment comparison - Scoring matrix, Dynamic programming- FASTA and BLAST- Multiple sequence alignments -Phylogenetic alignment- Evolution, Element of Phylogeny Methods- Protein structure visualization tools - RasMol, Swiss PDB Viewer-Protein identification programs- Mosaic-Protein interaction-Molecular docking-global and local alignment algorithms - Multiple sequence alignment-progressive alignment and Iterative alignment algorithms Pairwise

alignment based rigorous algorithm (Smith and Waterman) and Heuristic algorithms (FASTA and Blast).

### UNIT-III

Medical application of bioinformatics diseases, genes -Drug discovery history-steps in drug discovery-Target Identification- Target Validation- QSAR ,Lead Identification Preclinical pharmacology and toxicology -ADME-Drug designing -Rational drug design -Computer aided drug design- Ligand based approach -Target based approach- Structural biology-Homology modeling, Bioinformatics for microarray designing and transcriptional profiling, Bioinformatics for metabolic reconstruction -Bioinformatics for phylogenetic analysis.

### UNIT-IV

Biostatistics Concepts of statistics basic principles- History of Bio statistics-Recent trends in biostatistics-Variables measurements, functions and limitation-Data types of data-biological measurement- kind of biological data- functions of statistics and limitation of statistics- methods of collection of data- merits and demerits tabulation- representation of data by frequency distribution diagram (Simple/Multiple/Subdivided bar diagram, Pie diagram)- Graphs (Histogram, polygon, curve).

### UNIT-V

Mean median, mode and geometric mean Measures of dispersion, range, mean deviations standard deviation, Variance, Skewness, Kurtosis, quartile deviation merits and demerits- coefficient of variations- Correlation types and methods of correlation- Regression analysis.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
55	22	18	13	7	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Textbooks

1. J. M.Keith. 2008. Bioinformatics. Vol. 1: Data, sequence analysis & evolution. HumanaPress.
2. R. Norman T. J. Bailey, 2009. Statistical methods in Biology. University press, Cambridge
- Rastogi, V.B. 2009. Fundamentals of Biostatistics, Anne Books, India.

### References

3. Hagen. J. B. 2000. The origin of bioinformatics. Nat. Rev. Genetics 1:231-6.
4. Tyers, M., and Mann, M. 2003. From genomics to proteomics. Nature 422:193-7.
5. Sundarajan. S. and R. Balaji. 2005, Introduction of Bioinformatics, Himalaya Publishing house, Mumbai.

6. Zar, J.H. 2003. Biostatistical Analysis. Pearson Education (Singapore) Pvt. Ltd., Indian Branch, NewDelhi.
7. Rao S 2012 Introduction to Biostatistics and Research Methods, PHI Learning Pvt. Ltd.

### Web Source

<https://microbenotes.com/category/bioinformatics/>

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	22PBT2CCC2:1	Bioinformatics & Biostatistics					5	5			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓		✓	✓	✓	✓		✓	✓	✓	
CO2	✓	✓	✓		✓	✓	✓		✓	✓	
CO3	✓	✓		✓	✓	✓	✓	✓	✓	✓	
CO4	✓		✓	✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓		✓	✓	✓	✓	✓	
Number of Matches(✓) = 43 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

## SEMESTER II

Course Code: 22PBT2CCC2:2

Instruction Hours: 5

Credits: 5

Exam Hours: 3

Internal Marks: 25

External Marks: 75

### CORE CHOICE COURSE –II GENOMICS AND PROTEOMICS

#### Objectives

- Demonstrate the concept of Genomics
- Analyze the process of proteomics tools.

#### Course outcomes

- The students would have gained a better understanding of the organization of genomes in multiple levels of taxa and the methodologies and approaches used for the study of structural and functional genomics.
- The students would have also acquired knowledge on various genome mapping and sequencing methods, genomic markers, microarray technology and methods for proteomics.
- Acquire knowledge about human genome project
- To learn about pharmacogenetic studies
- To learn about genome physical mapping and sequencing

## UNIT-I Genome Structure

Genome sizes-microbial and organelle genomes -Centromeres and telomeres, tandem repeats-dispersed repeats (transposons)-Basic Sanger sequencing - automated sequencing-sequencing simple genomes –Sequencing large genomes- finalizing sequences-resequencing and Next generation sequencing (NGS).

## UNIT-II Microarray

DNA Micro array, Protein Micro array Transcriptomics -Applications and advantages of Micro arrays -DNA chips and SAGE technology-Organization of genome projects-human, plant, animal and microbial genome- Microarray- design- analysis visualization of data-Tools for microarray analysis-MADAM-Gene-Applications of Microarrays.

## UNIT-III Human Genome

Characteristics of human-genome sequence important genes associated with each chromosome – Mendelian and sex-linked traits in human inheritance -Genetic diseases due to defects in autosomal and sex linked genes.-Whole genome sequencing -Human Genome Project.

## UNIT-IV Proteomics

Identifying proteins in complex mixtures-Protein profiling, quantitative 2D GE-multidimensional chromatography- quantitative mass spectrometry- MALDI-TOF, TOF analysis and analytical protein chips-Protein structure data banks- protein data bank.

## UNIT-V Pharmacogenomics and New Drug Design

Introduction to drug design and developing new drugs -Procedure followed in drug design- Molecular modification of lead compounds- Prodrug and soft drugs-Physico-chemical parameters in drug design-QSAR.Protein-protein interaction.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
44	14	11	8	20	Global

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. Nacia Grant Cooper; (Ed.). The Human Genome Project; Deciphering the blueprint of heredity University Science books, CA, USA.2004.
2. Gary Zweiger. Transducing the Genome; Information, Anarchy and Revolution in Biomedical Sciences. Tata McGraw-Hill Publishers, New Delhi.2003.
3. C.Branden, and J.Troze. Introduction to Protein Structure. Second Edition.Garland Publishing, New Delhi.1999.

4.W.E. Evans and M.V. Relling. Pharmacogenomics: translating functional genomics into rational therapeutics. *Science* 286:487.1999.

### References

1. A.D.Baxevanis, and B.F.F. Ouellette.Eds. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Wiley Interscience. New York.2001.
2. D Higgins, and W.Taylor (Eds). Bioinformatics: Sequence,Structure and Databnks.Oxford University Press, Oxford.2000.
3. Higgins,D and Taylor,W (Eds).2000. Bioinformatics: Sequence, Structure and Databank. Oxford University press.

### Web source

[https://bio.libretexts.org/Courses/University\\_of\\_California\\_Davis/BIS\\_2A\\_\(2018\)%3A\\_Introductory\\_Biology\\_\(Singer\)/Bis2A\\_Winter\\_2019/Lecture\\_23%3A\\_Genomics%2C\\_Proteomics%2C\\_and\\_Metabolomics](https://bio.libretexts.org/Courses/University_of_California_Davis/BIS_2A_(2018)%3A_Introductory_Biology_(Singer)/Bis2A_Winter_2019/Lecture_23%3A_Genomics%2C_Proteomics%2C_and_Metabolomics)

### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	22PBT2CCC2:2	Genomics and Proteomics					5	5			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓		✓	✓	✓	✓		✓	✓	✓	
CO2	✓	✓		✓	✓	✓	✓		✓	✓	
CO3	✓		✓	✓	✓	✓		✓	✓	✓	
CO4		✓	✓	✓	✓	✓	✓		✓	✓	
CO5	✓	✓		✓	✓	✓	✓	✓		✓	
Number of Matches(✓) = 40 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

## SEMESTER II

Course Code: 22PBT2CP2  
Instruction Hours: 6  
Credits: 3

Exam Hours: 6  
Internal Marks: 40  
External Marks: 60

### CORE PRACTICAL –II rDNA TECHNOLOGY AND IMMUNOTECHNOLOGY(P)

#### Objective

- Demonstrate the genetic materials analysis process.
- Practically analyze the process of Immunology experiments.

#### Course outcomes

- Students will be exposed to the latest techniques employed in recombinant DNA technology related to DNA manipulation in prokaryotes and eukaryotes.
  - The student will be able to understand and develop the concept of recombinant DNA technique.
  - To gain hands on experience in gene isolation, cloning by PCR approach.
  - To learn identification of gene copies as well as integration of transgenes by Southern blot.
  - To gain hands on experience in Precipitation techniques and Agglutination techniques
- rDNATEchnology

1. Isolation of plasmids -small &large scale.
2. Size analysis of plasmids by agarose gelelectrophoresis.
3. Restriction digestion, ligation.
4. Preparation of competent *E.coli* cells &transformation of *E.coli* with recombinant DNA.
5. Selection methods(Blue white selection, insertional inactivation).
6. Primer design and PCR amplification of  $\beta$ (beta)-galactosidase.
7. Cloning of PCR production to pBR322.
8. Introduction of cloned genes and analysis by SDS-PAGE.
9. Southern blotting.
10. RFLP Analysis of 18srRNA of the genome.
11. Genetic diversity of *Pseudomonas* by RAPD.
12. Reporter gene assay(GUS/ $\beta$ (beta)-galactosidase).
13. Northen blotting.

#### Immunology

14. Basics-Bleeding, separation of serum, plasma. (Handson).
15. Precipitation techniques-Agargel diffusion, counter immuno-eletrophoresis, single radial immuno-diffusion,rocket immuno-electrophoresis (Hands on).
16. Agglutination techniques
17. Blood grouping and Rh factor;Latex agglutination–RF,ASLO, HBs Ag and CRP (Handson); Hemeagglutination -RPHA/IHA(Handson)
18. Labeled Assays
19. Enzyme Linked Immuno sorbent Assay (ELISA)(Handson).
20. Immuno flourescence(IF)(Handson).
21. Immuno histochemistry(IH)(Demonstration).
22. Immuno peroxidase(PAP)staining.
23. Radio immunoassays(RIA)(Theory).

Total Number of Topics	Local	Regional	National	Global	Category Based on %
23	9	8	5	1	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

#### Text Books

1. Richard A. Goldsby, Thomas J. Kindt. Barbara, A. Osborne, Janis Kuby. 2003. Immunology. 5<sup>th</sup> Edition, W. H. Freeman & Company.
2. J. Sambrook and D.W. Russel, CSHL. 2001. Molecular Cloning: A Laboratory Manual, Vols 1-3. Cold Spring Harbor Laboratory Press.

#### References

1. Najat Abdulrazzaq Hasan, 2021, Basic Molecular biology laboratory Manual, Zenodo Publisher.
2. S.K. Gakhar, Monika Miglani, Ashwani Kumar. 2019. Molecular Biology: A Laboratory Manual Dreamtech Press
3. Dr. David A Thompson. 2011. Cell and Molecular Biology Lab Manual.
4. George M. Malacinski. 2013. Freifeder's Essentials of Molecular Biology. Norosa Publishing House.
5. S. K. Gakhar 2013. Molecular Biology: A Laboratory Manual, I K International Publishing House Pvt. Ltd
6. Brenda D. Spangler. 2002. Methods in Molecular Biology and protein chemistry. John Wiley & sons, Ltd.
7. Stanley R. Maloy, Valley. J. Stewart. 2006. Genetic analysis of Bacteria. Cold Spring Harbor Laboratory Press.
8. John M. S. Barlett, David Stirling. 2003. PCR protocols. Humana Press Inc.
9. Robert E. Farrel Jr. 2000. RNA Methodologies. 2<sup>nd</sup> Edition. Academic Press Inc.

#### Web Source

[http://webstor.srmist.edu.in/web\\_assets/srm\\_mainsite/files/files/BT%200502%20-%20M Tech%20r-](http://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/BT%200502%20-%20M Tech%20r-)

#### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	22PBT2CP2	DNA Technology & Immuno technology (P)					8	4			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓		✓	✓	✓		✓	✓	✓	
CO2	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO3	✓	✓	✓		✓	✓	✓		✓	✓	

<b>CO4</b>	✓		✓	✓	✓	✓	✓	✓		✓
<b>CO5</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) = 45      Relationship: Very High										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

## SEMESTER II

**Course Code: 22PBT2EC2:1**  
**Instruction Hours: 5**  
**Credits: 4**

**Exam Hours: 3**  
**Internal Marks: 25**  
**External Marks: 75**

### ELECTIVE COURSE –II **IPR, BIOSAFETY AND BIOETHICS**

#### Objective

- To understand various aspects of IPR, biosafety regulations and bioethics concerns arising from the commercialization of biotech products.
- To give an idea about IPR, registration and its enforcement.

#### Course Outcomes

- Define the fundamental aspects of Intellectual Property Rights for development and management of innovative projects in industries.
- Outline the current trends in IPR and Govt. steps in fostering IPR .
- Explain about the ethical issues involving biological material.
- Utilize adequate knowledge in the use of genetically modified organisms and its effect on human health.
- Make use of critical thinking skills to analyze information and situations in order to respond and act ethically with regard to scientific research, practice, and technology.

#### UNIT -I Introduction to Intellectual Property and Types of IPs

Introduction to IPR- Basic concepts and need for Intellectual Property- types - Patents- Trademarks- Trade Secrete- Copyright- Geographical Indications- History of GATT and TRIPS Agreement-World Intellectual Property Rights Organization (WIPO)-IP rights in India and abroad (USA & Europe) - few Case Studies-patent-Turmeric Patent, GI Darjeeling Tea.

#### UNIT -II Patent Filing Procedures and Agreements

Patent- Elements of Patentability- Novelty, Non Obviousness (Inventive Steps)- patentable and nonpatentable - patenting life, Registration Procedure, Rights and Duties of Patentee, Assignment and license- Patent infringement- IPR Agreements and Treaties- Madrid Agreement- Hague Agreement- Budapest Treaty- PCT-Indian Patent Act 1970.

#### UNIT-III Biosafety

Introduction, biosafety issues in biotechnology - historical background-Introduction to Biological Safety Cabinets- Primary Containment for Biohazards-Biosafety Levels- Biosafety Levels of Specific Microorganisms- Recommended Biosafety Levels for Infectious Agents and Infected Animals.

#### UNIT-IV Biosafety Guidelines

Biosafety guidelines and regulations (National and International) - operation of biosafety guidelines and regulations of Government of India-Definition of GMOs and LMOs- Roles of Institutional Biosafety Committee, RCGM, GEAC, for GMO applications in food and agriculture- Environmental release of GMOs- Risk Analysis- Risk Assessment- Risk management and communication-Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

#### UNIT-V Bioethics

Introduction to ethics/ bioethics -purpose and principles of bioethics- Bioethics in medical -human cloning, Biotechnology and ethics, Benefits and risks of genetic engineering- ethical aspects of genetic testing - ethical aspects relating to use of genetic information - genetic engineering and bio warfare- Ethical implications of cloning: Reproductive cloning- therapeutic cloning- Ethical, legal and socioeconomic aspects of gene therapy, germ line, Overview of national regulations and relevant international agreements including Cartagena protocol- somatic, embryonic and adult stem cell research- GM crops and GMO's - biotechnology and biopiracy -ICMR Guidelines- Ethical implications of human genome project.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
56	20	7	8	18	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

#### Text Book

1. Bioethics - by Ellen Frankel Paul, Fred D. Miller, Jeffrey Paul, Fred Dycus Miller Cambridge University Press,2002.
2. Bioethics&Science,JohnA.Bryant,LindaBaggottlaVelle,JohnF.Searle .a2002.

#### Reference:

1. Bratati Banerjee,2018,Mahajan's Methods In Biostatistics, Jaypee Brothers Medical Publishers.
2. Wayne W. Daniel and Chad L. Cross,2014.Biostatistics: Basic Concepts and Methodology, Wiley.
3. B Antonisamy , Prasanna S. Premkumar , Solomon Christopher,2017,Principles and Practice of Biostatistics, Elsevier India.
4. Jose B. Cibelli, Robert P. Lanza, Keith H. S. Campbell, Michael D. West. 2002.Principles of Cloning, Academic Press, SanDiego,Gurdon.
5. Hoosetti, B.B. 2002. Glimpses of Biodiversity. Daya, NewDelhi.

#### Important Links

<http://www.w3.org/IPR/>  
<http://www.wipo.int/portal/index.html.en>  
 Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits
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<b>II</b>	22PBT3EC2:1	PR,BIOSAFTEY&BIOETHICS				5	4			
<b>Course Outcomes (COs)</b>	<b>Programme Outcomes(POs)</b>					<b>Programme Specific Outcomes(PSOs)</b>				
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>
<b>CO1</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>CO2</b>	✓	✓	✓		✓	✓	✓	✓	✓	✓
<b>CO3</b>	✓	✓	✓	✓	✓		✓	✓	✓	✓
<b>CO4</b>	✓	✓	✓	✓	✓	✓		✓	✓	✓
<b>CO5</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) = 42      Relationship: High										
<b>Mapping</b>	1-29%		30-59%		60-69%		70-89%		90-100%	
<b>Matches</b>	1-14		15-29		30-34		35-44		45-50	
<b>Relationship</b>	Very Poor		Poor		Moderate		High		Very High	

## SEMESTER II

**Course Code: 22PBT2EC2:2**  
**Instruction Hours: 5**  
**Credits: 4**

**Exam Hours: 3**  
**Internal Marks: 25**  
**External Marks: 75**

### **ELECTIVE COURSE-II** **PHARMACEUTICAL BIOTECHNOLOGY**

#### Objectives

- Make them understand the process of Pharmacy.
- Obtain the knowledge on the basics on health care area.

#### Course outcomes

- To create general understanding regarding basic principles involved in modern medicinal /structural chemistry systems.
- Acquire knowledge of History & principle of pharmacology
- Acquire comprehensive knowledge of Chemotherapeutic drugs
- Acquire comprehensive knowledge of Tissue Engineering
- Acquire knowledge of Production of biological protein

#### **UNIT-I**

History & principle of pharmacology- Drug names & classification systems –General principle of drug action- Pharmacokinetics, Pharmacodynamics- Measurement of drug action- Introduction to Pharmacology- Definition, historical landmarks and scope of pharmacology- nature and source of drugs- essential drugs concept and routes of drug administration, Agonists, antagonists, addiction, tolerance. Pharmacokinetics-Membrane transport, absorption, distribution, metabolism and excretion of drugs- Enzyme induction, enzyme inhibition, kinetics of elimination.

#### **UNIT-II**

Chemotherapeutic drugs-Protein Synthesis Inhibitors -AntiInflammatory, Antibacterial, Antifungal, Antiviral, Antihelminthic, Anticancer Drugs- Definition and basic knowledge of acute, subacute and chronic toxicity-Definition and basic knowledge of genotoxicity, carcinogenicity, teratogenicity and mutagenicity- Chronopharmacology-Definition of rhythm and cycles, Biological clock and their significance leading to chronotherapy.

#### **UNIT-III**

Principles and mechanisms of drug action. Receptor theories and classification of receptors, regulation of receptors-drug receptors interactions signal transduction mechanisms- G-protein-coupled receptors, ion channel receptor, dose response relationship, therapeutic index, combined effects of drugs and factors modifying drug action.

#### **UNIT-IV**

Prenatal diagnosis , Invasive Techniques, Amniocentesis, Fetoscopy, Chronic Villisampling(CVS) -NonInvasive Techniques, Ultra Sonography-Diagnosis using protein &enzyme smarkers, DNA/ RNA based diagnostics.

#### **UNIT-V**

Tissue Engineering - Skin, Liver, Pancreas -Recombinant vaccines -Cell adhesion basedtherapy: Integrins, Inflammation- Drug and Cosmetics Act, Drug Price Control order, Application for Investigational New Drug (IND)-Application for New drug Discovery (NDD)

according to Indian Control Authority & USFDA guidelines- Conducting bioequivalence studies- Ethical considerations in utilizing human subjects for drug discovery process- Helsinki's declaration- ICH GCP Guidelines- Ethical guidelines in utilizing animals for experimental purposes.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
37	8	6	12	13	Global

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

#### Text Books

1. Kulkarni SK. Handbook of experimental pharmacology. VallabhPrakashan.
2. R Endress, Plant cell Biotechnology, Springer-Verlag, Berlin, 1994.

#### REFERENCES:

1. Rang H. P., Dale M. M., Ritter J. M., Flower R. J., Rang and Dale's Pharmacology, Churchill Livingstone Elsevier (2020)
2. Katzung B. G., Masters S. B., Trevor A. J., Basic and clinical pharmacology, Tata McGraw-Hill 11th edition (2010)
3. W.C.Evans, Trease and Evans Pharmacognosy, 16th edition, W.B. Saunders & Co., London, 2009.
4. Mohammad Ali. Pharmacognosy and Phytochemistry, CBS Publishers & Distribution, New Delhi.  
Text book of Pharmacognosy by C.K. Kokate, Purohit, Gokhlae (2007), 37th Edition, NiraliPrakashan, New Delhi.
5. Herbal drug industry by R.D. Choudhary (1996), 1st Edn, Eastern Publisher, New Delhi.
6. K.D.Tripathi. Essentials of Medical Pharmacology (2016), JAYPEE Brothers Medical Publishers (P) Ltd, New Delhi
7. Sharma H. L., Sharma K. K., Principles of Pharmacology (2017), Parasmedical publisher Modern Pharmacology with clinical Applications, by Charles R.Craig & Robert.
8. Ghosh MN. Fundamentals of Experimental Pharmacology. Hilton & Company, Kolkata.

#### Web Source

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	22PBT2EC2:2	Pharmaceutical Biotechnology					5	4			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓		✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓		✓	✓		✓	✓	✓	
CO3	✓		✓	✓		✓	✓	✓	✓	✓	
CO4	✓	✓	✓		✓		✓		✓	✓	
CO5	✓	✓	✓	✓		✓	✓	✓	✓	✓	
Number of Matches(✓) = 42 Relationship: High											

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

## SEMESTER II

**Course Code: 22PBT2NME1:1**

**Exam Hours: 3**

**Instruction Hours: 3**

**Internal Marks: 25**

**Credits: 2**

**External Marks: 75**

### NONMAJOR ELECTIVE COURSE –I MUSHROOM TECHNOLOGY

#### Objectives

- To facilitate self-employment
- To know the nutrient value of mushroom
- This helps to the students to understand about the mycoprotein from fungi and its nutritional values.

#### Course outcomes

- Acquired knowledge about mushroom cultivation and Mushroom production
- Acquired knowledge about the economic importance of mushroom
- Describe and apply the uses and lore of many mushrooms and culture techniques to further explore their cultivation potential
- Acquired knowledge about applications of Mushroom
- To facilitate self-employment

#### UNIT - I

Introduction, history, scope of edible mushroom cultivation - Types of edible mushroom available in India, Calocybe indica, Volvariella Volvacea, Pleurotus sp., Agaricus bisporus- Mushroom culture, historical background.

#### UNIT - II

Pure culture, preparation of media (PDA and Oatmeal agar media) sterilization - Nutritional values, cultivation methods - Preparation of test tube slants to store mother culture - culturing of Pleurotus mycelium on petriplates - Preparation of mother spawn in saline bottle and polypropylene bags and their multiplication.

#### UNIT - III

Cultivation Technology, Infra structure, Substrates (locally available) polythene bag, vessels, Inoculation hood, inoculation loop, low cost stove, sieves, Cultural rack mushroom unit (Thatched house) - Mushroom bed preparation - Paddy straw-sugarcane trash-maize straw-banana leaves.

#### UNIT - IV

Storage and nutrition: Short term storage, Long term storage (scanning, Pickles, papads, drying, storage in salt solutions) - Nutrition: Proteins, amino acids, mineral elements - Nutrition: Carbohydrates, Crude fiber content, Vitamins.

#### UNIT - V

Food preparation- Types of foods prepared from mushroom - soup, cutlet, omelette, samosa, pickles, curry. Research Centres -National level and Regional Level Cost benefit ratio- Marketing in India and abroad Export value.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
22	11	3	7	2	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

#### Text Book

1. Zadrazil.F&K.Grabbe1983"EdibleMushroom,Biotechnology"Vol.3,Weinheim:VerlagChemie,Berlin.
2. Kannaiyan.2001.Handbook ofEdibleMushrooms"TNAUPublication.

#### References

3. Marimuthu*etal.*,(1991)OysterMushrooms,Dept.ofPlantpathology,TNAU,Coimbatore.
4. NitaBahl (1988)Handbook ofMushrooms,IIedition, Vol.I&II.
5. PaulStamets,J.S.andChilton,J.S.(2004).MushroomCultivator:Apracticalguideto growing mushrooms at home, Agarikon Press.
6. Shu-TingChang,PhilipG.Miles,Chang,S.T.(2004).Mushrooms:Cultivation,nutritionalvalue, medicinaleffect andenvironmentalimpact, 2nd ed,CRCpress.
7. Swaminathan M. (1990) Food and Nutrition, Bappco. The Bangalore PrintingandPublishing Co. Ltd.,Bangalore.
8. Tewari and Pankaj Kapoor S.C. (1988) Mushroom cultivation, MittalPublications,Delhi.
9. Changs.T.W.A.Hayanes 1978."BiologycultivationofMushrooms" AcadPress.N.Y.

Topics in previous year	Total no of topics	Total no of topic s revised added	% revision
19	21	2	11.76

#### RelationshipMatrixforCOs, POsandPSOs

Semester	Code	TitleoftheCourse					Hours	Credits				
II	20UBT2NME2:1	MushroomTechnology					3	2				
Course Outcomes (COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		

<b>CO1</b>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>CO2</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>CO3</b>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>CO4</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
<b>CO5</b>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
NumberofMatches(✓)=43      Relationship:High										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	VeryPoor	Poor	Moderate	High	VeryHigh

**Course Code: 22PBT2NME1:2**  
**Instruction Hours: 3**  
**Credits: 2**

**SEMESTER II**

**Exam Hours**

**Internal Marks: 25**

**External Marks:**

**75**

**NONMAJOR ELECTIVE COURSE –I**  
**VERMICOMPOSTING TECHNOLOGY**

**Objectives**

- To facilitate self-employment
- To know about the vermicomposting and its agricultural value
- This is helps to the students to understand about the earthworm and its applications.
- To know about organic fertilizer.

**Course outcomes**

- Acquired knowledge about mushroom cultivation and Mushroom production
- Acquired knowledge about economic importance of mushroom
- Describe and apply the uses and lore of many mushrooms and culture techniques to further explore their cultivation potential
- Acquired knowledge about applications of Mushroom
- To facilitate self-employment.

## UNIT - I

**Earthworms: Taxonomic position and diversity** - Types: morphological and ecological grouping - Ecological roles and economic importance of earthworms - need for earthworm cultur- Equipments for Hematology.

## UNIT - II

**Vermiculture: definition, scope and importance** - common species for culture - Environmental requirements, culture methods, wormery breeding techniques, indoor and outdoor cultures , monoculture and polyculture ,relative merits and demerits - Parts of photometer, types of photometry, colorimetry, spectrophotometry.

## UNIT - III

**Applications of vermiculture** - Vermiculture Bio-technology - Vermincomposting, use of vermicastings in organic farming / horticulture - earthworms for management of biomedical solid wastes , feed / bait for capture / culture fisheries , forest regeneration.

## UNIT - IV

**Marketing the products of vermiculture, quality control-** market research, marketing techniques , creating the demand by awareness, demonstration, and advertisements , packaging and transport , direct marketing.

## UNIT - V

Future perspectives, Predator / pathogen control in wormeries - Cost-benefit analysis of vermicomposting - Potentials and constraints for vermiculture in India.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
21	8	2	11	3	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

## TEXT BOOK

1. Brady, C.N,1974"TheNatureandPropertiesofsoils"MacmillanpublishingCo.NewYork,London.
2. Edwards, C.A.,andBohlen, P.J., 1996. BiologyandEcologyofEarthworms,ChapmanandHall,LondonIsmail,S.A.,1997,Vermiculture: TheBiologyEarthwormOrientLongman.

## REFERENCE

1. Edwards, C.A and Bohlen, P.J. 1996, Biology and Ecology of earthworms- 3rd Edition, Chapman and hall.
2. Ismail, S.A., 1970, Vermicology. The biology of earthworms. Orient Longman, London.
3. Lee, K.E., 1985. Earthworms- Their ecology and relationship with soil and land use, Academic Press, Sydney.
4. Brady, C.N, 1974 "The Nature and Properties of soils" Macmillan publishing Co. New York, London.

### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	20UBT2NME2:2	Vermicomposting Technology					3	2			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
CO2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
CO3	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
CO4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	
CO5	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Number of Matches (✓)=43		Relationship: High									

5.

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

### SEMESTER III

Course Code: 22PBT3CC5

Instruction Hours: 6

Credits: 5

Exam Hours: 3

Internal Marks: 25

External Marks: 75

### CORECOURSE –V PLANT BIOTECHNOLOGY

#### Objective

- Criticize and relate to the concept of plant tissue culture methods.
- Describe the applications transgenic plants.

#### Course Outcomes

- Acquired knowledge about the basic principles and techniques involved in plant cell culture and to understand the concepts of transformation and achievements of biotechnology in Plant systems.
- Design experiments for functional characterization of plant genes and to identify those suitable for creating agronomic ally important traits.
- Conceptualize plant transformation, selection of desirable genes for crop improvement, design binary vector and procedure for generating GM crops.
- Evaluate critically the safety issues of GM crops and products in the society.
- To understand the concepts of modern technology pertaining to large scale production of agricultural products.

#### UNIT I

**Basics of Plant Tissue culture-Plant tissue culture techniques-*Invitro* pollination and fertilization- Embryo culture and its applications- Embryogenesis and organogenesis- Micropropagation- haploids and their applications-Somaclonal variations and applications- Endosperm culture and production of triploids- Establishment of plant tissue culture- Culture media (types of media)- Explant: selection and preparation- History of Plant tissue culture-Tissue culture media Murashige and Skoog - Plant Growth Regulators**

#### UNIT-II

**Protoplast Culture-Genetic Manipulation- Genome Organization (*Arabidopsis thaliana*)- Introduction to protoplast isolation, culture and regeneration- methods of fusing protoplasts- somatic hybridization- Protoplast and tissue culture manipulation for genetic manipulation of plants- Cytoplasmic Male Sterility (CMS)- Thermo sensitive genic Male sterility (TGMS).**

#### UNIT-III

**Plant Transgenesis - Agrobacterium mediated gene transfer - Agrobacterium based vectors (Ti plasmids and Ri plasmids)- viral vectors and their applications - Direct gene transfer method selector poration, micro injection and particle bombardment-Characterization of transgenics- screen able and selectable markers - Marker free methodologies and gene targeting.**

## UNIT-IV

**Transgenic plants** - Transgenic rice with Vitamin A –transgenic plants with stress tolerance for drought and salinity- crop improvement, herbicide resistance-insect resistance,virus resistance-plants as bioreactors-Primary metabolite production-Secondary metabolite production-Organic foods and GMO-Genetically modified foods application-future applications- ecological impact of transgenic plants- Crop Improvement (Flavr savr tamato, Golden Rice)-Advantages and disadvantages of transgenic crops-Biosafety concerns and regulations of transgenic plants- Production of Organic food -Organic food, types of organic food, identifying organic food-organic food & preservatives- Genetic modification in food industry -back ground,history, controversies over risks, application, future applications.

## UNIT-V

**Plant Molecular Biology Techniques**-Quantitative Real time PCR- Southern blotting, Northern blotting, Western blotting- DNA sequencing methods and their applications- DNA finger printing in plants-Marker assisted selection(MAS) for crop improvement- Production of biofertilizers (Azolla): Criteria for strain selection-steps for preparing biofertilizers (Seed pelleting, inoculant carriers, quality standards for inoculants)- Green manuring.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
56	29	18	36	11	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. Slater A., Scott N.W. and Fowler, M.R. 2008. Plant Biotechnology - The genetic manipulation of plants. Oxford University press,USA.
2. Krishna G.K. A. Elangovan S.Devika 2016.Plant Biotechnology,New Vishal Publication.
3. Slater A., Scott N.W. and Fowler, M.R. 2008. Plant Biotechnology - the genetic manipulation of plants. 2<sup>nd</sup> Edition. Oxford University press,USA.
4. H.S. Chawla, 2002. Introduction to Plant Biotechnology. Oxford and IBH P Publishing Co. Pvt. Ltd. NewDelhi.

## References

1. Phundan Singh.2013.Principles of Plant Biotechnology.Kalyani Publishers,India.
2. V. Kumaresan. 2015. Applied Plant Biotechnology. Saras Publication,India.
3. Phundan Singh, 2013. Principles of Plant Biotechnology. KalyaniPublishers,India.
4. V. Kumaresan, 2015. Applied Plant Biotechnology. Saras Publication,India.
5. Singh, 2014. Plant Biotechnology, 2<sup>nd</sup> Revised Edition, Kalyani Publishers,India.
6. Nirmala 2021Plant Biotechnology Mjp Publishers
7. Halford N , 2015,Plant Biotechnology: Current And Future Applications Of Genetically Modified Crops,John WileyPublishers.
8. Singh. 2014. Plant Biotechnology, 2<sup>nd</sup> Revised Edition, Kalyani Publishers, India.
9. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. 2000. Molecular cell Biology. 4<sup>th</sup>Edition,W.H. Freeman & Company.

## Web Source

[https://annamalaiuniversity.ac.in/studport/download/agri/gen/resources/GPB%20316%20PLANT%20BIOTECHNOLOGY%20\(2+1\)%20-%20Online%20Study%20Material.pdf](https://annamalaiuniversity.ac.in/studport/download/agri/gen/resources/GPB%20316%20PLANT%20BIOTECHNOLOGY%20(2+1)%20-%20Online%20Study%20Material.pdf)

## Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
III	22PBT3CC5	Plant Biotechnology					6	5			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓		✓	✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓		✓	✓		✓	✓	✓	
CO3	✓	✓		✓	✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓	✓		✓	✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches(✓) = 45 Relationship: Very High											
<b>Mapping</b>	1-29%		30-59%		60-69%		70-89%		90-100%		
<b>Matches</b>	1-14		15-29		30-34		35-44		45-50		
<b>Relationship</b>	Very Poor		Poor		Moderate		High		Very High		

## SEMESTER III

Course Code: 22PBT3CC6  
Instruction Hours: 6  
Credits: 5

Exam Hours: 3  
Internal Marks: 25  
External Marks: 75

### CORECOURSE –VI ANIMAL BIOTECHNOLOGY

#### Objective

- Outline the characterization of the gene therapy concept.
- Comprehend the mechanism of animal cell culture.

#### Course Outcomes

- To have an understanding about the basics of Animal cell culture, transgenic animals, pest & animal management, Molecular markers and regulations about the use of Biotechnology.
- To improve artificial embryo transfer and nuclear transfer methods and applications.
- To learn the various type cell morphology, stages, and fertilization and transformation techniques employed in animal systems.
- Be able to describe gene transfer technologies for animals and animal cell lines.
- Be able to describe techniques and problems both technical and ethical in animal cloning.

#### UNIT-I

**Animal Cell, Tissue and Organ Culture**-History, Definitions, steps for preparation of cell culture room, culture Environment (Substrate and Media) - Techniques for establishing of cell lines - insect cell culture , organ and embryo culture - cryo preservation ,valuable products-Artificial insemination (IUI, ICSI) - Embryo transfer - cloning (DOLLY, MOLLY and POLLY)-Nuclear transplantation- *in vitro* fertilization technology- Genetic Engineering in animals – Transformation of animal cells- Cloning vectors- RTPCR-animal viral vectors.

#### UNIT-II

**Transgenic Animal**-Development and uses - mice, cattle, goat, fish and sheep and transgenic pets- Tendered meat production-Featherless chicken production-Recent trends in transgenic animal production-Transgenic breeding strategies -Molecular farming(products with strategic importance)- Insulin production using GMO- Stem cell differentiation and transplantation- Bioethics and stem cell research Transgenic Animals –Insulin– Growth Hormones.

#### UNIT-III

**Pest and Animal Management**- Juvenile hormone analogues - pheromones and genetic manipulation- Biotechnology of silkworms- Transgenic silk production - Baculo viruses vector and foreign gene expression- Biotechnological approach to the production of live feed.

#### UNIT-IV

**Molecular Markers** - Use of nucleic acid probes and antibodies in clinical diagnosis and tissue typing- Mapping of human genome - HGP (Human genome project), RFLP, RAPD and its applications- Genetic engineering approaches for the correction of genetic disorders- Human cloning, Gene silencing- Animal right activities Blue cross in India - Society for prevention of cruelty against animals- Ethical limits of Animal use- Human Rights and Responsibilities- Proteomics in disease biomarker side identification.

## UNIT-V

**Regulating the use of Biotechnology** - Regulating DNA technology - DNA barcoding-Regulating food and food ingredients- **Human gene therapy- Initial public concerns –accumulation of defective genes in future generation-** Future of gene therapy- Patenting Biotechnology inventions.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
60	23	9	20	12	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. B Singh, SK Gautam and MS Chauhan. 2015. Textbook of Animal biotechnology. TeriPublication.
2. M.K.Sateesh.2010.Biotechnology:V: (Including Animal Cell Biotechnology, Immunology and Plant Biotechnology). 2<sup>nd</sup> Edition. New Age International Pvt. Ltd.Publishers.

### References

3. Ashish S. Verma (Editor), Anchal Singh 2013, Animal Biotechnology: Models In Discovery and Translation 1st Edition, Kindle Edition Academic Press.
4. K. Srivastava, R. K. Singh, M. P. Yadav,2010,Animal Biotechnology ,Cbs Publisher
5. Renga MM.2013, Animal Biotechnology, Agrobios Publication.
6. R. Ian Freshney.2010. Culture of Animal cells & Manual of basic technique. 6<sup>th</sup> Edition. Wiley – Blakwellpublication.
7. Bernard B. Glick, Jack J. Pastunak. 2009. Molecular Biotechnology principles and application of Recombinant –DNA
8. R. Sasidhara. 2006. Animal Biotechnology. MJPublishers
9. Duhcy R.C. 2007. Text book of biotechnology. S.Chand & CompanyLtd.

### Web Source

<https://velhightech.com/wp-content/uploads/2019/04/BT-6007-Animal-Biotechnology.pdf>

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits
III	22PBT3CC6	Animal Biotechnology	6	5
Course	Programme Outcomes(POs)		Programme Specific Outcomes(PSOs)	

Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓		✓	✓	✓	✓
CO3	✓	✓		✓	✓	✓		✓	✓	✓
CO4	✓	✓	✓		✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) = 45 Relationship: Very High										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

## SEMESTER III

**Course Code: 22PBT3CCC3:1**  
**Instruction Hours: 6**  
**Credits: 5**

**Exam Hours: 3**  
**Internal Marks: 25**  
**External Marks: 75**

### **CORE CHOICE COURSE –I** **ENVIRONMENTAL BIOTECHNOLOGY**

#### Objectives

- Make them understand the process of ecosystem.
- Obtain the knowledge on the basics on nanotechnology.

#### Course outcomes

- To acquire knowledge about environmental pollution-sources, effects and control measures of environmental pollution.
- To be aware of the national and international concern for protecting the environment.
- To gain knowledge on the importance of environmental education and ecosystem.
- Gain an understanding of producing novel nano biologics and Nanopharmaceuticals
- Expand their knowledge on Ethical, Safety and regulatory issues of Nanomedicine.

#### UNIT I

Pollution and its types-Global Environmental Problems-Industrial Pollution and its remedy- Greenhouse effect and global warming-Measures to control greenhouse effect, acid rain, climate change- Depletion of ozone -ozone hole- effect of ozone depletion - Measures to control ozone depletion- depletion of natural resources- deforestation and loss of biodiversity- El Nino-Southern oscillation and La Niña-sea level rise.

#### UNIT II

Treatment processes for wastewater and sewage- Waste water and sewage treatment - Aerated lagoons- Activated sludge,-Trickling filters and biological tower- rotating biological contactors- Landfill technologies - landfill sites; Composting - composting plant process- aerated pile system- Tunnel composting- rotating drum systems- anaerobic composting; Lagoons - Aerobic Stabilization Lagoons and Anaerobic Stabilization Lagoons.

#### UNIT III

Biotechnological methods for pollution detection and abatement- General bioassay in pollution monitoring- DNA-gene probe- Immuno assay- Bio luminescent Lux reporter gene technology- Biosensor in environmental analysis- Photosynthesis as a means of reducing CO2 emission- biological calcification- biological nitrogen and phosphorus removal from wastewater-Plants in aquatic metal pollution abatement- Engineering Strategies for Bioremediation - In Situ and Ex Situ Bioremediation.

#### UNIT IV:

Emerging techniques in specific pollution problems and eco-friendly bio products- biofiltration- novel electrochemical DNA sensor- Biodegradation of polymer - polyethylene and polypropylene- poly (L-lactide), Bioremediation of crude oil spills- Biopesticide- biofertilizer- bio energy and biofuels- biological hydrogen generation- microbial fuel cell (MFC)-biodegradable plastics.

#### UNIT V:

Value added byproducts of Environmental Biotechnology- Composting, aerobic intensive bioconversion of organic wastes into fertilizer- recovery of metals from - mining, industrial waste, waste stream by sulfate reducing Bacteria-recovery of phosphate and ammonia by iron reducing and oxidizing Bacteria.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
55	15	13	18	9	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

#### Text Books

1. Jogdand, S.N. 2005. Environmental Biotechnology. 1<sup>st</sup> Edition. Himalaya Publishing House, Bombay.
2. Technoglous, G., Burton, F.L. and Stensel, H.D. 1995. Wastewater Engineering – Treatment, Disposal and Reuse. 3<sup>rd</sup> Edition. Metcalf and Eddy, Inc., Tata Mc Graw Hill, NewDelhi.

#### References

1. De, A.K. 2004. Environmental Chemistry. Wiley Eastern Ltd. NewDelhi.
2. Ratner, M. and Ratner, D. 2005. Nanotechnology: A Gentle Introduction to the Next Big idea. Pearson Education, Inc. NJ, USA.
3. Christef, M., Niemeyer, C.A., Mirkin. 2004. Nano biotechnology. Concepts, Application and Properties. Wiley - VCH Publishers, New York.
4. Tuan Vo-Dinh. 2007. Nanotechnology in Biology and Medicine: Methods, Devices and Applications. Taylor and Francis Inc., London.
5. Challa S.S.R. Kumar (Ed). 2006. Biological pharmaceutical Nanomaterial, Wiley-VCH Verlag GmbH & Co, KgaA. Weinham, Germany.

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[https://www.brainkart.com/subject/Environmental-Biotechnology\\_242/](https://www.brainkart.com/subject/Environmental-Biotechnology_242/)

[https://www.phys.sinica.edu.tw/TIGP-NANO/Course/2011\\_Spring/classnotes/NanoA\\_Week1.pdf](https://www.phys.sinica.edu.tw/TIGP-NANO/Course/2011_Spring/classnotes/NanoA_Week1.pdf)

#### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
III	22PBT3CCC3: 1	Environmental Biotechnology					6	5			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓	✓	✓	✓	✓		✓	✓	
CO3		✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓		✓	✓	✓	✓		✓	
CO5	✓		✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches(✓) = 45 Relationship: Very High											
Mapping	1-29%	30-59%			60-69%		70-89%		90-100%		
Matches	1-14	15-29			30-34		35-44		45-50		

<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High
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### SEMESTER III

**Course Code: 22PBT3CCC3:1**

**Instruction Hours: 6**

**Credits: 5**

**Exam Hours: 3**

**Internal Marks: 25**

**External Marks: 75**

### CORECOURSE –II MARINE BIOTECHNOLOGY

#### Objectives

- Obtain the knowledge on the basics on Marine organisms.
- Outline the characterization of the concept of marine biotechnology.

#### Course Outcomes

- The students will be able to know marine microbes and their applications
- The students will be able to understand Aquaculture for research
- Have acquired a detailed knowledge of pharmaceutical products from marine organism
- The students will be able to understand Environmental impacts of aquatic biotechnology
- The students will be able to know biomaterials and bioprocessing

#### UNIT-I

**Introduction to marine microbes in the ocean -History of marine biotechnology- Application of marine microbes- Recent trends in marine biotechnology-Scope of marine biotechnology-Importance of marine diversity- Marine biodiversity:Diversity&adaptation-Recent trends in marine biotechnology-Scope of marine biotechnology-Importance of marine diversity - Euphotic, mesopelagic, bathopelagic, benthos, deep sea- Marine microbial diversity: Marine microbial habitats - Microbial distribution in the oceans- Macro ecological theory and ocean microbes- Factors that impact marine microbial diversity-Interactions between marine microbes and marine macroorganisms- Symbiosis within vertebrates-Microbial effects on the ecology and life history of marine invertebrates-Marine viruses- Application of marine science- Coral reeves- Marine animal and habits-Jelly fish life cycle**

#### UNIT-II

**Aquaculture and biotechnology -Importance of aquaculture, Criteria of selection of species for aquaculture- Culture practices of milk fish, mullets and sea bass-Monoculture, polyculture and integrated fish farming .Culture practices of tiger shrimp, *Macrobrachium rosenbergi*- crabs and lobsters- Culture practices of edible oyster, pearl oyster and mussel-Importance of oyster -Poisonous sea snakes-Culture practices of Seaweeds- Applications of**

seaweeds Fish genetics: gynogenesis, androgenesis, polyploidy, control of sex, artificial insemination, eye stalk ablation- Transgenesis and DNA Vaccine development for aquacultured fish, cryopreservation.

### UNIT-III

**Biomedical importance of marine organisms-** Screening for new metabolites from marine microorganisms -Importance of marine microbes- Production of useful chemicals by marine microalgae -Bioenergy production, Marine enzymes- Fatty acids from lipids of marine organisms.- Marine pharmacology: Potentialities in the treatment of infectious diseases- Osteoporosis , Alzheimer’s disease- New antibiotics and medicines from marine organisms- The secondary metabolites and biosynthetic gene clusters of marine cyanobacteria. Secondary metabolites from marine actinomycetes and fungi, Probiotics.

### UNIT-IV

**Biomaterials and bioprocessing-Byproducts:** processing of low cost fish, minced meat-fish oil-fish meal, fish sausages-isinglass, glue, fish silage, fin rays-chitosan, chitin pearlescence, agar, alginates, carrageenan and heparin.

### UNIT-V

**Environmental impacts of aquatic biotechnology-**Human impacts on marine microbial diversity-Critical microbially mediated equilibria that impact environmental and human health - Using marine microbes to ameliorate environmental deterioration- Control of oils pills and bioremediation. Environmental issues- Effects of biofouling and biodeterioration on marine structure-Protection methods against corrosion and fouling-Application of biotechnology in controlling the biodeterioration of wood and synthetic substances in the sea-Application of marine science- Coral reeves- Redtides: Causative factors and effects on the organisms of marine environment.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
51	22	16	19	13	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

1. Proksch and Werner E.G.Muller, Frontiers in Marine Biotechnology, Horizon Bioscience, 2006.

References

1. Le Gal, Y., Ulber, R, Marine Biotechnology I. Advances in Biochemical Engineering/Biotechnology (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg. Vol. 96. Pp. 287, 2005
2. Le Gal, Y., Ulber, R, Marine Biotechnology II: Advances in Biochemical Engineering/Biotechnology (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg. Vol. 97. Pp. 261, 2005.
3. Jennie Hunter-Cevera, David Karl and Merry Buckley, Marine microbial diversity: The key to earth's habitability: A Report from the American academy of microbiology, Published by American Academy of Microbiology, held (April 8- 10, 2005) in San Francisco, California. Pp. 28, 2005.

Web Source

<https://www.seamester.com/pdf/student-academic-materials/OCB-student-handbook-v3.6.pdf>

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
III	22PBT3CCC3:1	Marine Biotechnology					6	5			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓		✓	✓	✓		✓	✓	✓	
CO2	✓		✓	✓	✓	✓	✓		✓	✓	
CO3	✓	✓		✓	✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓		✓	✓	✓		✓	✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches(✓) = 43 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

### SEMESTER III

Course Code: 22PBT3CP3

Instruction Hours: 6

Credits: 3

Exam Hours: 6

Internal Marks: 40

External Marks: 60

#### COREPRACTICAL –III

#### PLANT AND ANIMAL BIOTECHNOLOGY(P)

##### Objective

- Demonstrate the experiments of plant biotechnology.
- Practically analyze the process of animal biotechnology.

##### Course outcomes

- Acquired knowledge about hands on training on plant & animal tissue culture and biotechnology.
- Explain the basis for formulation of plant tissue culture medium for growth and differentiation of plants
- Discuss the importance and applications of different techniques employed in tissue culture and storage of plant germplasm
- Illustrate the preparation of mesophyll protoplasts and analyze their fusing using PEG.
- To know Animal cell culture and different type of cell culture and application of cell culture.

##### PLANTBIOTECHNOLOGY

1. Introduction to the laboratory and general Safety Practices for plant cell, Plant growth and development. Laboratory Report Guidelines (Theory & Demo).
2. Aseptic culture techniques for establishment and maintenance of cultures (Handson).
3. Tissue culture media preparation: Preparation of stock solutions of MurashigeSkoog basal medium and plant growth regulator stocks (Hands on).
4. Mechanical isolation of protoplast .Enzymatic isolation of protoplast and culture(Handson).
5. Isolation of plant genomic DNA by modified CTAB method(Handson).
6. Isolation of plasmid DNA
7. Micropropagation method
8. Transformation of leaf discs with Agrobacterium(Handson).
9. Expression of foreign genes in to plant cells: use of Agrobacterium tumefaciens(Theory).
10. Morphogenesis in tobacco leaf tissue(Handson).
11. Regeneration abilities of the Shoot Apical Meristem(SAM).
12. Preparation of chloroplast from leaves(Handson).
13. Effect of different light wave lengths on germinating corn embryos(Handson).
14. Measurement of photosynthesis(Handson).
15. Protoplast Isolation
16. Separation of thylakoid and stromal proteins bySDS-Gelelectrophoresis.
17. Isolation of DNA& RNA from light and dark-grown seedlings.

##### ANIMALBIOTECHNOLOGY

18. Isolation of DNA from Animal liver.
19. Isolation of DNA from human cheek cells.
20. Isolation of DNA from blood.
21. Quantification of DNA by spectrophotometric method.
22. Size analysis of DNA byAgarosegel electrophoresis.
23. Isolation& identification of stem cells

Total Number of Topics	Local	Regional	National	Global	Category Based on %
23	11	4	7	1	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

#### Text Books

1. Monica. A. Hughes. 1999. Plant Molecular Genetics. Pearson Education limited, England.
2. Harrison, M.S. and Bal, I.R. 1997. General techniques of all culture Cambridge University press.

#### References

1. S S Purohit, 2006, A Laboratory Manual of Plant Biotechnology, Agrobios (India).
2. Chawla, 2008, Plant Biotechnology: Laboratory Manual For Plant Biotechnology Oxford & Ibh Publishing Company Pvt. Ltd.
3. Ss.Purohit 2010, A Laboratory Manual Of Plant Biotechnology, Agrobios (India).
4. Amit Gupta, 2019, Immunology And Animal Biotechnology - A Laboratory Manual , Lap Lambert Academic Publishing.
5. Sunil D Purohit & Neelu Joshi, 2017, Molecular Biology & Biotechnology (A Practical Manual) Agrobios (India).
6. M. S. Clark. 1997. *Plant Molecular Biology: A Laboratory Manual*. Springer-Verlag.
7. Slater A., Scott N.W. and Fowler, M.R. 2008. Plant Biotechnology - the genetic manipulation of plants. 2<sup>nd</sup> Edition. Oxford University press, USA.
8. H.S. Chawla, 2002. Introduction to Plant Biotechnology. Oxford and IBH P Publishing Co. Pvt. Ltd. New Delhi.

#### Web Source

[https://www.academia.edu/21781061/Lab\\_in\\_Industrial\\_Plant\\_and\\_Animal\\_Biotechnology\\_Students\\_Manual](https://www.academia.edu/21781061/Lab_in_Industrial_Plant_and_Animal_Biotechnology_Students_Manual)

#### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
III	22PBT3CP3	Plant and Animal Biotechnology (P)					8	5			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

<b>CO4</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>CO5</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) = 46 Relationship: Very High										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

### SEMESTER III

**Course Code: 22PBT3EC3:1**  
**Instruction Hours: 5**  
**Credits: 4**

**Exam Hours: 3**  
**Internal Marks: 25**  
**External Marks: 75**

### ELECTIVE COURSE –I **STEM CELL BASICS AND APPLICATION**

#### Objectives

- Outline the characterization of the stem cells and its components.
- Comprehend the mechanism of stem cells culture and signal.

#### Course outcomes

- To strengthen the knowledge of students on Stem cell basics and their applications for the benefit of mankind.
- To impart knowledge about stem cell culturing and stem cell signalling.
- To acquire knowledge about Embryonic Stem Cells and Adult stem cell
- To know about Stem cell policy, ethics and stem cell research.
- To acquire knowledge about Gene therapy

#### UNIT-I

Definition, properties of stem cells- self renewal, clonality, pluripotency, totipotency- Where Do Stem Cells Come From - stem cells of the early embryo, ontogeny of adult stem cells- stem cell niche-Molecular Bases of Pluripotency- signal transduction cascades to the stem cell nucleus - Present Perspective and Future Challenges.

#### UNIT-II

Pluripotent Stem Cells in the Early Embryo- Embryonal Carcinoma Cells- Derivation of Embryonic Stem Cells- Factors Influencing ES Cell Derivation- Embryonic Germ Cells- Genome manipulation in ES cells - Insertional Mutagenesis and Gene Trapping- Targeted Gene Modification- Chromosome Engineering- Maintenance of ES Cell Pluripotency.

### UNIT-III

Somatic stem cells - test for identification of adult stem cells - adult stem cell differentiation - trans differentiation - plasticity - different types of adult stem cells: Hematopoietic stem cells, mesenchymal stem cells, Bone Marrow Stem Cells, Adipose (fat) Stem Cells.

### UNIT-IV

Reservoirs of postnatal stem cells- current approaches to tissue engineering- ex vivo culture of postnatal stem cells, delivery of stem cells- reconstruction of the skeleton - bone and cartilage, skeletal and cardiac muscle regeneration; ex vivo reconstructions - cells, scaffolds, and bioreactors-activation of local and distant endogenous stem cells.

### UNIT-V

Stem cells in spinal cord injury- heart disease, diabetes, gene therapy- Genome editing of stem cells- Ethics of Human Stem Cell Research- FDA Product and Preclinical Regulatory considerations-Computational stem cell biology-applications of Bioinformatics Tools in Stem Cell Research.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
38	17	4	6	11	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### TEST BOOKS

1. Kursad Turksen, Embryonic Stem cells - Protocols, 2nd Edition, Humana Press, 2002.
2. Stem cell and future of regenerative medicine. By committee on the Biological and Biomedical applications of Stem cell Research. National Academic press, 2002.

### References

1. AriffBongso, EngHin Lee “Stem Cells: From Bench to Bedside” World Scientific Publishing Company. 2005.
2. C S Potten “Stem Cells” Elsevier,2006.
3. Daniel R. Marshak “Stem cell biology” Cold Spring Harbor Laboratory Press,2013.
4. Robert Lanza “Essentials of Stem Cell Biology” Elsevier, 2009.
5. Peter Quesenberry “Stem cell biology and Gene Therapy” Wiley-Liss,2005.

### Web source

<https://www.yourgenome.org/facts/what-is-a-stem-cell>

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits
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<b>III</b>	22PBT3EC3:1	Stem Cell Basics and Application				5	4			
<b>Course Outcomes (COs)</b>	<b>Programme Outcomes(POs)</b>					<b>Programme Specific Outcomes(PSOs)</b>				
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>
<b>CO1</b>	✓	✓		✓	✓	✓	✓	✓	✓	✓
<b>CO2</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>CO3</b>	✓	✓	✓	✓		✓	✓	✓	✓	✓
<b>CO4</b>	✓		✓	✓	✓	✓	✓		✓	✓
<b>CO5</b>	✓	✓	✓		✓	✓	✓	✓	✓	✓
Number of Matches(✓) = 45 Relationship: Very High										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

### SEMESTER III

**Course Code: 22PBT3EC3:2**

**Instruction Hours: 5**

**Credits: 4**

**Exam Hours: 3**

**Internal Marks: 25**

**External Marks: 75**

### ELECTIVE COURSE –I DEVELOPMENTAL BIOLOGY

Objective

- Outline the characterization of the gametes.
- Comprehend the mechanism of embryonic development.

Course outcomes

- This helps to the students to understand about organization and function in animals.
- To know about processes of growth and development and fertilization in mammals
- Students will be able to give two examples of organogenesis, including genes and signal transduction pathways that lead to organ system formation.
- Students will be able to explain embryonic patterning, using examples that include genes known to act in patterning events.
- Students will be able to generally describe the concepts of cellular competence, induction, specification, commitment and differentiation in embryonic development.

UNIT-I

Gametogenesis and Fertilization - Definition, scope & historical perspective of development Biology - Gametogenesis, Spermatogenesis, Oogenesis - Fertilization, Definition, mechanism - types of fertilization - Different types of eggs on the basis of yolk.

UNIT- II

Early embryonic development cleavage - Definition, types, patterns & mechanism - Blastulation, Process, types & mechanism - Gastrulation: Morphogenetic movements, epiboly, emboly, extension, invagination, convergence - de, lamination, Formation & differentiation of primary germ layers Fate Maps in early embryos.

### UNIT- III

Embryonic Differentiation - Embryonic Differentiation - Cell commitment and determination - the epigenetic landscape, a model of determination and differentiation - control of differentiation at the level of genome - transcription and post, translation level Concept of embryonic induction Primary, secondary & tertiary embryonic induction - neural induction and induction of vertebrate.

### UNIT-IV

Organogenesis, Neurulation, notogenesis, development of vertebrate eye – Fate of different primary germ layers - Development of behavior - constancy & plasticity, Extra embryonic membranes - placenta in Mammals.

### UNIT-V

Organization of shoot and root apical meristem, and development - Leaf development and Phyllotaxy – Development of Microsporangium and Megasporangium - Pollination, Embryo – Embryosac development and double fertilization in plants - seed formation and germination, Outline of experimental embryology.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
33	8	4	8	9	Global

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### TextBooks

1. Gilbert, Scott's. 10<sup>th</sup> edition (2014). Developmental biology. Sinauer Association, Inc. Publishers.
2. Chattopadhyay. S. 2016. An Introduction to Developmental Biology, Books and Allied (P) Ltd, Kolkata. First Edition.

### References

3. Bruce M Carlson, Patten's Foundation of Embryology, Tata McGraw Hill Co.
4. Balinsky, B.I., 1981. 5<sup>th</sup> edition. An Introduction to Embryology, W.B. Saunders Co., Philadelphia
5. Verma, P.S., Agarwal, V.K., and Tyagi., 1995. Chordate embryology, S. Chand & Co., New Delhi

Semester	Code	Title of the Course					Hours	Credits			
III	22PBT3EC3:2	Developmental Biology					5	4			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
CO2	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

<b>C03</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>C04</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>C05</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Number of Matches(✓)=42 Relationship:High										
<b>Mapping</b>	1-29%		30-59%		60-69%		70-89%		90-100%	
<b>Matches</b>	1-14		15-29		30-34		35-44		45-50	
<b>Relationship</b>	Very Poor		Poor		Moderate		High		Very High	

### SEMESTER III

Course Code: 22VABT2:1

Exam Hours: 3  
Internal Marks: 25  
External Marks: 75

Credits: 2

### VALUE ADDED COURSE –II FOOD AND NUTRITION

#### Objectives

- Obtain the knowledge on the basics on Food system.
- Outline the characterization of the concept of nutrition system.

#### Course outcomes

- Acquired knowledge of Nutrition and Food Science
- Acquired comprehensive knowledge of role of Nutrition in human life
- This course comprehensive knowledge of Carbohydrates, Protein, Vitamins and Lipids
- Acquired comprehensive knowledge of Food pyramid
- Acquired comprehensive knowledge of nutritional deficiency disorder.

#### UNIT-I

**Definitions :** Food Science, Food, Nutrients, Nutrition Status- Malnutrition, under Nutrition, over Nutrition, Balanced diet, Hunger- Hollow Hunger- Hidden Hunger- Appetite- Health- Meal, Menu- Balanced Diet and Food Groups: Basic four and Basic five- Nutritional Classification of foods - Energy yielding, Body Building and protective foods- **Cooking Methods: Moist and Dry heat methods of cooking, merits and demerits- Fireless cooking- Advantages of cooking method.**

#### UNIT-II

**Introduction to Nutrition and Food Science-** Definition, history, RDA, factors affecting RDA- Methods used for deriving RDA- Basic five food groups and the functions of food- Food pyramid- Food safety- Food regulations in India.

#### UNIT-III

**Lipid classification, function, digestion and absorption, sources, excess and deficiency disorder-** Carbohydrates classification, functions, digestion and absorption, Sources, deficiency diseases- Role of fibre in human Nutrition, Energy units- Carbohydrate, protein, fat as a source of energy- Uses of carbohydrates.

UNIT-IV

Protein, classification, functions, sources digestion and absorption, sources and deficiency disorders.

UNIT-V

Vitamins , Fat soluble vitamins A, D, E & K, functions, sources, requirements deficiency diseases-Water soluble vitamins B like thiamine, Riboflavin, Niacin, Phridoscin, Folic acid, B2 - Vitamin Cand their functions sources requirements and deficiency diseases -Minerals , Calcium, phosphorus, Sodium, Potassium, Iron, Iodine, Flourine and their functions, sources requirements and deficiencydiseases.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
30	4	3	15	8	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

Text Books

1. ArunaThaker &ArleneBarton,MulticulturalHandbookofFood,NutritionandDietetics(2012),BlackwellPublishing.
2. MichaelGibney,Hester.H.Voster&Frans. J.Kok,IntroductiontoNutrition(2002),BlackwellPublishin

References

1. GuthrieH.A.–IntroductoryNutritionC.V.MosbyCo. St.Louis.
2. Bogert, J.G.V.Briggs, D.H.CallowayNutritionandphysicalfitness(1985), 11thedition
3. W.B.SaundersCo.,Philadelphia,London,Toranto.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
III	22VABT2:1	Food and Nutrition					0	2			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓		✓		✓	✓	✓	
CO2	✓		✓	✓	✓	✓	✓		✓	✓	
CO3	✓	✓	✓		✓	✓	✓	✓	✓		
CO4	✓		✓	✓	✓	✓		✓	✓	✓	
CO5	✓	✓		✓	✓	✓	✓		✓	✓	
Number of Matches(✓) = 41 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

### SEMESTER III

**Course Code: 22VABT2:2**

**Credits: 2**

**Exam Hours: 3**  
**Internal Marks: 25**  
**External Marks: 75**

### VALUE ADDED COURSE –II QUALITY CONTROL AND HYGIENIC PRACTICE

#### Objectives

- Make them understand the process of hygienic practices in industries.
- Obtain the knowledge on the basics on Quality control and management.

#### Course outcomes

- Acquire the knowledge about Quality control and management
- To learn the basic knowledge in First aid procedures.
- To maintain the microbiological quality in all the needy environment
- To create a basic understanding of the hygienic practices in industries.
- To learn the hygienic healthy practices and Health from environmental factors.

#### UNIT-I Quality control

Quality assessment of Equipment's, chemicals, glass wares and laboratory environments - Variance - Quality control calculations- Quality management-Maintenance of records and reports-Regulations of quality measurements-Types of quality measurement.

## UNIT-II Quality assurance and policy I

Quality assurance - Definition, designing of microbiology laboratory, applications-In house Committee for quality assurance-Persons involved, Internal Microbial Quality control Policy-Quality Check at every step from collection of raw materials till it reaches the customer-Implementation of ISO standards and history- definitions, principles and use of HACCP in Food Industry.

## UNIT- III Quality assurance and policy II

Quality assessment of disposal –decontaminated matters and other biological effluents-Quality management in transportations of cultures. BIS -Biological parameters references and standards. Good laboratory practices- Management of laboratory hazards and knowledge in First aid procedures.

## UNIT-IV Quality control organizations

Role, function, monitoring and mitigation activities of quality control (National, international and non-govt.) organizations -ISO/TC 34, 48, 93, 147, 190, 194, 255; ISO 9000;ISO 22000; ISO 9001;ISO9004;ISO19011;-AS9100;ISO13485;ISO/TS 16949;MBNQA;-Lean;SixSigma;TQM-USDA,FDA,HARPC,IFPTI,-FoodSafetyand Standards Authority of India.

## UNIT-V Hygienic practice

Hygienic practices in industries- antibiotics-disinfectants, definition, sources, determination of antimicrobial efficiency - evaluation of disinfectants, factory and hospital hygiene-good manufacturing practices-sterilization control and sterility assurance.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
29	4	9	13	3	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text Books

1. Food Microbiology,2005,Frazier and D.C.Westhoff, Third Ed, TATA McGra Hill Pub. New Delhi.
2. Rajesh Bhatia and Rattan lal Ichhpujani. 1995. I ed. “Quality assurance in Microbiology”.

### References

1. Industrial Pharmaceutical Microbiology- II: Standards & Controls. Editors – Dr Norman Hodges and Professor Geoff Hanlon (University of Brighton). (REF; [www.euomed.uk.com](http://www.euomed.uk.com)).

2. Water Analysis – A practical guide to Physico – Chemical & Microbiological water examination and Quality assurance – W.Schneider, W.Fresenius & K.E. Quentin. Springer – Verlag Pub. Heidelberg.

**Web source**

[https://ec.europa.eu/programmes/erasmus-plus/project-result-content/908fceb3-6d8d-43a0-bc76-d780aeb1a13b/Hygiene-Sanitation-Handbook\\_ENG.pdf](https://ec.europa.eu/programmes/erasmus-plus/project-result-content/908fceb3-6d8d-43a0-bc76-d780aeb1a13b/Hygiene-Sanitation-Handbook_ENG.pdf)

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course	Hours	Credits						
III	22VABT2:2	Quality Control and Hygienic Practices	-	2						
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓		✓		✓	✓	✓
CO2	✓		✓	✓	✓	✓	✓		✓	✓
CO3	✓	✓	✓		✓	✓	✓	✓	✓	
CO4	✓		✓	✓	✓	✓		✓	✓	✓
CO5	✓	✓		✓	✓	✓	✓		✓	✓
Number of Matches(✓) = 41 Relationship: High										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

**SEMESTER IV**

**Course Code: 22PBT3CC7**  
**Instruction Hours: 6**  
**Credits: 5**

**Exam Hours: 3**  
**Internal Marks: 25**  
**External Marks: 75**

**CORECOURSE –VII**  
**BIOPROCESS TECHNOLOGY**

**Objectives**

- Criticize and relate to the concept of bioprocess technology
- Describe the applications Industrial microbes

**Course outcomes**

- The students will be able to demonstrate a familiarity with the wide diversity of microbes, and their potential for use in microbial biotechnology
- The students will be able to understand screening methods for Industrial microbes
- Have acquired a detailed knowledge of number of products which are produced by industrial fermentation processes
- The students will be able to understand Biology of Industrial Microorganisms
- The students will be able to know the Industrial production of various products

## UNIT-I

Basic principle of Biochemical engineering Isolation, screening and maintenance of industrially important microbes- Types of enzymes produced from industries-Microbial growth and death kinetics (an example from each group-particularly with reference to industrially useful microorganisms) -Strain improvement for increased yield and other desirable characteristics -Microbial Growth and Preservation-Mathematical expression of bacterial growth, generation time and growth rate-Different phases of growth & growth curve and -Batch, continuous and synchronous cultures-Diauxic growth and factors affecting microbial growth-Stress response-Microbial death curve under adverse conditions-Strain improvement for increased yield, other desirable characteristics - Measurement and control of bioprocess parameters, basic principles of feed - control, proportional, integral and derivative control.

## UNIT- II Concepts of basic mode of fermentation processes

Bioreactor designs and types of fermentation and fermentors -Types of fermentor-Concepts & basic modes of fermentation -Batch, fed batch and continuous fermentation-Conventional fermentation versus biotransformation -Solid substrate, surface and submerged fermentation -Fermentation economics and fermentation media-Fermenter design - mechanically agitated, pneumatic and hydrodynamic fermenters-Large scale animal and plant cell cultivation and air sterilization-Upstream processing-media formulation, sterilization, aeration and agitation-Measurement and control of bioprocess parameters, scale up and scale down process.

## UNIT- III Down stream processing

Bioseparation - filtration, centrifugation, sedimentation, flocculation, microfiltration, sonication-Cell disruption- enzymatic lysis and liquid - liquid extraction-Purification by precipitation (ammonium sulfate, solvent), electrophoresis and crystallization. -Extraction (solvent, aqueous two phase, super critical) and chromatographic techniques-Reverse osmosis and ultrafiltration-Drying, crystallization, storage and packaging-Treatment of effluent and its disposal.

## UNIT-IV Applications of enzymes in food processing

Mechanism of enzyme function and reactions in food processing-Enzymic bioconversions e.g.starch and sugar conversion processes-High fructose corn syrup, hydrolyzed protein and their down stream processing-Baking by amylases, deoxygenation and de-sugaring by glucose oxidase,-beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.

## UNIT-V Applications of Microbes in food processing and production

Fermented foods and beverages, food ingredients and additives used in fermentation and their purification-Fermentation as a method of preparing and preserving foods-Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products-Process wastes - whey, molasses, starch substrates and other food wastes for bioconversion to useful products-Bacteriocins from lactic acid bacteria -production and applications in food preservation.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
51	21	12	18	15	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

#### Text Books

1. Jackson AT. 1991. Bioprocess Engineering in Biotechnology. Prentice Hall, EngelwoodCliffs.
2. Shuler ML and Kargi F. 2002. Bioprocess Engineering: Basic concepts, 2<sup>nd</sup> Edition, Prentice Hall, EngelwoodCliffs.

#### References

1. Young M.M. and Reed. 2004. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine. Vol 1, 2, 3 and 4. Elsevier India Private Ltd, India.
2. Mansi EMTEL and Bryle CFA. 2007. Fermentation Microbiology and Biotechnology. 2<sup>nd</sup> Edition, Taylor & Francis Ltd, UK.
3. Kalaichelvan, 2021, Bioprocess Technology, Mjp Publishers
4. Ogaku Ravindra, 2015, Advances in Bioprocess Technology, Springer Nature
5. Michael L. Shuler / Fikret Kargi, 2015, Bioprocess Engineering: Basic Concepts, Pearson Education India.

#### Web source

<https://www.studocu.com/en-gb/document/university-college-london/bioprocess-analysis/lecture-notes-all-lectures-not-chronologically/634786>

#### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
IV	22PBT3CC7	Bioprocess Technology					6	5			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓		✓	✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓	✓	✓	✓		✓	✓	✓	
CO3	✓		✓	✓	✓	✓	✓	✓	✓	✓	
CO4	✓	✓		✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches(✓) = 46 Relationship: Very High											
Mapping	1-29%	30-59%			60-69%		70-89%		90-100%		
Matches	1-14	15-29		30-34		35-44		45-50			
Relationship	Very Poor	Poor		Moderate		High		Very High			

## SEMESTER IV

**Course Code: 22PBT3CC8**  
**Instruction Hours: 6**  
**Credits: 5**

**Exam Hours: 3**  
**Internal Marks: 25**  
**External Marks: 75**

### **CORECOURSE –VIIi** **FOOD BIOTECHNOLOGY**

#### Objectives

- Make them understand the process of food processing.
- Obtain the knowledge on the basics on food technology.

#### Course outcomes

- To gain knowledge on the basic principles of food processing and the various methods used to process foods
- To be aware of the processed food products available in the market.
- To understand the basic principles of processing and the unit operations employed in a food processing plant
- To help the students to understand about the industrial food process and consumer safety.
- Acquired knowledge about Technology of Fruits and Vegetables, milk, Cereals and Pulses

#### UNIT-I Technology of Fruit and Vegetable Processing

Climacteric and Non climacteric fruits-Overview of processing technologies-Edible coatings - Osmotic dehydration - Fruit and Vegetable dehydrations- Fruit and Vegetable powders – Quality control.

#### UNIT-II Cereals and Pulses Technology

Milling of Cereals - Rice, Wheat, Maize, Sorghum, Oats, Barley-Parboiling of rice - Products from rice-Convenience food products from rice, Maize - Processing of maize - Tortillas Quality control.

#### UNIT -III Dairy Technology

Milk- Physical and Chemical properties of milk-Pasteurisation of milk. Process for the manufacture of Cheese,Butter, Yoghurt,Dahi,Ice-cream,-Whey products-Quality control.

#### UNIT-IV Technology of Plantation products

Tea, Coffee and Cocoa (Chemistry and Technology)-Process for manufacture of CTC and Green tea, Instant tea,Instant coffee-Cocoa processing -Fermentation, Manufacture of cocoa powder, chocolates

#### UNIT-V Technology of Meat, Fish and Poultry products

Comminuted meat products - cured meats - Bacon and Ham -Luncheon meats - Sausages, Canning and Dehydration, curing and Smoking- Irradiation- Eggs Processing-Liquid eggs, Pasteurisation, Egg white-Methods of analysis and quality control of Meat and egg products.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
32	13	10	4	5	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

#### Text Books

1. Mountney G.J. and Parkhurst R.C. Poultry Products Technology, 3rd Edition, Food Products Press Inc., NY, 2005.
2. Ranken Michael D. and Ranken M.D. Handbook of Meat Product Technology, Blackwell Science, U.K. 2000.

#### References

1. Goyal&Kumari: SureshChandra,2009,Agricultural Processing and Food Technology.
2. P J Fellows,2016, Food Processing Technology: Principles and Practice (Woodhead Publishing Series in Food Science, Technology and Nutrition), Woodhead Publishing.
3. Gillian Evans D'suza,2016,Food Processing Technology, Oxford Book Company
4. N. K. Jain ,2011,Fundamentals of Food Science Technology Processing and Preservation, Cyber Tech Publications.
5. Atul Agnihotri ,2017,Food Processing Technology, crescent publishing new delhi.
6. Nandan Sit and S Laxmikant Badwaik ,2018,Innovations in Food Processing Technology, New India Publishing Agency.
7. Lisa Jordan,2019,Food Processing and Preservation Technology, Syrawood Publishing House.
8. Dr. Vedprakash D. Surve ,2019,Food Technology and Processing, Oxford Book Company.

#### Web source

<https://unaab.edu.ng/food-science-and-technology-lecture-notes/>

#### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
1V	22PBT4CC8	FoodBiotechnology					6	5			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓		✓	✓	✓	✓	✓		✓	✓	
CO2	✓	✓	✓	✓	✓	✓		✓	✓	✓	
CO3	✓	✓		✓	✓	✓	✓		✓	✓	

<b>CO4</b>		✓	✓		✓	✓	✓	✓		✓
<b>CO5</b>	✓	✓	✓	✓		✓	✓	✓	✓	✓
Number of Matches(✓) = 41    Relationship: High										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

## SEMESTER IV

Course Code: 22PBT4EC  
Instruction Hours: 6  
Credits: 5

Exam Hours: 3  
Internal Marks: 25  
External Marks: 75

### CORECOURSE –VII BIOTECHNOLOGY FOR ENTREPRENEURS

#### Objectives

- Categorize and explain the role of Project management
- Compare and contrast the functions of Generation of Fund

#### Course outcomes

- To promoting bio-entrepreneurship
- Acquired knowledge about Project management
- Acquired knowledge about Generation of Fund
- Acquired knowledge about immobilization methods
- Acquired knowledge about Biotech enterprises

#### UNIT- I Introduction to Entrepreneurship

Entrepreneurship definition, factors necessary for entrepreneurship - desirables in a start up - mistakes to be avoided-pillars of bio-entrepreneurship - promoting bio entrepreneurship-biotechcompany road map, legal, regulatory and other business factors.

#### UNIT-II Identification of a Project

Project management: Search for a business idea, concept of project and classification-project identification, project formulation -project design and network analysis-project report, project appraisal.

#### UNIT- III Assessment of a Project

Financial analysis-Ratio analysis, Investment process, Break even analysis-Profitability analysis, Budget and planning process -Sources of finance: Source of development finance- Project financing, Institutional financing to Entrepreneurs- Financial institutions, Role of consultancy organizations.- Marketing channels: Methods of marketing-marketing channels, Marketing institutions and assistance.

#### UNIT-IV Generation of Fund

Funding of biotech business (Financing alternatives, VC funding, funding for biotech in India,Exit strategy,licensing strategies, valuation)-support mechanisms for entrepreneurship (Bio entrepreneurship efforts in India, difficulties in India experienced, organizations supporting biotech growth, areas of scope,funding agencies in India,biotech policyinitiatives)-Role of knowledge centers and R&D (knowledge centers like universities and research institutions, role of technology and upgradation).

## UNIT-V Biotechenterprises

Setting up Small, Medium & Large scale industry-Quality control in Biotech industries-Location of an enterprise, steps for starting a small industry-Incentives and subsidies, exploring export possibilities.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
26	5	4	15	5	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### TEST BOOKS

1. D.Hyne & John Kapeleris. 2006. Innovation and entrepreneurship in biotechnology: Concepts, theories & cases.
2. Richard Dana Ono. 1991. The Business of Biotechnology: From the Bench of the Street. Butterworth-Heinemann.
3. Martin Grossmann. 2003. Entrepreneurship in Biotechnology: Managing for growth from start-up to Initial Public Offering

### References

1. Yali Friedman. 2008. Best Practices in Biotechnology Education. Logos Press.
2. Robert Nicholas Trigiano and Dennis John Gray. 2004. Plant Development and Biotechnology CRC Press. 358pages.
3. Vasant Desai. 2005. Dynamics of Entrepreneurial Development and Management. 6<sup>th</sup> Edition. Himalaya Publishing House, 2005.
4. Prasannan. Projects: Planning Analysis, Selection, Implementation & Review. 7<sup>th</sup> Edition.

### Web source

<https://dl.acm.org/doi/book/10.5555/2769770>

### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
IV	22PBT4EC	Biotechnology for Entrepreneurs					6	5				
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		

<b>CO1</b>	✓		✓	✓	✓	✓	✓	✓	✓	✓
<b>CO2</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>CO3</b>	✓	✓	✓	✓		✓	✓	✓	✓	✓
<b>CO4</b>	✓	✓	✓	✓	✓	✓	✓	✓		✓
<b>CO5</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Matches(✓) = 47 Relationship: Very High										

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

## SEMESTER IV

**Course Code: 22PBT4NME2:1**  
**Instruction Hours: 3**  
**Credits: 2**

**Exam Hours: 3**  
**Internal Marks: 25**  
**External Marks: 75**

### NON MAJOR ELECTIVE COURSE –II FORENSIC SCIENCE

#### Objectives

- To understand the basic concepts in Forensic science
- To familiarise with analytical tools and sample preparation methods.

#### Course outcomes

- Understand the basis of Crime scenario.
- Demonstrate the sample preparation and processing from various specimens
- Familiarise with the available analytical tools and techniques for Forensic science.
- Analyse various case studies based on Personal identification techniques.
- Apply the knowledge in various problem solving aspects

#### Unit I:

Crime Scenario in India - Introduction to crime and history-Sociological aspects of crime and criminals in society-Types of crime and its causes -property crimes, public order crimes-violent crimes, cyber-crimes.

#### Unit II:

Forensic Examination of Body and Semen Fluids-Molecular mechanisms for identification of the evidences from the criminal.

#### Unit III:

Forensic Examination of Hair and Tissue-Molecular mechanisms for identification of the evidences from the criminal

#### Unit IV:

Personal Identification-Personal identification techniques as somatoscopy, somatometry-osteometry and craniometry their importance in determination of age and sex.

#### Unit V:

Techniques and Applications -New and future technologies -DNA chips -SNPs and limitations of DNA profiling-Application of Molecular techniques to Forensic. Case study based on DNA finger printing-Disputed property, paternity, criminal identification.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
25	7	4	8	6	National

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

### Text book

1. Dr. Rukmani Krishnamurthy. Introduction to Forensic Science in Crime Investigation. Selective and scientific books publishers and distributors, New Delhi. (2005).
2. Kirby, LT. DNA Fingerprinting Technology. Palgrave Macmillan UK. (2009).

### References

1. Kelly M. Pyrek ,2017.Pioneers In Forensic Science: Innovations And Issues In Practice, CRC Press.
2. Phill Jones,2012.Forensic Science For Writers, Createspace Independent Pub
3. Jo – Anne Bright and Michael Coble Forensic DNA Profiling: A practical guide to assigning likelihood Rarios CRC Press 2019
4. Pankaj Shrivastava, HirakRanjann Dash, Forensic DNA typing: Principles, Applications and Advancements Springer 2020.
5. Sara costontokis, 2017.,World Of Forensic Science,Gale Virtual Reference Library.

### Web Source

<https://microbenotes.com/dna-fingerprinting-principle-methods-applications/>

<https://www.vedantu.com/biology/dna-fingerprinting>

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
IV	22PBT4NME2:1	Forensic Science					3	2			
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO2	✓		✓	✓	✓	✓	✓		✓	✓	
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO4	✓	✓		✓	✓	✓	✓		✓	✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

Number of Matches(✓) = 45    Relationship: High

<b>Mapping</b>	1-29%	30-59%	60-69%	70-89%	90-100%
<b>Matches</b>	1-14	15-29	30-34	35-44	45-50
<b>Relationship</b>	Very Poor	Poor	Moderate	High	Very High

## SEMESTER IV

Course Code: 22PBT4NME2:2  
Instruction Hours: 3  
Credits: 2

Exam Hours: 3  
Internal Marks: 25  
External Marks: 75

### NON MAJOR ELECTIVE COURSE –II HUMAN ANATOMY AND PHYSIOLOGY

#### Objectives

- Categorize and explain the role of human organ, cellular and molecular levels.
- Compare and contrast the functions of the human body

#### Course outcomes

- Acquire comprehensive knowledge of structure and functions of human body.
- Acquired comprehensive knowledge of respiratory organ and its functions
- This course focuses on anatomical terminology, anatomical identification and physiological processes of human body
- Acquired comprehensive knowledge of excretion
- Acquired comprehensive knowledge of endocrine glands - structure, secretions and functions.

#### UNIT - I

Human organs Anatomical view - Sensory organs: eye, Ear, Nose-Circulatory organ: Heart, Lungs, Kidney, liver-Digestive system: Small and large intestine.

#### UNIT - II

Respiration - Respiratory organ and its functions-Transport of gases [CO<sub>2</sub>+O<sub>2</sub>]- Respiratory quotient-Circulation - Types, Composition, Properties and Functions of blood.

#### UNIT - III

Excretion - kinds of excretory products-Kidney disease-mechanism of urine formation in mammals - Hormonal regulation of excretion -Kidney failure and Transplantation.

#### UNIT - IV

Nervous tissue - Neuron - Structure, types of neurons-Nervous disorder-Nerve Impulse - Synapse - Synaptic transmission of impulses-Neuro-transmitters -Receptors - Photoreceptor-eye, structure of retina - visual pigments -Physiology of vision.

#### UNIT - V

Endocrine glands - structure, secretions and functions-Endocrine disorders-pituitary, Hypothalamus, thyroids, Adrenal, Thymus, Islets of Langerhans. Gonad-Testis, Ovary.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
35	9	14	6	6	Local

\*Colour indicates –Green-Local, Pink-Regional, Blue-National, Brown-Global

Text Books

1. S.C. Rastogi. Essentials of Animal Physiology. New Age International Publishers. 2001.
2. **Elaine Marieb, Patricia Brady, 2019, Human Anatomy, Marieb Human Anatomy**, Pearson Publisher
3. **Elaine Marieb and Katja Hoehn, 2018, Human Anatomy & Physiology**, Pearson Publisher.

References

1. Nedu,2021,Anotomy and Physiology ,NeduLLc Publishers.
2. Odiya and Norris,2021,Anotomy and Physiology ,Dummins Publishers.
3. AdilAsagar,2014,Consise Anotomy and Physiology ,Medtech Publishers.
4. Rahol phate,2008,Anotomy and Physiology ,Dummins Publishers.
5. Sambasivaiah, Kamalakararao and Augustine chellappa. A Text book of Animal Physiology and Ecology, S. Chand and co., Ltd., New Delhi - 110 055. (2000).
6. **Elaine Marieb, Patricia Wilhelm,2016,Human Anatomy, Global Edition**, Pearson Publisher.
7. **Elaine Marieb , Suzanne Keller, 2017,Essentials of Human Anatomy & Physiology**, Pearson Publisher.
8. Elaine N. Marieb,2016,Essentials of Human Anatomy & Physiology, Pearson Publisher.

Web source

[https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture\\_notes/nursing\\_students/ln\\_human\\_anat\\_final.pdf](https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/nursing_students/ln_human_anat_final.pdf)

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
IV	22PBT4NME2:2	Human Anatomy and Physiology					3	2				
Course Outcomes (COs)	Programme Outcomes(POs)					Programme Specific Outcomes(PSOs)						
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5		
CO1	✓	✓	✓		✓	✓	✓	✓	✓	✓		
CO2	✓		✓	✓	✓	✓		✓	✓	✓		
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓		
CO4	✓	✓		✓		✓	✓	✓		✓		
CO5	✓	✓		✓	✓	✓	✓	✓	✓	✓		
Number of Matches(✓) = 43 Relationship: Very High												

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

## **SEMESTER - IV**

**Course Code:** 22PBT4PW

**Marks:** 100

### **Project Work**

1. All PG final year students have to carry out their project in various institutes/research centers.
2. The objective of the project is to enable the students to work as group.
3. Each group is limited to maximum of four students.



## Syllabus for M. Phil., Biotechnology



**PG & Research Department of Biotechnology**  
**THANTHAI HANS ROEVER COLLEGE**  
**Autonomous and affiliated to Bharathidasan University, Trichy**  
**Nationally accredited by NAAC**  
**Perambalur – 621 212**  
**THANTHAI HANS ROEVER COLLEGE (Autonomous)**  
**Perambalur – 621 212**

## M. Phil. Biotechnology – Course Structure under CBCS

(Applicable to the candidates admitted from the academic year 2022-2023 onwards)

	Course and Subject code	Title of the course	Marks			Credit
			IA	UE	Total	
<b>Semester I</b>	Course I (22MPBT1CC1)	Research methodology	40	60	100	4
	Course II (22MPBT1CC2)	Advances in Biotechnology	40	60	100	4
	Course III (22MPBT1CC3)	Teaching and Learning skills	40	60	100	4
	Course IV (22MPBT1CC4)	Paper on topic of research (Guide will prepare the syllabus and it will be sent to the COE)	40	60	100	4
<b>Semester II</b>	22MPBTPW	Dissertation and Viva-Voce (Viva-Voce – 50 and Dissertation – 150 marks)	-	-	200	8

### For each Course other than the Dissertation

Continuous Internal Assessment	=	40 Marks
End Semester Examination	=	60 Marks
Total	=	100 Marks

### Question paper pattern for Course I - III

10 questions compulsory 10 x 01	=	10 Marks (2 from each unit)
5 questions 05 x 04	=	20 Marks (either or type, one from each unit)
3 questions from 5 03 x 10	=	30 Marks (one question from each unit)
Total	=	60 Marks

### Question paper pattern for Course IV

5 Questions 05 x 12	=	60 Marks (either or type, one from each unit)
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### CIA components

Tests (2x10)	=	20 Marks
Term Paper	=	10 Marks
Seminar & Assignment	=	10 Marks

**Semester: I**  
**Hours: 4**

**Course Code: 22MPBT1CC1**  
**Credit: 4**

## **COURSE –I: Research Methodology**

### **Objectives**

- To enable the research scholars understand the basic concepts of research methods.
- To expose the research scholars have thorough knowledge on Research.

### **UNIT - I**

**Introduction to research methodology**-What is research? -Basic and applied research-Essential steps in research- Defining the research problem- Research/Experimental design- Literature collection- Literature citation- Research report: components Format of thesis and dissertation - Manuscript/research article-Review monographs -Bibliography and Reference -Significance of research.-Ethical issues of research

### **UNIT - II**

**Biophysical Methods- Scope of biophysics**-Analysis of biomolecules using UV/Visible-Fluorescence- IR spectroscopy-IR scopy - Circular dichroism -NMR and ESR spectroscopy -Structure determination using x-ray diffraction and NMR -Analysis using light scattering - GCMS-GCMS application -Different type of mass spectrometry and surface plasma resonance methods -Radiolabeling techniques Properties of different types of radioisotopes normally used in biology their detection and measurement - Incorporation of radioisotopes in biological tissues and cells - Molecular imaging of radioactive material safety guidelines.

### **UNIT - III**

**Microscopic Techniques** -Visualization cells and subcellular components by light microscopy, Resolving powers of different microscopes -Microscopy of living cells -Electron microscope-Flouresence microscope -Scanning and transmission microscopes -Different fixation and staining techniques for EM-Freeze, etch and freeze-fracture methods for EM -Image processing methods in microscopy -Histochemical and Immunotechniques Antibody generation-Detection of molecules using ELISA, RIA, western blot -Immunoprecipitation Monoclonal antibody-Hybridoma technology -Flowcytometry-immunofluorescence microscopy -Detection of molecules in living cells -In situ localization such as FISH and GISH.

## UNIT - IV

**Electrophysiological Methods** -Single neuron recording - Patch clamp recording -ECG-Brain activity recording -Lesion and stimulation of brain -Pharmacological testing PET MRI -fMRI CAT -Computational methods- Nucleic acid and protein sequence database- data mining methods for sequence analysis- web based tools for sequence searches motif analysis and presentation.

## UNIT - V

**Statistical Methods** -Applications of statistical methods-Measures of central tendency and dispersal -Probability distributions (Binomial, Poisson and normal)- Sampling distribution -Difference between parametric and non-parametric statistics -Confidence interval -Errors Levels of significance-Regression and correlation; T test; analysis of variance -X2 test -Basic introduction to Muetrovariate statistics, etc.,

Total Number of Topics	Local	Regional	National	Global	Category Based on %
74	24	19	39	22	National

## References

1. C.R. Kothari, IInd edition (2004) Research methodology, Methods and techniques, New Age Internation (P) Ltd, Publishers, New Delhi.
2. Jerrod H. Zar (1999) Biostatistical analysis by, Prentice Hall International, Inc. Press, London.
3. Attwood. T.K and Parry-Smith D.J. (2002) Introduction to Bioinformatics, Pearson education Singapore.
4. Sharma.BK.Instrumental methods of chemical analysis.
5. Upadhyay, Upadhyay and Nath, Biophysical chemistry.

6. Khandpur R.S. Handbook of biomedical instrumentation, Tata Mc GrawHill.
7. Brigal.L.Williams,A biologist guide to principle and techniques of practical biochemistry.

**Semester: I**  
**Hours: 4**

**Course Code: 22MPBT1CC2**  
**Credit: 4**

## **COURSE –II: Advances in Biotechnology**

### **Objectives**

- To enable the research scholars to understand current advances in Biotechnology.
- To expose the research scholars have thorough knowledge on genetic engineering, animal, plant, Microbial and Nano Biotechnology applications.

### **UNIT- I**

Plant Biotechnology-**Applications of plant biotechnology**-Production of transgenic plants tolerant to biotic stresses-Genetically improved crops(Golden rice)-Bt and Terminator - Technology Protecting Systems (GURTs)-Clean Gene Technology-Gene silencing Anti Sense RNA technology (FlavrSavr)-RNA interference-Production technology for Plantigens-Plantibodies-Food vaccines-Bioplastics.

### **UNIT- II**

**Animal Biotechnology-Scope of animal biotechnology**-Animal cell cultures-Primary & Continuous cell lines-Animal Virus derived vectors SV-40&Baculovirus-Expression vectors - GST and pET-based vectors-Protein purification -Histag GSTtag MBPtag-Inclusion bodies-Transgenic mice, fish and sheep-Hybridomatechnology-Recombinant vaccines production-Gene therapy-Stem cell technology -Somatic cell-Nuclear transfer-Xeno transplantation.

### **UNIT- III**

Microbial Biotechnology-**Scope and techniques**-Importance of microbial technology-Selection and improvement of strains for biomass production-Production of recombinant proteins-Enzymes and vaccines in microbes-Bioprospecting of Microbial diversity- Bioweapons and Bioshields-Direct Mutagenesis-Protein engineering-Principle of microbial reaction engineering and novel metabolites-Uses of Genetically Engineered Microbes in Agriculture, Industries and Medicine.

#### UNIT- IV

Nanobiotechnology-Carriers for Drug Delivery- Overview of nano technology- Nano carriers -Cubosomes-Hexosomes-Virosomes-Viruslike Nanoparticles- Microbial Nanoparticles Magnetosomes and Bacteriorhodopsins-Nanoparticles for Biomedical Imaging-Immuno fluorescent -biomarker Immunogold labeling-Iron oxide nanoparticles for Magnetic Resonance Imaging (MRI)- Nanosphere- Nanocapsule - Nanobods-Nanowire Applications of Nanobiotechnology - Biochips, Nucleic acid nanoparticles-Nanotubes and Nano rods-Fullerenes for Drug Delivery.

#### UNIT- V

Ethical Issues in Biotechnology-Biosafety Biosafety cabinet-Biosafety cabinet types Biosafety for human health and environment. Social and ethical issues of biosafety-Use of genetically modified organisms (BT cotton and BT brinjal) and their release into the environment-Special procedures for r DNA based products- Intellectual property rights-patenting (Process and Product)-Bioethics-Ethical issues of Synthetic biology-Nanobiotechnology.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
78	14	24	39	34	National

#### References

1. Glick BR and Pasternak JJ. 2010. Molecular Biotechnology: Principles and applications of recombinant DNA, 4<sup>th</sup>Ed. ASM Press, Washington, USA.
2. Watson JD *et al.*, 2007. Recombinant DNA: Genes and Genomes- a short course. 3<sup>rd</sup>Ed. Cold Spring Harbor Laboratory Press, CSHL, New York, USA.

3. Brown TA. 2010. Gene cloning and DNA Analysis- An Introduction, 6<sup>th</sup>Ed. Blackwell Science Ltd. Oxford, UK.
4. Satish MK. 2008. Bioethics and Biosafety. I K International Publishing House PvtLtd,India.
5. DeepaGoel and ShominiParashar. 2013. IPR, Biosafety and Bioethics. 1st Ed. Pearson Education, India

**Semester I**  
**Hours:4**

**Course Code: 22MPB1CC4**  
**Credit: 4**

### **COURSE –IV: Teaching and Learning skills**

#### **Objectives**

- Acquaint different parts of computer system and their functions
- Understand the operations and use of computers and common accessories.
- Appreciate the role of ICT in teaching, learning and Research
- Acquire the knowledge of communication skill with special reference to its elements, types, development and styles
- understand the communication process through the web

#### **Unit-I**

**Computer Application Skills Computer system**-Characteristics, Parts and their functions -Different generations of Computer Operation of Computer: switching on / off / restart, Mouse control-Use of key board and some functions of key- **Information and Communication Technology (ICT)- Definition, Meaning, Features Trends** -Integration of ICT in teaching and learning - **ICT application Using word processors, spread sheets, Power point slides in the classroom** - **ICT for Research Online journals, ebooks, Courseware, Tutorials, Technical reports - Theses and Dissertations.**

#### **Unit- II**

**Communication Skills** **Communication** -Definitions - Elements of Communication: Sender, Message, Channel, Receiver, Feedback and Noise-Types of Communication: Spoken and written- Non verbal communication - Intrapersonal, Interpersonal, Group and Mass communication-Barriers to communication - Mechanical, Physical, Linguistic & Cultural-Skills of communication: Listening, Speaking, Reading and writing-Methods of developing fluency in oral and written communication - style, Diction and Vocabulary - Classroom communication and dynamics.

### **Unit-III**

**Communication Technology** Communication Technology -Bases, Trends and Developments - Skills of using Communication Technology-Computer Mediated Teaching-Multimedia- E content-Satellite based communication EDUSAT and ETV channels, Communication through web Audio and Video applications on the Internet, interpersonal communication through the web.

### **Unit-IV**

Pedagogy Instructional Technology -Definition, Objectives and Types-Difference between Teaching and Instruction-Lecture Technique Steps, Planning of a Lecture, Delivery of a lecture-Narration in tune with the nature of different disciplines-Lecture with power point presentation Versatility of lecture technique - Demonstration Characteristics Principles Planning Implementation and Evaluation -Teaching Learning Techniques - Team Teaching Group discussion, Seminar, Workshop, Symposium and Panel Discussion -Models of teaching: CAI, CMI and WBI.

### **Unit-V**

**Teaching Skills** **Teaching skill** -Definition, Meaning and Nature-Types of Teaching skills -Skill of Set Induction-Skill of Stimulus Variation-Skill of Explaining-Skill of Probing Questions-Skill of Black Board writing and Skill of Closure - Integration of Teaching Skills -Evaluation of Teaching Skills.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
49	32	6	8	20	Local

### References:

1. Bela Rani Sharma (2007), Curriculum Reforms and Teaching Methods, Sarup and sons, New Delhi.
2. Don Skinner (2005), Teacher Training, Edinburgh University Press Ltd., Edinburgh.
3. Information and Communication Technology in Education: A Curriculum for Schools and programme of Teacher development, Jonathan Anderson and Tom Van Weart, UNESCO, 2002.
4. Kumar K.I (2008) Educational Technology, New Age International Publishers, New Delhi.
5. Mangal, S.K. (2002) Essential of Teaching – Learning and Information Technology, Tandon Publications, Ludhiana.
6. Michael D. and William (2000), Integrating Technology into Teaching and Learning: Concepts and Applications, Prentice Hall, New York.
7. Pandey S.K. (2005) Teaching Communication, Commonwealth Publishers, New Delhi.
8. Ram Babu A. and Dandapani S (2006) Microteaching (Vol.1&2) Neelakamal Publications, Hyderabad.
9. Singh V.K. and Sudarshan K.N. (1996) Computer Education, Discovery Publishing Company, New York.
10. Sharma R. A. (2006) Fundamentals of Educational Technology, Surya Publications, Meerut
11. Vanaja. M. and Rajasekar S. (2006) Computer Education, Neelkamal Publications, Hyderabad.

**Semester: I**

**Course Code: 22MPBTEC5:1**

**Hours: 5**

**Credit: 4**

### **CORE COURSE-I: BIOMOLECULES**

#### **Objectives**

- To know about Bio-molecules
- To understand the metabolic pathway of bio molecules.
- To know about structure, properties and functions of bio molecules.

#### **UNIT - I**

**Carbohydrates** - Properties and biological importance of ribose, deoxyribose, glucose, fructose, galactose, lactose, maltose, sucrose, starch, glycogen, cellulose and chitin - Biomolecule metabolism concepts-Carbohydrate metabolism-glycolysis, gluconeogenesis, HMP Shunt, TCA Cycle. ETC(Mitochondria) -arrangement of electron carriers in the electron transport chain, Oxidative phosphorylation (Chemiosmotic theory)-Fate of pyruvate in aerobic and anaerobic condition.

#### **UNIT - II**

**Lipids** -Definition and classification of lipids -Lipid metabolism concepts-Fatty acids-classification, structure and properties-Structure and biological functions of phospholipids, sphingolipids, glycolipids. Steroids. Structure, properties, functions of cholesterol, sex hormones, bile acids, phytosterols and cytoesterol-Membrane composition and structure, Fatty acid oxidation. -Regulation of fatty acid metabolism, Ketone bodies.

### UNIT - III

**Proteins and Aminoacids** - Biological significance-Structure of Proteins-primary,secondary, tertiary and quaternary -Ramachandran plot. -Classification of protein-based on solubility, shape, composition function. Globular proteins. - Hemoglobin and myoglobin-Fibrous proteins- keratin and collagen-Properties of proteins in aqueous solutions: **Isoelectric pH, electrophoretic mobility, hydrolysis of proteins, denaturation and renaturation of proteins**, protein stability and protein folding.-**Biosynthesis of amino acids**-Amino acid deamination-**transamination**, oxidative deamination; urea cycle & its regulation.

### UNIT - IV

**Nucleic acid and Vitamins** - Structure of Purines, Pyrimidines, nucleosides and nucleotides -DNA double helical structure. A,B and Z forms of DNA-Structure of RNA. RNA- types and biological role -Vitamins classification and Functions.

### UNIT - V

**Inborn error metabolism** -**Disorders of carbohydrate metabolism**-Glycogen storage disease -Disorders of amino acid metabolism- Phenylketonuria-maple syrup urine disease -Albinism and Alkaptonuria-**Disorders of fatty acid oxidation and mitochondrial metabolism**-Medium chain acyl coenzyme A -**dehydrogenase deficiency** -Disorders of purine and **pyrimidine metabolism**-Lesch-Nyhan syndrome -Lysosomal storage disorders-Gaucher's disease, **Niemann Pick disease**.

Total Number of Topics	Local	Regional	National	Global	Category Based on %
52	4	6	8	42	Global

### Text Books

1. Nelson, D.L., Cox, M.M. 2008. Lehninger Principles of Biochemistry, 5th Edition. W.H.Freeman and Company, USA.
2. Stryer, L. 2000. Biochemistry, 4th Edition. W.H. Freeman and Company, New York.
3. Voet, D and Voet, J.G. 2012. Biochemistry, 4th Edition. John Wiley&Sons Publishers

### References

1. A.L. Lehninger- D.L. Nelson and M.M Cox (2003) - Principles of Biochemistry - Worthpublishers- New York.
2. L. Stryer- (2002) - Biochemistry- W.H. Freeman and Co. New York.
3. C. Branden J.Tooze. (1999)- Introduction to protein structure – Publishing Inc.
4. Thomas Devlin (2002) - Textbook of Biochemistry by John publishers.
5. Voet and Voet - Principles of Biochemistry
6. Van Holde and Mathew- Principles of Biochemistry.