

2020

# **B.Sc BIOTECHNOLOGY**

## **Course Structure and Syllabus**

(For the candidates admitted from the academic year 2020-2021 onwards)

### **CHOICE BASED CREDIT SYSTEM (CBCS)**



**THANTHAI HANS ROEVER COLLEGE (AUTONOMOUS)**

**(Nationally Re-Accredited by NAAC with B<sup>++</sup>)**

**(Affiliated to Bharathidasan University, Tiruchirappalli)**

**ELAMBALUR, PERAMBALUR – 621 220**



**Thanthai Hans Roever College (Autonomous), Elambalur, Perambalur - 621 220**  
**B.Sc BIOTECHNOLOGY - UG Course Structure under CBCS**  
**(For the candidates admitted from the academic year 2020-2021 onwards)**

Semester	Part	Course Code	Title of the Course	Ins. Hours/ Weeks	Credits	Exam Hours	CIA (Max)	ESE (Max)	Total (Max)
1	I	20UT1	Tamil - I (Ikkala Ilakkiyam - Kavithai, Sirukathai, Urainadai, Ilakkiya Varalaru)	6	3	3	25	75	100
1	II	20UE1	English -I (Communicative English - I)	6	3	3	25	75	100
1	III	20UBT1CC1	General Microbiology	5	4	3	25	75	100
1	III	20UBC1AC1	Biochemistry	5	3	3	25	75	100
1	III	20UBT1CP1	General Microbiology - Lab	4	3	3	40	60	100
1	III	20UBT1PE1	Professional English for Life Sciences-I	2	2	3	25	75	100
1	IV	20UVE	Value Education	2	2	3	25	75	100
<b>Total</b>				<b>30</b>	<b>20</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>700</b>
2	I	20UT2	Tamil - II (Idaikkala Ilakkiyam - Bakthi, Puthinam, Ilakkiya Varalaru)	6	3	3	25	75	100
2	II	20UE2	English -II (Communicative English – II)	6	3	3	25	75	100
2	III	20UBT2CC2	Cell Biology	4	4	3	25	75	100
2	III	20UBC2AC2	Applied Biochemistry	4	3	3	25	75	100
2	III	20UBT2CP2	Cell Biology - Lab	3	3	3	40	60	100
2	III	20UBC2AP1	Biochemistry - Lab	3	2	3	40	60	100
2	III	20UBT2PE2	Professional English for Life Sciences-II	2	2	3	25	75	100
2	IV	20UES	Environmental Studies	2	2	3	25	75	100
<b>Total</b>				<b>30</b>	<b>22</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>800</b>
3	I	20UT3	Tamil-III (Kappiya Ilakkiyam, Nadagam, Ilakkiya Varalaru)	6	3	3	25	75	100
3	II	20UE3	English -III (Language Through Literature and Communicative Skills – I)	6	3	3	25	75	100
3	III	20UBT3CC3	Molecular Biology	6	4	3	25	75	100
3	III	20UBT3CP3	Molecular Biology - Lab	3	3	3	40	60	100
3	III	20UBI3AC3	Bioinformatics	4	3	3	25	75	100
3	IV	20UBI3AP2	Bioinformatics - Lab	3	2	3	40	60	100
3	IV	NME1	NME1	2	2	3	25	75	100
<b>2 Total</b>				<b>30</b>	<b>20</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>700</b>

4	I	20UT4	Tamil-IV (Pazhanthamizh Ilakkiyam, Ilakkiya Varalaru & Pothukkatturai)	6	3	3	25	75	100
4	II	20UE4	English -IV (Language Through Literature and Communicative Skills – II)	6	3	3	25	75	100
4	III	20UBT4CC4	rDNA Technology	6	5	3	25	75	100
4	III	20UBT4CP4	rDNA Technology - Lab	3	3	3	40	60	100
4	III	20UZO4AC4	Developmental Biology	5	4	3	25	75	100
4	IV	NME2	NME2	2	2	3	25	75	100
4	IV	20UBT4SBE1:1 20UBT4SBE1:2 20UBT4SBE1:3	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>22</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>700</b>
5	III	20UBT5CC5	Plant Biotechnology	5	5	3	25	75	100
5	III	20UBT5CC6	Animal Biotechnology	5	5	3	25	75	100
5	III	20UBT5CC7	Biostatistics and Biosafety	5	5	3	25	75	100
5	III	20UBT5CP5	Plant and Animal Biotechnology - Lab	4	4	3	40	60	100
5	III	20UBT5MBE1:1 20UBT5MBE1:2 20UBT5MBE1:3	1.Immunology 2.Bio Instrumentation 3.Nanotechnology	5	3	3	25	75	100
5	IV	20UBT5SBE2:1 20UBT5SBE2:2 20UBT5SBE2:3	1.Medical lab technology 2.Biofertilizer 3.Dairy technology	2	2	3	25	75	100
5	IV	20UBT5SBE3:1 20UBT5SBE3:2 20UBT5SBE3:3	1.Aquaculture 2.Apiculture 3.Sericulture	2	2	3	25	75	100
5	IV	20USSD	Soft Skill Development	2	2	3	25	75	100
<b>Total</b>				<b>30</b>	<b>28</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>800</b>
6	III	20UBT6CC8	Microbial Biotechnology	6	6	3	25	75	100
6	III	20UBT6CC9	IPR and Bioethics	6	6	3	25	75	100
6	III	20UBT6CP6	Microbial Biotechnology - Lab	5	4	3	40	60	100
6	III	20UBT6MBE2:1 20UBT6MBE2:2 20UBT6MBE2:3	1.Food technology 2.Enzyme technology 3.Biodiversity and conservation	6	5	3	25	75	100
6	III	20UBT6MBE3:1 20UBT6MBE3:2 20UBT6MBE3:3	1.EnvironmentalBiotechnology 2.Cancer Biology 3.Stem Cell Biology	6	5	3	40	60	100
6	V		Extension Activities	-	1	-	-	-	-
6	V	20UGS	Gender Studies	1	1	3	25	75	100
<b>Total</b>				<b>30</b>	<b>28</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>600</b>
<b>Grand Total</b>				<b>180</b>	<b>140</b>				<b>4300</b>

Language Part – I	-	4
English Part - II	-	4
Stream -B-Professional English for life Sciences	-	2
Core Paper	-	9
Core Practical	-	6
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 (Credit only)	-	1

\* 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

<b>Note:</b>	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**

The passing minimum for CIA shall be 40% out of 25 marks [i.e. 10 marks] The passing minimum for Semester Examinations shall be 40% out of 75 marks [i.e. 30 marks]

### **FOR PRACTICAL**

The passing minimum for CIA shall be 40% out of 40 marks [i.e. 16 marks] The passing minimum for Semester Examinations shall be 40% out of 60 marks [i.e. 24 marks]

### List of Skill Based Elective Courses

<b>Skill Based Elective</b>	<b>Course Code</b>	<b>Title of the Courses</b>
<b>Skill Based Elective - 1</b>	20UBT4SBE1:1 20UBT4SBE1:2 20UBT4SBE1:3	Mushroom and Vermi technology Food and Nutrition Phytochemicals and Herbal Medicine
<b>Skill Based Elective - 2</b>	20UBT5SBE2:1 20UBT5SBE2:2 20UBT5SBE2:3	Medical lab technology Biofertilizer Dairy technology
<b>Skill Based Elective - 3</b>	20UBT5SBE3:1 20UBT5SBE3:2 20UBT5SBE3:3	Aquaculture Apiculture Sericulture

### List of Non Major Elective Courses

<b>Non Major Elective Courses</b>	<b>Course Code</b>	<b>Title of the Courses</b>
<b>Non Major Elective Courses – 1</b>	20UBT3NME1	Biotechnology
<b>Non Major Elective Courses – 2</b>	20UBT4NME2	Pharmaceutical Biotechnology

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

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

#### **Undergraduate Programmes**

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 (PSO's)**

PSO 1: Acquire knowledge of the fundamentals of Biotechnology.

PSO 2: Understand the applications of Biotechnology in Agriculture, Industry and research.

PSO 3: To acquire technological knowledge connecting disciplinary and interdisciplinary aspects of biotechnology.

PSO 4: Ability to communicate effectively and equipped with laboratory skills in biotechnology.

PSO 5: Recognize the importance of biotechnological applications as to usher next generation entrepreneurship.

## **SEMESTER - I**

**Course Code: 20UBT1CC1**  
**Instruction Hours: 5**  
**Credits: 4**

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

### **CORE COURSE - I**

#### **GENERAL MICROBIOLOGY**

##### **Course outcomes**

- The course supports 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 History of microbiology**

Definition and scope of microbiology-History of microbiology, classification and nomenclature of microorganism, 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.

##### **UNIT - II Bacteria, Fungi, Virus, Algae and Protozoa**

General structure and function of microorganism - Bacteria, Fungi, Virus, Algae and Protozoa.

##### **UNIT - III Microbial Energetics**

Nutritional requirements of bacteria and different media used for bacterial culture, types of Nutrition (Phototrophs, autotrophs and Chemoautotrophs) Microbial growth curve, Factors affecting microbial growth- pH, light, temperatures, desiccations, osmotic pressure, radiation, pure culture techniques- pour plate, spread plate and streak plate.

## **UNIT - IV Sterilization of microorganisms**

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 Microbial application**

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.

### **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 S and 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(✓) = 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: 20UBT1CP1**  
**Instruction Hours: 4**  
**Credits: 3**

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

### CORE PRACTICAL - I

#### GENERAL MICROBIOLOGY (P)

##### Course outcomes

- This practical is designed to give an understanding about the basic techniques in Microbiolog
  - To know about isolation of microorganism from different sample
  - Describe the basic principles of sterilization and media preparation.
  - Differentiate organisms based on structural and biochemical properties.
  - Develop skills associated with isolating and enumerating microorganisms from various sources.
  - Apply knowledge and skills gained in this course to be useful in fur her research
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.
  6. Isolation of microbes and slide preparation – quantitative methods of microbes. Characterization bio fertilizer microbes.

##### References

1. Bucker, J.M., Caldwell, C.A., Zachgo, E.A. 1990. A Laboratory course, Academic Press.
2. Harold J. Berson 1994. Microbial Applications. WM.C. Brown Publishers.
3. William Claus. G.W.1989. Understanding Microbes – A Laboratory textbook for Microbiology, W.H. Freeman and Co., New York.
4. Cappuccino J.G. & Sherman N. (2002). Microbiology: A laboratory manual, Addison Wesley.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
I	20UBT1CP1	General Microbiology - Lab					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(✓) = 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: 20UBC1AC1**  
**Instruction Hours: 5**  
**Credits: 3**

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

### **ALLIED COURSE - I**

#### **BIOCHEMISTRY**

##### **Course outcomes**

- 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 Atoms**

Structure of atoms and biomolecules: atomic theory, valency, atomic weight, molecular weight, Molarity, molality and normality. Chemical Bonding, properties of Water, ionization constant, pH and buffers.

##### **UNIT - II Carbohydrates**

Macromolecules-Carbohydrates-Structure, classification, properties and functions of mono, di and polysaccharides.

##### **UNIT - III Protein**

Protein-Structure, Classification, properties and function. Classification, Properties and function of amino acids.

##### **UNIT - IV Lipids**

Lipids-Classification, Structure, Properties and function Vitamins-Classification, Properties and its functions.

## **UNIT - V Instrumentation**

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

### **Text Books**

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

### **References**

1. Stryer.L. (2003) Biochemistry, V. Edition. W.H. Freeman & Co. NY.
2. Robert K. Murray Daryl K. Granner, Peter. A.Mayes. & Victor W. Rodwell (2004) Harpers Biochemistry – Prentice Hall International, ISBN-8385-3612-3.
3. Geoffrey L. Zubay, William W. Passon, Dennis L. Vance, (1988), Principles of Biochemistry, IVedition, W. M. C. Brown Publishers, Australia.
4. Murray, R.K. A. Grannor, D.K. Mayes, P.A. and Rodwell V. W. (2000) Harper's Biochemistry, McGraw Hill Pvt. Ltd., New Delhi.
5. Voet D & Voet J.G (1990) Biochemistry, John Wiley & Sons, New York.
6. Zubay G (1998). Biochemistry 2/e, McMillan Publishers New York, Collier McMillan Company, London.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
I	20UBC1AC1	Biochemistry					5	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(✓) = 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: 20UBT2CC2**  
**Instruction Hours: 4**  
**Credits: 4**

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

### CORE COURSE - II

#### CELL BIOLOGY

##### 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 cell cycle and its regulation
- Getting sound knowledge on principle and applications of various microscopy. Gain expertise in the isolation of various cell organelles and staining of cellular

##### **UNIT - I Fundamentals of cell structure**

Discovery of cells; Basic properties of cells; Different classes of cells - Prokaryotic and eukaryotic cells. Cell division: Cell cycle; mitosis; meiosis, binary fission.

##### **UNIT - II Cellular membranes and matrices**

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.

## **UNIT - IV Cellular organelles in energy metabolism**

Mitochondria – structure and function; Chloroplast – structure and function. Structure of nucleus – nuclear membrane, nucleolus, chromatin, structure of nucleic acids.

## **UNIT - V Methods in cell biology**

Microscopy - Light microscope, TEM, SEM, Use of radioisotopes; Staining procedures.

### **Text Books**

1. Freifelder D. 1985. Molecular Biology, Narosa Publishing House. New Delhi.
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. 6<sup>th</sup> Edition. Garland Science, Taylor & Francis group Publishers.
5. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. 1995. Molecular Cell Biology. 3<sup>rd</sup> Edition. W.H. Freeman Publishers.

### **References**

1. Watson JD, Gilman M, Witkowski J and Zoller M. 1992. Recombinant DNA. Scientific American Books. 2<sup>nd</sup> Edition. New York.
2. Blackburn GM and Gait MJ. 1996. Nucleic Acids in Chemistry and Biology. Oxford University Press.
3. Lodish H, Baltimore D, Beck A, Zipursky SL, Matsudaria P and Darnell J. 1995. Molecular Cell Biology. Scientific American Books.
4. Cooper M 1995. The Cell Molecular Approach. 2<sup>nd</sup> Edition. ASM Press.
5. Lewis J Kleinsmith and Valerie M Kish. 1980. Principle of Cell and Molecular Biology 2<sup>nd</sup> Edition. Benjamin-Cummings Publishing Company.
6. De Robertis, EDP and E.M.F Robertis. 1980. Cell and Molecular Biology. 7<sup>th</sup> Edition. Saunders Company.
7. T.A. Brown. 2011. Introduction to genetics: A molecular approach. 1<sup>st</sup> Edition. Garland Science.
8. 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.
9. Benjamin Lewin. 2008. Genes XI. 9<sup>th</sup> Edition. Jones & Bartlett Learning.
10. R.A. Meyers. 1995. Molecular Biology and Biotechnology. A comprehensive desk reference. (Ed) Wiley-Blackwell Publishers.



Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	20UBT2CC2	Cell Biology					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(✓) = 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 - II

**Course Code: 20UBT2CP2**  
**Instruction Hours: 3**  
**Credits: 3**

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

### CORE PRACTICAL - II

#### CELL BIOLOGY LAB

#### Course outcomes

On successful completion of the course, the student will be able to

- 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

1. Microscope – Bright field and Dark field
2. Micrometry
3. Structure observation - Prokaryotic & Eukaryotic cell
4. Cell count - Prokaryotic & Eukaryotic cell
5. Observation – Different types of cells – parenchyma, collenchymas, sclerenchyma, epithelium
6. Size and shape of an organism (prokaryote) – simple staining, use of ocular micrometer
7. Motility of an organism – Hanging drop
8. Cell Staining – Cytochemical methods - Demonstration of Cellular and sub-cellular components
9. Sub cellular fractionation
10. Osmosis and tonicity
11. Cell division - Mitotic stages - Preparation of Onion Root Tip
12. Cell division - Meiotic stages - Preparation of Tradescantia Flower bud
13. Cell division – Binary fission of yeast
14. Polytene and diplotene chromosome – Chirinamous larva
15. Microtome – Temporary & permanent slide preparation.

## References

1. David A. Thompson. 2011. Cell and Molecular Biology Lab. Manual.
2. P.Gunasekaran. 2007. Laboratory Manual in Microbiology. New Age International.
3. D O Hall, S E Hawkins. 1974. Laboratory Manual of Cell Biology. British Society for Cell Biology, Published by Crane, Russia.
4. Mary L. Ledbetter. 1993. Cell Biology: Laboratory Manual. Edition: 2. Published by RonJon Publishing. Incorporated.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
II	20UBT2CP2	Cell Biology – Lab					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	✓	✓		✓	✓		✓	✓	✓	✓		
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: 20UBC2AC2**  
**Instruction Hours: 4**  
**Credits: 3**

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

### ALLIED COURSE - II

#### APPLIED BIOCHEMISTRY

##### Course outcomes

- 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 students 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, ultracentrifuge, differential and density gradient. Determination of molecular weight - sedimentation velocity and sedimentation equilibrium.

##### 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 and HPLC, GC-MS, LC-MS.

##### UNIT - III Electrophoresis

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

##### UNIT - IV Spectroscopy

Beer-Lambert law and its limitations. 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 and ESR techniques.

### **UNIT - V Crystallography**

Principle, instrumentation and applications 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).

#### **Text Books**

1. P.Palanivelu and M.Saliu. 2009. Analytical Biochemistry and Separation Techniques. 4<sup>th</sup> Edition, MKU, Madurai.
2. Friefelder, D.M. 1983. Physical Biochemistry: Applications 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-Inter science, 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 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. Chinapublications.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	20UBC2AC2	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(✓) = 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: 20UBC2AP1**  
**Instruction Hours: 3**  
**Credits: 2**

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

### ALLIED PRACTICAL - I

#### BIOCHEMISTRY (P)

#### Course outcomes

- 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 students 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

#### References

1. Arun Rastogi, Mathur, N.B.L Mathur, N.B. L. 2010. An Introduction to Practical Biochemistry. Anmol Publications, India.
2. Rajan, S. 2010. Experimental Procedures in Life Sciences. AnjanaaBook House.
3. Jayaraman. 2011. Laboratory manual in Biochemistry. New age International private limited.
4. P.Palanivelu and M.Saliu. 2009. Analytical biochemistry and separation techniques. 4<sup>th</sup> Edition, MKU, Madurai.
5. Sadasivam .S and Manickam A. 2009. Introduction to Practical Biochemicstry. 2<sup>nd</sup> Edition. New Age International Private Ltd. Publishers.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	20UBC2AP1	Biochemistry – Lab					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(✓) = 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 - III

**Course Code: 20UBT3CC3**  
**Instruction Hours: 5**  
**Credits: 4**

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

### CORE COURSE - III

#### MOLECULAR BIOLOGY

##### Course outcomes

- 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 – actin, myosin and intermediate filaments. 3-dimensional organization of cytoskeleton. **Nucleus:** Nucleus, nuclear envelope, nucleoplasm, chromatin and chromosomes, allele, loci, gene. Nuclear division.

##### UNIT - II Classical genetics

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

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

Characteristics of genetic code. **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.

##### UNIT - IV DNA Replication & repair

Prokaryotic and Eukaryotic DNA replication. Mechanism 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.

## **UNIT - V Regulation of gene expression**

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.

### **Text Books**

1. Ajoy Paul. 2011. Textbook of Cell and Molecular Biology. Books and Allied Ltd.
2. Benjamin Lewin. 2007. Gene IX. 9<sup>th</sup> 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. 6<sup>th</sup> Edition. Benjamin Cummings Publishing Company Inc.
4. Watson JD, Gilman M, Witkowski J, Zoller M. 1992. Recombinant DNA. Scientific American Books.

### **References**

1. Bruce Alberts, Alexander. Johnson. Julian Lewis, 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	20UBT3CC3	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(✓) = 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: 20UBT3CP3**  
**Instruction Hours: 3**  
**Credits: 3**

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

### CORE PRACTICAL - III MOLECULAR BIOLOGY (P)

#### Course outcomes

After completion of this course successfully, the students will be able to

- Utilize laboratory skills to enhance understanding of genomic and plasmid DNA isolation
- Develop responsible conduct of laboratory skills appropriate to the field of molecular biology
- Apply the molecular biology techniques to biotechnological approaches
- In this course the students will get hands on experience in Molecular Biology techniques.
- To know about DNA isolation, separation and estimation technique.

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. Preparation of *E. coli* competent cells.
10. Transformation of bacteria – CaCl<sub>2</sub> method.
11. Bacterial conjugation.
12. Transduction.

#### References

1. M. Mooyoung. 1985. Comprehensive Biotechnology. Vol. 2, 3 & 4. Pergamon press.
2. Dr. David A Thompson. 2011. Cell and Molecular Biology Lab Manual.
3. George M. Malacinski. 2013. Freifelder's Essentials of Molecular Biology. Norosa Publishing House.
4. Stanely R. Maloy, Jhon E Cornan Jr, David Freifelder. 1994. Microbial genetics. 2<sup>nd</sup> Edition. Jones and Bartlett publisher.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
III	20UBT3CP3	Molecular Biology - Lab					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	✓	✓		✓	✓	✓	✓	✓	✓	✓	
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: 20UBI3AC3**  
**Instruction Hours: 4**  
**Credits: 3**

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

### **ALLIED COURSE - III**

#### **BIOINFORMATICS**

##### **Course outcomes**

- Describe the importance of DNA and protein sequence alignments, methods of alignment and application
- Describe bioinformatics 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.

##### **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 - Trans membrane protein prediction<sup>20</sup> 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. Protein-ligand interaction, Next generation sequence.

### Text Books

1. Harshawardhan, P. (2005) Bioinformatics principles and application. Tata McGraw Hill Publishers. New Delhi.
2. Manikandan Vijayaraj, 2002. Bioinformatics for beginners, Kalaikathir Achchagam, Coimbatore.
3. Mount, D.W. 2005. Bioinformatics Sequence and genome analysis (II<sup>nd</sup> edition) CBS Publishers. New Delhi.

### References

1. Hagen. J. B. (2000). The origin of bioinformatics. Nat. Rev. Genetics 1:231-6.
2. Tyers, M., and Mann, M. 2003. From genomics to proteomics. Nature 422:193-7.
3. Sundarajan. S. and R. Balaji. (2005), Introduction of Bioinformatics, Himalaya Publishing house, Mumbai.
4. Westhead, D.R, H.J. Parish and R.M. Twyman. (2003) Bioinformatics Viva books Private Ltd. New Delhi.
5. J. M.Keith. Bioinformatics. Vol. 1: 2008 Data, sequence analysis & evolution. Humana Press.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
III	20UBI3AC3	Bioinformatics					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(✓) = 44 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: 20UBI3AP2**  
**Instruction Hours: 3**  
**Credits: 2**

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

### ALLIED PRACTICAL - II

#### BIOINFORMATICS (P)

#### Course outcomes

After completion of this course successfully, the students will be able to

- To provide practical experience in the analysis of protein sequence
- Perform DNA and protein sequence alignments, methods of alignment and apply scoring schemes
- Demonstrate knowledge of various biological databases and computational tools
- Perform alignment of multiple sequences and build phylogenetic trees.
- Perform search using variants against various publically available databases.

1. Study of Nucleic acid sequence databanks – GenBank, EMBL nucleotide sequence databank, sDDBJ, UniGene.
2. Study of protein data banks - PIR, Swiss-PROT, UniPROT.
3. Study of Protein Structure and Classification databases – PDB, SCOP, CATH, FSSP, PDBSUM.
4. Study of Domain / Motif databases – BLOCKS, PRINTS, SBASE and PFAM.
5. Gene structure and function prediction (using GenScan, GeneMark).
6. Sequence similarity searching (NCBI BLAST)
7. Protein sequence analysis (ExpASy proteomics tools).
8. Multiple alignments – CLUSTALW.
9. Building structure for a given sequence using Homology modeling.
10. Evaluation of protein structure by Swiss PDB viewer and by other molecular visualization tools.

#### References

1. Droit, A., Poirier, G. G., and Hunter, J. M. 2005. Experimental and bioinformatic approaches for interrogating protein-protein interactions to determine protein function. *J. Mol. Endocrinol.* 34:263–80.
2. Stanton, L. W. 2001. Methods to profile gene expression. *Trends Cardiovasc. Med.* 11:49–54.



Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course				Hours	Credits			
III	20UBI3AP2	Bioinformatics – Lab				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(✓) = 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: 20UBT4CC4**  
**Instruction Hours: 6**  
**Credits: 5**

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

### CORE COURSE - IV

#### rDNA TECHNOLOGY

##### 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 and recombinant protein production.
- To explain the construction of DNA & c DNA 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 students 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 - Polymerase, Transferase, Kinase and Ligase.

##### UNIT - II Different types of Vectors

Plasmids, 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): 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.

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.

### **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. 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. 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.W 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, DM. and BD. 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. Tvan 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	20UBT4CC4	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											

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: 20UBT4CP4**  
**Instruction Hours: 3**  
**Credits: 3**

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

### CORE PRACTICAL - IV

#### rDNA TECHNOLOGY (P)

#### 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.

1. Isolation of genomic DNA from plant, animal cells & from bacteria
2. Isolation of plasmid DNA – small & large scale
3. Size analysis of plasmids by agarose gel electrophoresis
4. Restriction digestion – single & double digestion.
5. Ligation.
6. Preparation of competent *E.coli* cells
7. Transformation of *E.coli* with recombinant DNA.
8. Selection & screening of rDNA products – Antibiotic resistance, Blue white colony.
9. PCR amplification
10. Southern blot and northern blot.
11. RAPD
12. RFLP

#### References

1. J. Sambrook and D.W. Russel. 2001. Molecular Cloning: A Laboratory Manual, Vol. 1-3. CSHL.
2. T.A. Springer. 1985. Hybridoma Technology in the Biosciences and Medicine. Plenum Press New York.
3. Judith W. Zyskind and Sanford I. Bernstein. 1989. Recombinant DNA Laboratory Manual. Academic press.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
IV	0UZO4AC4	Developmental Biology					5	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(✓) = 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: 20UZO4AP4**  
**Instruction Hours: 5**  
**Credits: 4**

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

### ALLIED COURSE - IV

### DEVELOPMENTAL BIOLOGY

#### 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

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

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

Organogenesis, Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germ layers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals.

### UNIT - V Organization of shoot and root

Organization of shoot and root apical meristem, and development. Leaf development and Phyllotaxy. Development of Microsporangium and Mega sporangium, Pollination, Embryo -Embryo sac development and double fertilization in plants, seed formation and germination. Outline of experimental embryology

### Text Books

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

1. Bruce M Carlson, Patten's Foundation of Embryology, Tata McGraw Hill Co.
2. Balinsky, B.I., 1981. 5 edition. An Introduction to Embryology, W. B. Saunders Co., Philadelphia
3. Verma , P.S., Agarwal, V.K., and Tyagi., 1995. Chordate embryology, S. Chand & Co., New Delhi

### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
IV	20UZO4AC4	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	✓	✓	✓		✓	✓	✓	✓	✓	✓		
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 - V

**Course Code: 20UBT5CC5**  
**Instruction Hours: 5**  
**Credits: 5**

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

### CORE COURSE - V

#### PLANT BIOTECHNOLOGY

##### Course outcomes

- This course is acquired basic knowledge about plant tissue culture, transgenesis and genetic modifications in agriculture.
- 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 Plant tissue culture

Plant tissue culture techniques, *in-vitro* pollination and fertilization, embryo culture and its applications, embryogenesis and organogenesis, micro propagation, haploids and their applications, somoclonal variations and applications, Endosperm culture and 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.

##### UNIT - III Applications of Plant Genetic Engineering

Genetic engineering & crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors.

##### 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.

## UNIT - V Organic food

Production of organic food, types of organic food, identification of organic food, organic food & preservatives.

### Text Books

1. Gamborg O.L and Philips, G.C. 1995. Plant Cell, Tissue and organ culture - Fundamental methods. Narosa Publishing House, New Delhi.
2. Slater A., Scott N.W. and Fowler, M.R. 2008. Plant Biotechnology - The genetic manipulation of plants. Oxford University press, USA.

### References

1. Phundan Singh, 2013. Principles of Plant Biotechnology. Kalyani Publishers, India.
2. V. Kumaresan, 2015. Applied Plant Biotechnology. Saras Publication, India.
3. 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	20UBT5CC5	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(✓) = 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: 20UBT5CC6**  
**Instruction Hours: 5**  
**Credits: 5**

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

## CORE COURSE - VI

### ANIMAL BIOTECHNOLOGY

#### Course outcomes

- 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 type cell morphology, stages and fertilization and transformation techniques employed in animal systems.
- The course helps the students 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) 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 preparation for Animal cells culture. Types of cell culture: Primary and secondary cell culture, cell transformation, cell lines, Insect cell lines, stem cell cultures, Tests: cell viability and cytotoxicity. Biology of cultured cells, measurement of growth, cell synchronization, senescence and apoptosis. Organ culture and transplantation, Cryopreservation.

#### UNIT - III Genetic engineering in animals

GMO (Genetically modified organism), methods of DNA transfer into animal cells - calcium phosphate co precipitation, micro-injection, electroporation, Liposome encapsulation, Biological vectors - Bacteria, Virus. Hybridoma technology, DOLLY, Vaccine production.

## **UNIT - IV Gene therapy**

Mapping of human genome, Human Genome Project (HGP). RFLP, RAPD and its applications. Gene silencing, DNA finger printing and Forensic Science. Molecular diagnosis of Genetic disorders.

## **UNIT - V Transgenics**

Transgenic animals. Production and recovery of products from animal tissue cultures: cytokines, Plasminogen activators, Blood clotting factors, Growth hormones, insulin Transgenic animals – Merits and demerits -Ethical issues in animal biotechnology, transgenic microbes and animals.

### **Text Books**

1. B.Singh,SKGautam and MS Chauhan. 2013. Textbook of Animal biotechnology. The Energy and Research Institute.
2. M.K. Sateesh. 2010. Biotechnology: V: (Including Animal Cell Biotechnology, Immunology and Plant Biotechnology). 2<sup>nd</sup> Edition. New Age International.

### **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	20UBT5CC6	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(✓) = 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 - V

**Course Code: 20UBT5CC7**  
**Instruction Hours: 5**  
**Credits: 5**

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

### CORE COURSE - VII

### BIOSTATISTICS AND BIOSAFETY

#### 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-basicprinciples

Variables - measurements, functions and limitation; Data -types of data, 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.

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## **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 and relevant International Agreements including Cartagena Protocol.

### **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. Sokal, R.R. and F.J. Rohlf. 1981. Biometry. W.K. Freeman. San Francisco.
2. Zar, J.H. 2003. Biostatistical Analysis. Pearson Education (Singapore) Pvt. Ltd., Indian Branch, New Delhi.
3. <http://www.cbd.int/biosafety/background.shtml>
4. [http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section 3.](http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3)

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Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
V	20UBT5CC7	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											

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: 20UBT5CP5**  
**Instruction Hours: 4**  
**Credits: 4**

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

### CORE PRACTICAL - V

#### PLANT AND ANIMAL BIOTECHNOLOGY (P)

##### 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 (Hands on).
3. Tissue culture media preparation: Preparation of stock solutions of Murashige Skoog basal medium and plant growth regulator stocks (Hands on).
4. Protoplast isolation – 1. Mechanical 2. Enzymatic
5. Protoplast culture (Hands on).
6. Isolation of plant genomic DNA (Hands on).
7. Size analysis of DNA by Agarose Electrophoresis (Hands on).
8. Photoperiodism.
9. Transformation of leaf discs with *Agrobacterium* (Hands on).
10. Expression of foreign genes into plant cells: use of *Agrobacterium tumefaciens* (Theory).
11. Morphogenesis in tobacco leaf tissue (Hands on).
12. Regeneration of the Shoot Apical Meristem (SAM).
13. Preparation of chloroplast from pea (Hands on).

##### Animal Biotechnology

1. Isolation of DNA from Animal liver
2. Isolation of DNA from human cheek cells
3. Isolation of DNA from blood
4. Quantification of DNA by spectrophotometric method
5. Size analysis of DNA by Agarose gel electrophoresis
6. Animal cell culture - Preparation of media
7. Types of Animal cell culture – Primary, secondary & established.

## References

1. M. S. Clark. 1997. *Plant Molecular Biology: A Laboratory Manual*. Springer-Verlag.
2. 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.
3. H.S. Chawla, 2002. *Introduction to Plant Biotechnology*. Oxford and IBHP Publishing Co. Pvt. Ltd. New Delhi.
4. Monica. A. Hughes. 1999. *Plant Molecular Genetics*. Pearson Education limited, England.
5. Harrison, M.S. and Bal, I.R. 1997. *General techniques of all culture* Cambridge University press.
6. Prasash M. and Arora. C.K.. 1998. *Plant tissue culture*, Ammol publication Pvt. Ltd.
7. Darling D.C. and Morgan S.J. 1994. *Animal cells, culture Media*. Wiley, New York.

### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
V	20UBT5CP5	Plant and Animal Biotechnology – Lab					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

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## SEMESTER - VI

**Course Code: 20UBT6CC8**  
**Instruction Hours: 6**  
**Credits: 6**

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

### CORE COURSE - VIII

### MICROBIAL BIOTECHNOLOGY

#### 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. Microbial growth and death kinetics with reference to industrially useful microorganisms. Strain improvement for increased yield and other desirable characteristics.

#### 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 Upstream processing

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

#### UNIT - IV Downstream 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 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, 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 – production and applications in food preservation.

### Text Books

1. Jackson AT. 1991. Bioprocess Engineering in Biotechnology. Prentice Hall, Engelwood Cliffs.
2. Shuler ML and Kargi F. 2002. Bioprocess Engineering: Basic concepts, 2<sup>nd</sup> Edition. Prentice Hall, Engelwood 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	20UBT6CC8	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(✓) = 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: 20UBT6CC9**  
**Instruction Hours: 6**  
**Credits: 6**

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

### CORE COURSE - IX

#### IPR AND BIOETHICS

##### Course outcomes

- Exposure to legal and socio economic impacts of biotechnology. To understand the ethical implications in Biotechnological applications.
- Exposure to ethical concerns of biotechnology research
- To understand the ethical, social, legal aspects in biology and bio containment.
- To understand the ethical implications in Biotechnological applications.
- To understand the intellectual property rights, biosafety of genetically engineered products and guidelines in India.

##### UNIT - I Introduction to Intellectual Property

Types of IP: Patents, Trademarks, Copyright & Related Rights, Design, Draft design, Traditional Knowledge, Geographical Indications- importance 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.

##### UNIT - II Patent Filing Procedures

National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes Patent licensing and 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. Trade secret.

## **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,

## **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

### **Text Books**

1. Bioethics - by Ellen Frankel Paul, Fred D. Miller, Jeffrey Paul, Fred Dycus Miller Cambridge University Press, 2002.
2. Bioethics & Science, John A. Bryant, Linda Baggott la Velle, John F. Searle .a2002.

### **References**

1. Jose B. Cibelli, Robert P. Lanza, Keith H. S. Campbell, Michael D. West. 2002. Principles of Cloning, Academic Press, San Diego, Gurdon.
2. Hoosetti, B.B. 2002. Glimpses of Biodiversity. Daya, New Delhi.
3. Martin. M.W. and Schinzinger.R. 2003. Ethics in engineering. 3<sup>rd</sup> Edition, Tata McGraw-Hill, New Delhi.
4. BAREACT. 2007. Indian Patent Act 1970 Acts & Rules. Universal Law Publishing Co. Pvt. Ltd.
5. Kankanala, K. C. 2007. Genetic Patent Law & Strategy. 1<sup>st</sup> Edition. Manupatra Information Solution Pvt. Ltd. Noida, India.
6. Senthil Kumar Sadhasivam and Mohammed, Jaabir. 2008. IPR, Biosafety and Biotechnology Management. Jasen Publications, Tiruchirapalli, India.
7. <http://www.cbd.int/biosafety/backgrounds.html>
8. <http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html>

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
VI	20UBT6CC9	IPR and Bioethics					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(✓) = 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 - VI

**Course Code: 20UBT6CP6**  
**Instruction Hours: 5**  
**Credits: 4**

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

### CORE PRACTICAL - VI

#### MICROBIAL BIOTECHNOLOGY (P)

##### Course outcomes

- This course the students will get hands on exposure on strain selection, fermentation, upstream & downstream the product.
  - Acquired knowledge about isolation of industrial important micro organism 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. Enzyme production – amylase production.
  8. Production of organic acids – Citric acid production by solid state fermentation.
  9. Antibiotic production by different strains of microbes (Theory).
  10. Test for sensitivity of microorganisms.
  11. Downstream processes of enzymes – dialysis.
  12. Immobilization of yeast cell by alginate beads
  13. Isolation & identification microbes from spoiled food.
  14. Production of yogurt, butter.
  15. Visit to Distillery unit; alcohol production and pharmacological industries. Pasteur Institute (Field visit).



## References

1. E. Mans, E.M.T. and C.F.A. Bryce, Taylor and Francis, UK. 2002. Fermentation technology and Biotechnology.
2. Ghose, T.K and P.Ghose. 2003. Biotechnology in India. Springer Publishers, India.
3. Glazer, A.N and H. Nikaido. 1995. Microbial Biotechnology. W.H. Freeman and Co., New York.
4. Stanbury, P.F., A. Whitaker and S.J. Hall. 1995. Principles of fermentation Technology, Pergamon, UK.
5. Wolf. Cruzer and Annalise Cruzer. 2000. Biotechnology Text Book of Industrial Microbiology. Panima Publishing House, New Delhi.
6. Patel, A.H. 2001. Industrial Microbiology. Macmillan India Ltd.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
VI	20UBT6CP6	Microbial Biotechnology - Lab					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(✓) = 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 - V

**Course Code: 20UBT5MBE1:1**  
**Instruction Hours: 5**  
**Credits: 3**

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

### MAJOR BASED ELECTIVE - I

#### IMMUNOLOGY

##### Course outcomes

- To understand the immune system, its components and their functions
- To comprehend the different type 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, tolarogen, 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 Nonspecific 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 Histocompatibility Complex - MHC genes, MHC in immune responsiveness and disease susceptibility. HLA typing. Kinetics of immune response and memory.

**CMI response** - T cell development, maturation, activation and differentiation. T cell receptor and determinant. T cell subsets. TCR complex. Antigen processing and presentation.

**HI response - B cell:** B cell development, maturation, activation and differentiation. B cell receptor and determinants. B cell subsets. Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants. Generation of antibody diversity.

**Unresponsiveness:** tolerance, suppression and potentiation.

#### **UNIT - IV Vaccinology**

Active, passive and combined immunization. Live, killed, attenuated, plasma derived, sub unit, recombinant DNA, protein based, plant-based, peptide, anti- idiotypic and conjugate vaccines – production & applications. Role and properties of adjuvants & ISCOMS.

#### **UNIT - V Clinical Immunology**

Immunity to infection. - Bacteria, viral, fungal and parasitic Hypersensitivity – Type I, II, III and IV. Autoimmunity Transplantation immunology. Tumor & Cancer immunology and immunotherapy Immunodeficiency

#### **Text Books**

1. E. Riott. 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, I S.J.Artin, I D.R.Burton and I I.M.Roitt. 2006. Essential Immunotechnology. 12<sup>th</sup> Edition. Wiley & Blackwell.
5. Richard M. Hyde. 2012. Microbiology and Immunology. 3<sup>rd</sup> Edition. Springer Science & Business Media.

#### **References**

1. Brostoff J, Seaddin JK, Male D, Roitt IM., 2002. Clinical Immunology. 6<sup>th</sup> Edition. Gower Medical Publishing.
2. Paul. 1999. Fundamental of Immunology. 4<sup>th</sup> Edition. LippencottRaven.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
V	20UBT5MBE1:1	Immunology					5	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(✓) = 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: 20UBT5MBE1:2**  
**Instruction Hours: 5**  
**Credits: 3**

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

### **MAJOR BASED ELECTIVE - I**

### **BIOINSTRUMENTATION**

#### **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

#### **UNIT - III Spectroscopy**

Colorimeter, Spectrometer, UV visible spectrometer, X – ray spectrometer, ELISA reader, Atomic absorption spectrometer, Flame photometer, Fluorimeter & Spectro fluorimeter.

#### **UNIT - IV Separation Techniques**

**Centrifugation** - Principle, operation, types & applications. **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, MoldiTof

### References

1. S.Sadasivam., A. Manickam. 1996. Biochemical Methods. 2<sup>nd</sup> Edition. New Age International (p) Ltd, Publishers.
2. Dr. G.Rajagobal., Dr. B.D.Toora. 2001. Practical Biochemistry. 1<sup>st</sup> Edition. Ahuja Book Company Pvt.Ltd.
3. J.Jayaraman. 2000. Laboratory Manual in Biochemistry. New Age International (p).
4. Plummer Mu, David T. Plummer. 1988. Introduction to Practical Biochemistry. Tata McGraw-Hill Education.
5. M. Mooyoung. 1985. Comprehensive Biotechnology. Vol. 2, 3 & 4. Pergamon press.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
V	20UBT5MBE1:2	Bio Instrumentation					5	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(✓) = 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: 20UBT5MBE1:3**  
**Instruction Hours: 5**  
**Credits:**

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

### MAJOR BASED ELECTIVE - I

#### NANOTECHNOLOGY

##### 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

Introduction - Scope and Overview, Length scales, Importance of Nanoscale and technology. History of Nanotechnology, Future of Nanotechnology: Nanotechnology Revolution, Silicon based Technology.

##### UNIT - II

Nanoparticles - Introduction, 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

Applications of nanotechnology: Nanosensors - types and its applications. Nanocarriers for Drug Delivery - Polymeric Nanoparticles as Drug Carriers. Micelles for Drug Delivery. Nanomedicine- Nanotechnology for Cancer Research and Therapy.

##### UNIT - IV

Environmental Nano Remediation Technology - Thermal, Physico-Chemical, and Biological methods. Nano Filtration for the Treatment of Wastes, Removal of Organics, Inorganics and Pathogens. Nanotechnology for Water Purification.

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## UNIT - V

Ethical issues in nanotechnology: Introduction, Socio-economic Challenges, with special Reference to Nanomedicine, Social and Ethical Issues, Economic Impacts.

### Text Books

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

### References

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

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
V	20UBT5MBE1:3	Nanotechnology					5	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(✓) = 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

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## SEMESTER - VI

**Course Code: 20UBT6MBE2:1**  
**Instruction Hours: 6**  
**Credits: 5**

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

### MAJOR BASED ELECTIVE - II

#### 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 know about Food borne 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 operations employed in a food processing plant.

##### UNIT - I Microorganisms associated with food

Microorganisms associated with food - bacteria, fungi and yeast. Enzymes in food preparation. Food contaminations. Food preservation. Food carcinogens & mutagen (N-nitrosamines, Acrylamide & their mode of action)

##### UNIT - II Food borne diseases

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 & Sucrolose)

##### UNIT - III General principle

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

##### UNIT - IV Food engineering operations

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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, HACCP FDA.

### UNIT - V Cleaning and sanitation of process plants

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).

#### Text Books

1. B.Siva 2011.Food Processing & Preservation –PHI Learning Pvt Ltd.

#### References

1. D.G. Rao, 2010. Fundamentals of Food Engineering –PHI Learning Pvt Ltd.
2. Narang, Food Microbiology.
3. Michael P. Doyle, Larry. R. Food Microbiology – Fundamentals & Frontiers
4. Frazier, Food Microbiology.
5. Yiu Hui & G. Khachatourians, Food Biotechnology.
6. Ibeq, Laramie & Bhunia, Fundamentals of Food Microbiology, CRC Press.

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

Semester	Code	Title of the Course					Hours	Credits			
VI	20UBT6MBE2:1	Food 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(✓) = 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

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## SEMESTER - VI

**Course Code: 20UBT6MBE2:2**  
**Instruction Hours: 6**  
**Credits: 5**

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

### MAJOR BASED ELECTIVE - II

#### ENZYME TECHNOLOGY

##### 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 enable the learner to realize the importance of enzymes in daily life, the properties of enzymes, the use of enzymes in industry, research and human health, and methods for the discovery of novel enzymes will be thoroughly explored
- 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 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.

##### UNIT - II Steady state kinetics

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

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

Role of co-enzyme in enzyme catalysis - Co-enzyme regeneration, mechanism of enzyme action, eg. 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 - 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.

### **Text Books**

1. Renuga Harekrishnan Biomolecules and Enzymes,
2. Thomas M Devlin. Textbook of Biochemistry with Clinical Correlations, 7th edition, Wiley publisher. 2010.
3. Albert L Lehninger, David L Nelson and Michael M Cox. Lehninger Principles of Biochemistry, 2nd edition, Wiley publisher. 2010.
4. Sathyanarayana U and Chakrapani U. Biochemistry, 4th edition, Elsevier publishers. 2013.

### **References**

1. Blazej, a. &Zemek.j. 1987. Inter Biotech, 87, Enzyme technologies, Elsevier.
2. Murray moo - Young. 1988. Bioreactor immobilized enzyme and cells. Fundamentals and applications, elseyler, applied science.
3. Rehm,h.j and Yeed, g. 1988. Biotechnology, Vol. 7a, Enzyme technology, Elsevier.
4. William, b. Jakoby, 1984. Methods in Enzymology, vol.104, enzyme purification and related techniques.
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 textbook of Biochemistry, 2nd edition, Ahuja Publishing House. 2010.
8. Reginald H Garrett and Charles M Grisham, 5th edition. Biochemistry, Brooks Cole publishers. 2012.

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Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
VI	20UBT6MBE2:2	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(✓) = 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 - VI

**Course Code: 20UBT6MBE2:3**  
**Instruction Hours: 6**  
**Credits: 5**

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

### MAJOR BASED ELECTIVE - II

### BIODIVERSITY AND CONSERVATION

#### Course outcomes

- To acquire knowledge with respect to biodiversity, its threats and its conservation and appreciate the concept of interdependence.
- To be aware of the national and international concern for protecting the environment.
- To observe the organization, functional morphology and diversity of representative Plant and animal.
- To study the fundamental knowledge about endangered plant and animals
- Improve the new discovery and commercialization of new products based on biological resources.

#### 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 turnover. Species-area relationships - Global distribution of richness - Centres of species diversity- Mega diversity centres- Hot spot analysis.

#### UNIT - II Loss of biodiversity

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) and inherent or intrinsic values, ethical and aesthetic values- An outline account on methods of valuing biodiversity.

### **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, Bio prospecting 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- Why conservation biology? Current practices in conservation- Habitat or ecosystem approaches- Species based approaches - Social approaches - Chipko movement- *In situ* (Afforestation, Social forestry, Agro forestry, Zoos, Biosphere reserves, National parks, Sanctuaries), and *ex situ* (Cryopreservation, Gene banks, Sperm banks, DNA banks, Tissue culture and Biotechnological strategies). Eco restoration, environmental and biodiversity laws, environmental education.

### **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
2. Meffe, G. K. and C. R. Carroll. 1994. Principles of Conservation Biology, Sinauer Associates, USA.
3. Groom bridge, 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	20UBT6MBE2:3	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(✓) = 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

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## SEMESTER – VI

**Course Code: 20UBT6MBE3:1**  
**Instruction Hours: 6**  
**Credits: 5**

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

### MAJOR BASED ELECTIVE - II

### ENVIRONMENTAL BIOTECHNOLOGY

#### Course outcomes

- 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 Concepts - Interactions between environment and biota; Concept of habitat and ecological niches; Limiting factor; Ecosystem dynamics and management: Stability and complexity of ecosystems; Energy flow, food chain, food web and trophic levels; Ecological pyramids, Population ecology.

#### UNIT - II

Environmental Pollution - Water Pollution: Sources of pollution. Industrial effluents, Domestic wastes, Agrochemical, Heavy metals, 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 pollution, Radioactive pollution, Thermal pollution and their Sources, effects, prevention and control measures.

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### **UNIT - III**

Bioremediation and Bio-leaching - Microbial bioremediation of oil spills and toxic metal ions. Phytoremediation. Microbial leaching of ores – direct and indirect mechanisms. Genetic Engineering in Environmental Biotechnology: Role of Genetically engineered microorganisms in environment.

### **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 VermiComposting.

### **UNIT - V**

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

### **Text Books**

1. Jogdand SN. Environmental Biotechnology. 2010. Himalaya Publishing House. New Delhi.
2. Gaston, K. J. 1996. Biodiversity: Biology of numbers and Difference. Blackwell.
3. Prescott, Harley, Klein. 2003. Microbiology. 5th Edition. McGraw Hill Publication.

### **References**

1. Alan Scragg. 1999. Environmental Biotechnology. Pearson Education Limited, England.
2. Jogdand, S.N. 1995. Environmental Biotechnology. Himalaya Publishing House, Bombay.
3. Chatterji AK. Introduction to Environmental Biotechnology. Prentice-Hall of India Private Limited. 2005.
4. Primack, R. B. 1993. Essentials of Conservation Biology, Sinauer Associates, USA
5. 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.

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Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
VI	20UBT6MBE3:1	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(✓) = 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: 20UBT6MBE3:2**  
**Instruction Hours: 6**  
**Credits: 5**

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

### MAJOR BASED ELECTIVE - III

#### CANCER BIOLOGY

##### Course outcomes

- To explore the cellular and molecular mechanisms underlying cancer development with the aim of understanding how changes in the normal growth and division processes lead to the formation of tumours.
- To acquire knowledge about Carcinogens
- To know about Cell Cycle regulation
- To know the knowledge of molecular and genetic basis of cancer.
- To understand the current concepts of cancer, including cancer diagnosis, cancer treatment and prevention

##### UNIT - I

Introduction - Growth characteristics of cancers cells; Morphological and ultra structural properties of cancer cells. Types of growth-hyperplasia, dysplasia, anaplasia and neoplasia. Nomenclature of neoplasms. Differences between benign and malignant tumors. Epidemiology of cancer.

##### UNIT - II

Cancer biology and biochemistry - Aberrant metabolism during cancer development; Paraneoplastic syndromes; Tumor markers; cellular protooncogenes - oncogene activation. Growth factors-EGF, TNF- $\alpha$  and TGF- $\beta$  and growth factor receptors-Signal transduction in cancer - Role of transcription factors.

##### UNIT - III

Carcinogenesis-radiation and chemical carcinogenesis-stages in chemical carcinogenesis - Initiation, promotion and progression. Free radicals, antioxidants in cancer; Viral carcinogenesis - DNA and RNA Viruses and human cancer; Cancer endocrinology.

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## UNIT - IV

Cell Cycle Regulation-Tumor suppressor genes p53, p21, Rb, BRACA1 and BRACA2. Telomeres, Telomerase and Immortality; cell-cell interactions, cell adhesion-invasion and metastasis-VEGF signaling, angiogenesis; Epigenetics-Role of DNA methylation in gene silencing- epigenetic silencing of tumor-suppressor genes; Apoptosis in cancer-Cell death by apoptosis-role of caspases; Death signaling pathways-mitochondrial and death receptor pathways.

## UNIT - V

Strategies of anticancer drug therapy-chemotherapy-gene therapy. Immunotherapy and Radiotherapy; Stem Cells and Cancer.

### Text Books

1. The Biological Basis of Cancer: R. G. McKinnell, R.E.Parchment, A.O. Perantoni, G.Barry Pierce, I. Damjanov. 2nd Edition, Cambridge University Press, 2006.
2. The Biology of Cancer: R. A. Weinberg. Garland Science. 2006.

### References

1. The Molecular Biology of Cancer: S.Pelengaris, M.Khan. Black well Publication. 2002.
2. The Cancer Hand Book: Malcolm R. Alison. Nature Publishing Group.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
VI	20UBT6MBE3:2	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 - VI

**Course Code: 20UBT6MBE3:3**  
**Instruction Hours: 6**  
**Credits: 5**

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

### MAJOR BASED ELECTIVE - III

#### STEM CELL BIOLOGY

##### Course outcomes

- 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 – similarities and differences between adult and embryonic stem cells – Functional characterization.

##### UNIT- II Embryonic Stem Cells

Stem cells and their developmental potential. In vitro fertilization-culturing of embryos-blastocyst-inner cell mass-isolation and growing ES cells in lab- Identification and 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-trans differentiation-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.

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## UNIT - IV Cancer Stem Cell Signaling

Introduction: Tumor stem cells - Breast Cancer Stem Cells: Identification - Signaling pathways: Notch signaling – Wnt signaling in stem cells and 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 -

### Text 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. Ariff Bongso, Eng Hin Lee “Stem Cells: From Bench to Bedside” World Scientific Publishing Company. 2005.
2. C S Potten “Stem Cells” Elsevier, 1996.
3. Daniel R. Marshak “Stem cell biology” Cold Spring Harbor Laboratory Press.
4. Robert Lanza “Essentials of Stem Cell Biology” Elsevier, 2009.
5. Peter Quesenberry “Stem cell biology and Gene Therapy” Wiley-Liss, 1988.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
VI	20UBT6MBE3:3	Stem Cell 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 - IV

**Course Code: 20UBT4SBE1:1**  
**Instruction Hours: 2**  
**Credits: 2**

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

### SKILL BASED ELECTIVE - I

#### MUSHROOM AND VERMI TECHNOLOGY

##### Course outcomes

- Acquired knowledge about mushroom cultivation and vermicompost 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 and Vermicomposting
- To facilitate self-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 flabellatus*, 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 earth worms as Epigeics -Introduction to earthworm biology -physical and chemical effects of earth worms on soils - Role of earthworms in soil -classification of earthworms based on ecological strategies- Burrowing activity of earthworms- Drilospheres - Microorganisms and their relationship with earthworms. Composting - anaerobic composting, aerobic composting, types of composting, vermicompost- earthworm species used in vermicompost production -



endemic species, exotic 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.

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

Antiviral value, antibacterial effect, antifungal effect, anti-tumour effect, haematological value cardiovascular & renal effect, in therapeutic diets, adolescence, for aged persons & diabetes mellitus. Delicious recipes of mushroom-Economic importance of mushrooms. Vermicomposting as a tool for solid waste management - a small scale industry and its economics.

#### **References**

1. Brady, C.N, 1974 "The Nature and Properties of soils" Macmillan publishing Co. New York, London.
2. Edwards, C.A., and Bohlen, P.J., 1996. Biology and Ecology of Earthworms, Chapman and Hall, London Ismail, S.A., 1997, Vermicology: The Biology Earth worm Orient Longman.
3. Changs. T. W.A. Hayanes 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.

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Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
IV	20UBT4SBE1:1	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(✓) = 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

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## SEMESTER - IV

**Course Code: 20UBT4SBE1:2**  
**Instruction Hours: 2**  
**Credits: 2**

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

### SKILL BASED ELECTIVE - I

#### FOOD AND NUTRITION

##### 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, 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.

##### 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

##### UNIT - III

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

##### UNIT - IV

Protein - classification – functions, sources digestion and absorption, sources and deficiency disorders.  
Lipids - Classification, functions, digestion and absorption, sources, excess and deficiency disorder

## **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.

### **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 Publishin

### **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, Toranto.
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, Mosbey Co. St. Louis.
5. M. Swaminathan “Principles of Nutrition and Dietetics”, 1993, Bappco 88, Mysore Road, Bangalore-560 018.
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.

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Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course				Hours	Credits				
1V	20UBT4SBE1:2	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(✓) = 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 - IV

**Course Code: 20UBT4SBE1:3**  
**Instruction Hours: 2**  
**Credits: 2**

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

### SKILL BASED ELECTIVE - I

#### PHYTOCHEMICALS AND 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 health care
- To enable the students 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

##### 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.

##### 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 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*, *Dioscorea*.); Tannins (Hydrolysable & Condensed types); Volatile Oils - extraction methods (*Clove*, *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.

### 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	20UBT4SBE1:3	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	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
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

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**SEMESTER - V**

**Course Code: 20UBT5SBE2:1**  
**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.

**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.

**UNIT - III**

Hematology - Blood-Collection of haematological specimens, 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.

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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.

## **UNIT - V**

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.

### **Text Books**

1. Rajan S. Medical Microbiology. MJP Publishers, Chennai. 2007.
2. Rajan S. Parasitology. SRS Publications, Chennai. 2007.

### **References**

1. K.L. Mukherjee, "Medical Laboratory Technology" Vol. I, II & III, Tata McGraw Hill Publishing company, New Delhi, 2008.
2. C.R. Maity, "Medical Laboratory Technology", New Central Book Agency Pvt Ltd. Kolkata, 2005.
3. Alan H Gowenlock, "Varley's Practical Clinical Biochemistry", CBS Publications & Distributors, New Delhi, 2009.
4. Monica Cheesbrough, "District Laboratory Practice" in Tropical Countries Part – 1 & 2 Cambridge Low- Price Edn. 2000.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
V	20UBT5SBE2:1	Medical lab 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(✓) = 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

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## SEMESTER - V

**Course Code: 20UBT5SBE2:2**  
**Instruction Hours: 2**  
**Credits: 2**

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

### SKILL BASED ELECTIVE - II

#### BIOFERTILIZER

##### 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*)

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

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.

##### UNIT - III Microbial Symbiotic association

*Rhizobium* - Taxonomy, physiology, Host-*Rhizobium* interaction, mass cultivation, carrier and base inoculants. Vermiculture - Earth worms and micro organisms - 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, isolation, stock plants and inoculums production of VAM.

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## 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.

### 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.

### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
V	20UBT5SBE2:2	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(✓) = 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: 20UBT5SBE2:3**  
**Instruction Hours: 2**  
**Credits: 2**

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

### SKILL BASED ELECTIVE - II

#### DAIRY TECHNOLOGY

##### Course outcomes

- To have the ability to use the acquired knowledge during milk processing and dairy processing equipments
- The course provides knowledge about dairy industry & manufacture of Dairy products
- The course provides knowledge about Fermented dairy products
- The course provides the Industrial approach of Biotechnology
- To improve the students entrepreneurial skill

##### UNIT - I Dairy Chemistry and Microbiology

Introduction, Basic dairy terminology, milk as raw material, composition, food value, contaminants, milk reception in dairies and tests, Quality and Quantity tests at reception, Cell count and other tests, Milk transport and storage in dairy plants, Cholesterol, fatty acids and their relation to cardiovascular diseases - Dietary recommendations - Applications of enzymes in dairy industry

##### UNIT - II Dairy Processing Equipments

Milk processing terminology, Processing flow sheet, Equipment employed, Pasteurisers (Heat Exchangers), Plant piping, Pumps, Cream separating Centrifuges, Homogenizers, Bottle and pouch fillers, Milk Chillers, Ice Cream Freezers. Vacuum Evaporators, Spray and Drum Dryers, Product instantizing equipment. Packaging of milk in bottles and sachets.

##### UNIT - III Manufacture of Dairy Products

Cheese – Types of cheese, Defects in cheese, Manufacture of paneer, Toned Milk, Sweetened Condensed milk, Khoa, Milk powder – Quality aspects

##### UNIT - IV Manufacture of Ice Cream and other Dairy Products

Manufacture of Ice cream - Chemistry and technology - Microbiology of ice cream – Quality, Aspects, Manufacture of Butter, Ghee - Grading of butter - Quality aspects, Extraction of casein from milk, properties, composition and industrial uses. Production of lactose and whey

## UNIT - V Fermented dairy products

Fermented products - Yoghurt, Curd, acidophilus milk etc. Energy use in Dairy plant, sources of energy, cost of energy, Control of energy losses and Energy conservation.

### Text books

1. National Institute of Industrial Research, Modern Technology of Milk processing and Dairy products, II Edition, NIIR Publications, India, 2004.
2. Tufail Ahmad: *Dairy Plant Systems Engineering* Kitab Mahal, Allahabad, India (1985)
3. Edger Spreer & Axel Mixa: *Milk and Dairy Product technology* Mercel dekker Inc. N.Y. (1998)

### References

1. Arthur W. Farral: *Engineering of Dairy and food Products* (II Edition 1970) Robert E. Krieger Publishing Co. NY.
2. Garret Smit : *Dairy Processing (Improved Quality)* Woodhead Publishing Ltd. CRC Press (2003).
3. W.M. Clunie Harvey and Harry Hill: *Milk Products* Bio Tech Books, New Delhi (1999).
4. Prof. H.G. Kessler: *Food Engineering and Dairy Technology* Verlag Kessler Publishing House, Germany (1981).
5. W. James Harper and Carl W. Hall: *Dairy Technology and Engineering* AVI Publishing, Westport, USA (1976).
6. Edger Spreer: *Milk and Dairy Product Technology* Mercel Dekkar Inc. New York, USA (2005)

### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
V	20UBT5SBE2:3	Dairy 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(✓) = 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

## SEMESTER - V

**Course Code: 20UBT5SBE3:1**  
**Instruction Hours: 2**  
**Credits: 2**

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

### SKILL BASED ELECTIVE - III

#### AQUA CULTURE

##### Course outcomes

- 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, Freshwater 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. Pre-stocking 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; Shell fish – culture of prawns and molluscs.

##### UNIT - IV Fish feed

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Fish feed and its importance, 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.

### **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.

#### **Text Books**

1. S. Ayyappan, J. K. Jena, A. Gopalakrishnan, Dr.A.K. Pandey. 2010. Handbook of Fisheries and Aquaculture. Indian Council of Agricultural Research. New Delhi.
2. K.K. Balachandran. 2001. Post harvest Technology in Fish and Fishery Products. Daya Publishing House. New Delhi.
3. Jhingran V.G. 1985. Fish and Fisheries of India. 3rd Edition. Hindustan Publ. Crop. India. Ltd. New Delhi.
4. T. V. R. Pillay and M. N. Kutty. 2005. Aquaculture Principles and Practices. Wiley Black-Well

#### **References**

1. Aline W. 1980. Fish diseases. Springer Verlag.
2. Midlen A.B and Redding T.A. 1998. Environmental Management for Aquaculture. 6th Edition. London: Chapman & Hall.
3. Wedmeyer G. Meyer F.P. and Smith L. 1999. Environmental Stress and Fish Diseases. Narendra Publ. House.
4. Woo P.T.K and Bruno D.W. 1999. Fish Diseases and Disorders. Vol. 3 Viral, Bacterial and Fungal Infection. Center for Agriculture and Biosciences International.
5. Felix S. Riji John K, Prince Jeyaseelan M.J. and Sundararaj V. 2001. Fish Disease Diagnosis and Health Management.

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Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
V	20UBT5SBE3:1	Aquaculture					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(✓) = 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

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## SEMESTER - V

**Course Code: 20UBT5SBE3:2**  
**Instruction Hours: 2**  
**Credits: 2**

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

### SKILL BASED ELECTIVE - III

#### APICULTURE

##### Course outcomes

- The students acquired knowledge about honey bees, its life style, 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. Honeybee – 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 bee hives – types – construction of space frames – Selection of sites – Handling – Maintenance – Instruments employed in Apiary

##### UNIT - IV

Honey – Composition – Honey extraction, seasonal maintenance- uses. Bee wax and its uses – National and International markets for Honey and Wax. Natural enemies and diseases of honey bees and their control measures.

## UNIT - V

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

### Text Books

1. Abrol, D. P. 1997. Bees and Beekeeping in India. Kalyani Publishers, Ludhiana.
2. Rare, S. 1998, Introduction to Bee keeping, Vikas Publishing house.

### References

1. Cherian, R. & K.R. Ramanathan, 1992 – Bee keeping in India
2. Singh, S.1982 – Bee Keeping – ICAR
3. Mishra,R.C. 1995. Honey Bees and Their Management in India. ICAR, New Delhi.
4. Sharma, P. and Singh L. 1987 – Hand book of bee keeping, Controller Printing and Stationery,
5. Shukla, G.S and Upadhyay, V.B. 1997. Economic Zoology. Rastogi Publications, Meerut.
6. Arumugam, N., Murugan, T., Johnson Rajeshwar, J. and Ram Prabhu, R. 2009. Applied Zoology. Saras Publication, Nagercoil.
7. Amsath, A. and Marimuthu Govindarajan, 2013. Apiculture. Lambert Academic Publishing.

### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
V	20UBT5SBE3:2	Apiculture					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(✓) = 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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## SEMESTER - V

**Course Code: 20UBT5SBE3:3**  
**Instruction Hours: 2**  
**Credits: 2**

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

### SKILL BASED ELECTIVE - III

#### SERICULTURE

##### Course outcomes

- The students acquired knowledge about the technique of silkworm rearing, cocoon production and silk reeling from sericulture.
- The students acquired knowledge about types of silkworms, distribution of races.
- The students acquired knowledge about mulberry cultivation
- Describe silkworm rearing house and appliances
- To kindle the young minds 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.

##### UNIT - II

Types of silkworms, distribution of races- 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.

##### UNIT - III

Silkworm 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 silkworm: uzi fly, dermistid beetle-control and preventive measures. Silkworm diseases: protozoan, viral, fungal and bacterial diseases and their control and preventive methods.

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## 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.

### Text Books

1. Ganga, G. and Sulochana Chetty, J. 2003. An Introduction to Sericulture (2nd Edition). Oxford and IBH Publishing co. Pvt-Ltd., New Delhi.
2. Taxima, Y. 1972. Hand Book of Silkworm Rearing. Fuji Publication, Tokyo.

### References

1. Ullal, S.R. and Narasimhanna, M.N. 1979. Hand book of Practical Sericulture. Central Silk Board, Bombay. 1. Jolly, M.S. (Ed) Appropriate sericultural Techniques, CSR & TI, Mysore.
2. Narasimhanna, M.N. 1988. Manual of silkworm egg production. CSB, Bangalore
3. Wupang-chun and da-chung. 1988. Silkworm rearing, pub. By FAO, Rome
4. Sengupta K. 1989. A guide for bivoltine sericulture:, Director , CSR & TI, Mysore
5. Krishnaswamy, 1986. Improved method of rearing young age silkworm: S. reprinted CSB, Bangalore.
6. Shukla, G.S. and Upadhyay, V.B. 1997. Economic Zoology. Rastogi Publications, Meerut.
7. Tomar, B.S and N.Singh. A Text Book of Applied Zoology. 2007. Emkay publications. Delhi.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
V	20UBT5SBE3:3	Sericulture					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(✓) = 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: 20UBT3NME1**  
**Instruction Hours: 2**  
**Credits: 2**

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

### NON MAJOR ELECTIVE - I

#### BIOTECHNOLOGY

##### Course outcomes

- This paper provides an in-depth scope and significance of various ecotechnological 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.

##### UNIT - II Food & Dairy Biotechnology

Microbes as food, feed. Prebiotics. Probiotics. Algae - SCP, Beta carotene, Fungi as food – Mushroom. Fermented food products.

##### UNIT - III Biotechnology for disease diagnosis

Clinical diagnosis. Lab diagnosis – Microscopy, Macroscopy, Biochemical, serological & Molecular diagnosis of diseases – PCR, RT –PCR, RAPD, RFLP, Karyotyping

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

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

##### UNIT - V Environmental Biotechnology

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

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## Text Books

1. D.Balasubramanian, C.F.A.Bryce, K.Dharmalingham, J.Green and K.Jayaraman.1996. Concepts in Biotechnology. Universities Press.
2. Ashok K. Chauhan. 2009. A Textbook of Molecular Biotechnology. I.K. International Publishing house Pvt. Ltd.
3. Chandrakant Kokate, SS Jalalpure, Pramod H.J. 2011.Textbook of Pharmaceutical Biotechnology. A division of Reed Elsevier India Pvt. Ltd.

## References

1. B.C. Bhattacharyya and Rintu Banerjee. 2007. Environmental Biotechnology. Oxford Higher Education Publication.
2. Krishna B Ghimire. 2000. Social change and conservation. London Earthscan Publ.
3. P.J.Delves,I, S.J.Artin,,I.D.R.Burtonand II.M.Roitt.2006. Essential Immunotechnology.12<sup>th</sup> Edition. Wiley & Blackwell.

### Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits				
III	20UBT3NME1	Biotechnology for human welfare					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(✓) = 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 - IV

**Course Code: 20UBT4NME2**  
**Instruction Hours: 2**  
**Credits: 2**

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

### NON MAJOR ELECTIVE - II

### PHARMACEUTICAL BIOTECHNOLOGY

#### Course outcomes

- To create general understanding regarding basic principles involved in modern medicinal/structural chemistry systems.
- 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.

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

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

#### UNIT- III Unit Operations in Biopharmaceutical Technology

Production of water for biopharmaceutical use, Filtration, mixing, Drying. Freeze drying, Sterilisation

#### 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 - Quality control , Good manufacturing practice.\*\*\*\*\*



## 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. Text book of medical physiology, W.B.Saunders, Hong Kong 1986.
2. S.S. Purohit, Kaknani, Saleja Pharmaceutical Biotechnology.
3. N.Murugesh, A concise Text Book of Pharmacology. Sixth edition. Sathya Publishers, Madurai.
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	20UBT4NME2	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(✓) = 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

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