

# **B.Sc., BIOTECHNOLOGY**

## **SYLLABUS**

**(For the students admitted in the academic year 2023–2024 Onwards)**



**DEPARTMENT OF BIOTECHNOLOGY & BIOINFORMATICS**

**BISHOP HEBER COLLEGE (Autonomous)**

**(Affiliated to Bharathidasan University)**

**(Nationally Reaccredited at the 'A' Grade by NAAC with the CGPA of 3.58 out of 4)**

**(Recognized by UGC as "College with potential for Excellence")**

**TIRUCHIRAPPALLI-620 017.**

**TAMILNADU, INDIA**

**LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK GUIDELINES BASED REGULATIONS FOR UNDER GRADUATE PROGRAMME**

<b>Programme:</b>	<b>B.Sc. BIOTECHNOLOGY</b>
<b>Programme Code:</b>	
<b>Duration:</b>	3 Years [UG]
<b>Programme Outcomes:</b>	<b>PO1:</b> Students understand the major concepts in Biology and understand the fundamental principles.
	<b>PO2:</b> Students will develop scientific outlook not only with respect to life science, but in all aspects related to life.
	<b>PO3:</b> Students are trained to apply and adapt appropriate techniques, resources, and instrumentation which will help them to pursue higher education or jobs after the programme.
	<b>PO4:</b> Students develop the ability to effectively communicate scientific information with strong ethics in written and oral formats.
	<b>PO5:</b> Students will understand their roles and responsibilities especially the protection of the people.
	<b>PO6:</b> Students become eligible to pursue higher education in their respective fields and engage in lifelong learning and enduring proficient progress.
<b>Programme Specific Outcomes:</b>	<b>PSO1:</b> Recall the fundamentals of Biotechnology which would enable them to comprehend the emerging and advanced biotechnology concepts in life sciences.
	<b>PSO2:</b> Inculcate deeper knowledge in practical skills enabling them to work with disciplinary and interdisciplinary aspects of biotechnology.
	<b>PSO3:</b> Enhance students' learning abilities, technological solutions in domains of biotechnology for their applications in industry and research and entrepreneurial skills.
	<b>PSO4:</b> Evaluate the need and impact of scientific techniques on the environment and the society, keeping in view their sustainable development.
	<b>PSO5:</b> Analyze the knowledge gained in Biotechnology for lifelong learning.

**Programme : B.Sc. Biotechnology -2023 onwards**

Sem .	Part	Course	Course Title	Course Code	Hours / week	Credits	Marks		
							CIA	ES E	Total
I	I	Language I	பொதுத்தமிழ் I	U23TM1L1	6	3	25	75	100
	II	English I	Language through Literature: Prose and Short Stories	U23EG1L1	6	3	25	75	100
	III	Core I	Cell and Molecular Developmental Biology	<a href="#">U23BT101</a>	5	5	25	75	100
		Core Prac. I	Cell and Molecular Developmental Biology Lab	U23BT1P1	3	3	40	60	100
		Allied I	Biological Chemistry	U23BT1Y1	3	3	25	75	100
		Allied Prac. I	Biological Chemistry Lab	U23BTYP1	3	2	40	60	100
	IV	SEC I	Herbal Medicine	U23BT1E1	2	2	25	75	100
		FC	Good Laboratory Practices	U23BT1N1	2	2	100	--	100
					<b>30</b>	23			
II	I	Language II	பொதுத்தமிழ் II	U23TM2L2	6	3	25	75	100
	II	English II	Language through Literature: Poetry and Shakespeare	U23EG2L2	6	3	25	75	100
	III	Core II	Genetics	U23BT202	5	5	25	75	100
		Core Prac. II	Genetics Lab	U23BT2P2	3	3	40	60	100
		Allied II	Fundamentals of Microbiology	U23BT2Y2	3	3	25	75	100
		Allied Prac. II	Fundamentals of Microbiology Lab	U23BTYP2	3	2	40	60	100
	IV	SEC II	Organic farming and Health Management	U23BT2E2	2	2	25	75	100
		SEC III	Clinical Nutrition and Dietary Management	U23BT2S3	2	2	25	75	100
					<b>30</b>	23			
III	I	Language III	பொதுத்தமிழ் III	U23TM3L3	6	3	25	75	100
	II	English III	Language through Literature: One Act Plays and Fiction	U23EG3L3	6	3	25	75	100
	III	Core III	Immunology and Immunotechnology	U23BT303	5	5	25	75	100
		Core Prac. III	Immunology and Immunotechnology Lab	U23BT3P3	3	3	40	60	100

		Allied III	Bioinstrumentation	U23BT3Y3	3	3	25	75	100
		Allied Prac. III	Bioinstrumentation Lab	U23BTYP3	3	2	40	60	100
	IV	SEC IV	Mushroom Cultivation	U23BT3S4	1	1	10 0	--	100
		SEC V	Vermitechnology	U23BT3S5	2	2	25	75	100
		EVS	Environmental Studies	U23EST41	1	--	--	--	--
					<b>30</b>	22			

IV	I	Language IV	பொதுத்தமிழ் IV	U23TM4L4	6	3	25	75	100
	II	English IV	Language through Literature	U23EG4L4	6	3	25	75	100
	III	Core IV	Genetic Engineering and rDNA Technology	U23BT404	5	5	25	75	100
		Core Prac. IV	Genetic Engineering and rDNA Technology Lab	U23BT4P4	3	3	40	60	100
		Allied IV	Bioinformatics and Biostatistics	U23BT4Y4	3	3	25	75	100
		Allied Prac. IV	Bioinformatics and Biostatistics Lab	U23BTYP4	2	2	40	60	100
	IV	SEC VI	Life Skills	U23BT4S6	2	2	10 0	--	100
		SEC VII	Startup Design in Biotechnology and Skill Development	U23BT4S7	2	2	10 0	--	100
		EVS	Environmental Studies	U23EST41	1	2	25	75	100
					<b>30</b>	25			
V	III	Core V	Plant Biotechnology	U23BT505	5	4	25	75	100
		Core VI	Animal Biotechnology	U23BT506	5	4	25	75	100
		Core Prac. V	Plant Biotechnology and Animal Biotechnology Lab	U23BT5P5	6	4	25	75	100
		Core Project	Core Project with Viva Voce	U23BT5P5	4	4	40	60	100
		Elective I	Nano Biotechnology	U23BT5:A	4	3	25	75	100
			Cancer Biology	U23BT5:B					
Elective II	Environment Management in Industries	U23BT5:C	4	3					

			Marine Biotechnology	U23BT5:D					
	IV	VLO	Abundant Life	U23VLO51	2	2	10 0	--	100
			Human Values	U23VLO52					
		Internship	Internship / Industrial Activity	U23BT5I1	--	2	10 0	--	--
					30	26			
VI	III	Core VII	Bioentrepreneurship	U23BT607	6	4	25	75	100
		Core VIII	Pharmaceutical Biotechnology	U23BT608	6	4	25	75	100
		Core Prac. VI	Environmental and Industrial Biotechnology Lab	U23BT6P6	6	4	40	60	100
		Elective III	Medical Biotechnology	U23BT6:A	5	3	25	75	100
			Forensic Science	U23BT6:B					
	Elective IV	Bioethics and Biosafety Aquaculture	U23BT6:C	5	3	25	75	100	
	IV	Extension Activity	Extension Activities	U23ETA61	--	1	--	--	--
		SBA	Professional Competency For Clearing Govt. Competitive Examinations	U23BT6N3	2	2	10 0	--	100
					<b>30</b>	21			
				Total Credits :		142			

# *SEMESTER – I*

**CORE- I: CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY**

Subject Code:U23 BT101	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1					5	5	25
<b>Learning Objective: On successful completion of the course, students will be able to</b>									
LO1	Have an insight of the cell as the fundamental unit of life and to compare the structure of the Eukaryotic cell with the primitive prokaryotic cell								
LO2	Analyze the structure and obtain a strong foundation about the functional aspects of cell organelles and cell membrane.								
LO3	Study the structure and functions of Nucleic acid and discuss the molecular mechanism of Replication, Transcription and Translation and post-translational modifications of proteins.								
LO4	Predict the response of cells to the intra and extracellular environment by studying about the intracellular signaling pathways.								
LO5	Understand the principles and molecular mechanisms involved in cellular differentiation, morphogenesis, growth and Potency of the cell.								
UNIT	Contents								No. of Hours
I	Discovery and diversity of cells - Cell theory - Structure of prokaryotic (bacteria) and eukaryotic cells (plant and animal cells).								10

II	Biomacromolecules and Biomolecules (Primary functions in the cell). Structure and Functions of Cell Organelles: Cell wall - Cell membrane - Cytoplasm - Nucleus - chromosomes -Endoplasmic reticulum - Ribosomes - Golgi bodies - Plastids - Vacuoles - Lysosomes - Mitochondria - Microbodies - Flagella - Cilia - Centrosome and Centrioles - Cytoskeleton.	20
III	Structure and functions of DNA and RNA -Central Dogma of the cell. DNA - Replication in prokaryotes - Transcription in Prokaryotes and Eukaryotes - RNA Processing - Genetic code- Translation - Similarities and differences in prokaryotic and eukaryotic translation - Post Translational Modifications - Protein Sorting - Protein degradation.	15
IV	Cell cycle - Cell cycle checkpoints - Cell division - Mitosis and Meiosis - Cellular differentiation - Cell junctions - Cell Adhesion – Extra Cellular Matrix - Cell to cell communications - Signal transduction - G - Protein Coupled Receptors Signal transduction pathways.	15
V	Gametogenesis - Spermatogenesis and Oogenesis in mammals. Fertilization- Types of cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals- Organogenesis.	15
<b>Total</b>		<b>75</b>
<b>Text Books</b>		
1	T. Devasena (2012), Cell Biology, Oxford University Press.	
2	Gupta, Renu&Makhija, Seema&Toteja, Ravi. (2018). Cell Biology: Practical Manual.	
3	Gilbert, S.F. 2016. Developmental Biology, 11 <sup>th</sup> edition. Sinauer Associates Inc. Publishers, MA. USA.	
4	Bruce Alberts, 6 <sup>th</sup> Edition (2014). Molecular Biology of the cell, W. W. Norton & Company.	
5	James D. Watson (2001), The Double Helix: A personal account of the Discovery of the Structure of DNA, Touchstone Publishers.	
<b>Reference Books</b>		
1	Karp's Cell and Molecular Biology: Concepts and Experiments. 8 <sup>th</sup> Edition (2015). Wiley Publications.	
2	James D. Watson, 7 <sup>th</sup> Edition (2014), Molecular Biology of the Gene, Pearson Publications.	
3	Geoffrey M. Cooper, 7 <sup>th</sup> Edition (2015). The Cell: A Molecular Approach, Sinauer	



	Associates, Qxford University Press.
4	LodishHarwey, 6 <sup>th</sup> Edition (2016), Molecular Cell Biology, W. H. Freeman Publications.
5	Wolpert L, Tickle C, 2015. Principles of Development, 5 <sup>th</sup> edition, Oxford University Press.
<b>Web Resources</b>	
1	<a href="http://www.cellbiol.com/education.php">http://www.cellbiol.com/education.php</a>
2	<a href="https://global.oup.com/uk/orc/biosciences/cellbiology/wang/student/weblinks/ch16/">https://global.oup.com/uk/orc/biosciences/cellbiology/wang/student/weblinks/ch16/</a>
3	<a href="https://dnalc.cshl.edu/websites/">https://dnalc.cshl.edu/websites/</a>
4	<a href="https://www.cellsignal.com/contents/science/cst-pathways/science-pathways">https://www.cellsignal.com/contents/science/cst-pathways/science-pathways</a>
5	<a href="https://nptel.ac.in/courses/102/106/102106025/11">https://nptel.ac.in/courses/102/106/102106025/11.</a>

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	3	2	1	3	-	3	3	2	3
<b>CLO2</b>	3	3	3	3	-	3	3	2	3
<b>CLO3</b>	3	3	3	2	-	3	3	2	2
<b>CLO4</b>	3	2	3	2	-	3	3	2	3
<b>CLO5</b>	3	3	2	2	-	3	3	2	3
<b>TOTAL</b>	<b>15</b>	<b>14</b>	<b>12</b>	<b>12</b>	<b>0</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>15</b>
<b>AVERAGE</b>	<b>3</b>	<b>2.8</b>	<b>2.4</b>	<b>2.4</b>	<b>0</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>



**Practical - I CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY LAB**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT1P1			4		3	3	40	60	100
<b>Learning Objective</b>									
LO1	Demonstrate the operation of Light Microscope								
LO2	Identify blood cells and its components								
LO3	Isolate and identify plant, and animal cells.								
LO4	Summarizes the concept of gametes								
LO5	Develop skill to perform cell fractionations.								
UNIT	Contents								No. of Hours
I	Components of a Compound / Light Microscope.								9
II	Blood smear preparation and Identification of Blood cells Buccal smear preparation and Identification of squamous epithelial cells.								9
III	Isolation and Identification of plant cells.								9
IV	Observation of sperm & Egg Mounting of chick Embryo - 24 hrs, 48 hrs, 72 hrs, 96 hrs. Types of placenta in mammals.								9
V	Cell fractionation and Identification of cell organelles (Demo)								9
<b>Total</b>								<b>45</b>	
<b>Text Books</b>									
1	K.V. Chaitanya, (2013), <i>Cell and molecular biology</i> : Lab manual, PHI publishers,. ISBN 978-81-203-800-4								

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC  
OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	3	3	3	3	2	3	3	2	2
<b>CLO2</b>	3	3	3	3	3	3	3	2	2
<b>CLO3</b>	3	3	3	3	3	3	3	3	3
<b>CLO4</b>	3	2	3	3	3	3	3	3	3
<b>CLO5</b>	3	3	2	3	2	2	2	3	3
<b>TOTAL</b>	<b>15</b>	<b>14</b>	<b>14</b>	<b>15</b>	<b>13</b>	<b>14</b>	<b>14</b>	<b>13</b>	<b>13</b>
<b>AVERAGE</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>	<b>3</b>	<b>2,6</b>	<b>2.8</b>	<b>2.8</b>	<b>2.6</b>	<b>2.6</b>

### Allied Paper I- BIOLOGICAL CHEMISTRY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT1Y1	3	1			3	3	25	75	100
<b>Learning Objective</b>									
LO1	Comprehend the importance of Chemistry and Biochemistry through the concept of acids and bases, and chemical bonding.								
LO2	Demonstrates the formation of different types of solutions, concentrations of solution and preparation of buffer solutions								
LO3	Recall the Structure, Classification, Chemistry and Properties of Carbohydrates and Explain Various Biochemical Cycles involved in Carbohydrate Metabolism.								
LO4	Recall the Structure, Classification, Chemistry and Properties of Lipids, Nucleic acid and Explain Various Biochemical Cycles involved in Fatty acid and Nucleic acid Metabolism.								
LO5	Understand the Structure, Classification, Chemistry and Properties of proteins amino acids and Identify and explain nutrients in foods and the specific functions in maintaining health.								
UNIT	Contents								No. of Hours
I	Atomic theory, formation of molecules, electronic configuration of atoms- s & p shapes of atomic orbitals. Periodic table, periodic classification, valency. Types of chemical bonds. Classification of organic compounds -. Hybridization in methane, ethane, acetylene, and benzene. Definition with examples- electrophiles, nucleophiles and free radicals. Types of reactions with an example: addition, substitution, elimination, condensation and polymerization. Electrophilic substitution reaction in benzene, nitration and sulphonation.								15
II	Acids & Bases properties and differences, Concepts of acids and bases- Arrhenius, Lowry-Bronsted and Lewis. Concentration of solution, ways of expressing concentrations of solutions – per cent by weight, normality, molarity, molality, mole fraction. pH of solution, pH scale, measurement of pH. Buffer solutions, properties of buffers, Henderson-Hasselbalch equation, mechanism of buffer								15

	action of acidic buffer and basic buffer.	
III	Importance to Biochemistry-the chemical foundation of life. Water: its unique properties, ionization of water, buffering action in biological system, properties and characteristics of water. Classification of carbohydrates. Properties of carbohydrates. Ring structure of sugars and conformations of sugars. Metabolism of Carbohydrates – Glycogenesis, Glycogenolysis, Cori's cycle, Glycolysis, TCA cycle, bioenergetics of carbohydrate metabolism.	15
IV	Classification of Lipids. Characteristics, Properties and Biological importance of lipids. Metabolism of Fatty acids, triglycerides, phospholipids, cholesterol. B-oxidation of fatty acids. Classification of nucleic acids. Purine and Pyrimidine bases. Classification of DNA & RNA. Metabolism of Nucleic acids, Salvage pathway.	15
V	Classification and structure of amino acids. Structural conformation of proteins. Classification of proteins. Properties and biological importance of amino acids and proteins. Degradation of Amino acids and Urea Cycle. Vitamins and Hormones. Role of hormones in metabolism. ATP production. Oxidative phosphorylation, Electron transport chain and Photophosphorylation.	15
<b>Total</b>		<b>75</b>
<b>Text Books</b>		
1	P.L. Soni , A Text-book of Inorganic Chemistry, 11 <sup>th</sup> Edition, S. Chand & Sons publications	
2	AbhilashaShourie, Shilpa S, Chapadgoankar&Anamika Singh (2020) Textbook of Biochemistry 1 <sup>st</sup> Edition	
3	J.L. Jain, 2016, Fundamentals of Biochemistry, S. Chand publication, 7th edition.	
4	A.C. Deb, 2016, Fundamentals of Biochemistry, New central book agencies, 7th edition.	
5	Satyanarayana .U, 2016, Biochemistry, MJ publishers 3 <sup>rd</sup> edition (2006).	
<b>Reference Books</b>		
1	Lehninger (2013) Principles of Biochemistry 4 th edition WH Freeman and Company NY	
2	Murray <i>et al.</i> , (2003) Harper's biochemistry 26 th edition Appleton and Lange Publishers	

	Florida USA
3	Geoffrey L. Zubay, William W. Parson, Dennis E. Vance, 1995, Principles of Biochemistry, W.C. Brown Publishers, 1995, 3rd edition.
4	LubertStryer (2007) Biochemistry –Stanford University 5 th Edition-W H Freemann and company San Francisco
5	BahlArun, Bahl B. S. (2016), A Textbook of Organic Chemistry, 22 <sup>nd</sup> Edition, S. Chand & Sons publications

#### Web Resources

1	<a href="http://dwb4.unl.edu/chem869p/chem869plinks/s">http://dwb4.unl.edu/chem869p/chem869plinks/s</a>
2	<a href="http://www.longwood.edu/staff/buckalewdw/C3%20Biomolecules.pp">www.longwood.edu/staff/buckalewdw/C3%20Biomolecules.pp</a>
3	<a href="https://www.britannica.com">https://www.britannica.com</a> › science › biochemistry
4	<a href="https://www.sciencedirect.com">https://www.sciencedirect.com</a> › topics › agricultural-and-biological-sciences
5	<a href="https://biochemistry.org">https://biochemistry.org</a> › education › careers › becoming-a-bioscientist › w

#### MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
<b>CLO1</b>	3	3	1	3	2	2	3	3	3
<b>CLO2</b>	3	2	1	3	2	2	3	3	3
<b>CLO3</b>	3	1	2	3	2	2	3	3	3
<b>CLO4</b>	3	2	3	3	2	1	3	3	3
<b>CLO5</b>	3	2	3	2	2	2	3	2	3
<b>TOTAL</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>14</b>	<b>10</b>	<b>9</b>	<b>15</b>	<b>14</b>	<b>15</b>
<b>AVERAGE</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2.8</b>	<b>2</b>	<b>1.8</b>	<b>3</b>	<b>2.8</b>	<b>3</b>

### Allied Practical I-BIOLOGICAL CHEMISTRY LAB

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BTYP1	4	1			2	3	40	60	100
<b>Learning Objective</b>									
LO1	Perform and estimate the amount of chemical substance present in a solution qualitatively. To analyze and detect the nature of various organic class of compounds qualitatively.								
LO2	Qualitatively analyze the carbohydrates and amino acids and report the type of carbohydrate based on specific tests. Differentiate the carbohydrates based microscopic examination of the crystal.								
LO3	Understand the methods of acidimetry, alkalimetry and permanganometry.								
LO4	Quantify Ascorbic acid in lemon by Dichlorophenol indo phenol dye method, Glycine by sorensens formal titration method.								
LO5	Estimate Glucose,Cholesterol and Proteins.								
UNIT	Contents								No. of Hours
I	<b>Systematic analysis of Organic compounds</b> Functional group tests (Carboxylic acid (Benzoic acid, phthalic acid), Phenol, Urea, Benzaldehyde, Aniline (Aniline not to be given for exam) Detection of elements (N, Halogens) Distinguish between aliphatic and aromatic compounds. Distinguish between Saturated and unsaturated compounds								9
II	<b>Qualitative Analysis</b> Qualitative analysis of carbohydrates - Glucose, Fructose, Lactose, maltose, sucrose, starch & glycogen. Qualitative analysis of amino acids - Tyrosine, Tryptophan, Arginine, Proline and Cysteine.								9
III	<b>Volumetric Analysis:</b> 1. Estimation of Glycine- Formal Titration. 2. Determination of Ascorbic acid – DCPIP method. 3. Estimation of Ferrous sulphate using standard Mohr's salt								9
IV	Colorimetric Analysis 1. Estimation of glucose 2. Estimation of Cholesterol- Zak's method								9



	3.Estimation of proteins – Bradford’s method	
<b>Total</b>		<b>45</b>
<b>Text Books</b>		
1	J. Jayaraman, Laboratory Manual in Biochemistry, New Age International Pvt Ltd Publishers, 2011.	
2	S. K. SawhneyRandhir, Singh, Introductory Practical Biochemistry, Alpha Science International Ltd, 2 <sup>nd</sup> edition, 2005.	
3	Irwin H.Segel, Biochemical calculations,Liss, Newyork,1991.	
<b>Reference Books</b>		
1	Dr. O P Panday, D N Bajpai, Dr. S Giri, PRACTICAL CHEMISTRY, S Chand, Revised edition 2016.	
2	Hands Thacher Clarke, A hand book of Oraganic:Qualitative and quantitative Analysis, 2007.	
3	N.S. Gnanapragasam and G. Ramamurthy, Organic chemistry Lab manual, S.Viswanathan Co. Pvt. Ltd., 1998.	

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
<b>CLO1</b>	3	3	3	3	3	3	3	3	3
<b>CLO2</b>	3	3	3	3	3	3	3	3	3
<b>CLO3</b>	3	3	3	3	2	3	3	3	3
<b>CLO4</b>	3	3	3	2	3	2	3	3	2
<b>CLO5</b>	3	3	2	3	3	3	3	2	3
<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>15</b>	<b>14</b>	<b>14</b>
<b>AVERAGE</b>	<b>3</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>

**NMEC-I HERBAL MEDICINE**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT1E1	4	1			2	2	25	75	100
<b>Learning Objective</b>									
LO1	The student can analyse the importance of herbal medicine								
LO2	can learn the role of herbal medicines for health								
LO3	Can explain about Tribal medicine								
LO4	can analyse the role of traditional medicine for today's health								
LO5	can demonstrate the use of medicinal herbs to health								
UNIT	Contents								No. of Hours
I	Ethnomedicine – definition, history and its scope – Inter disciplinary approaches in ethnobotany – Collection of ethnic information.								15
II	Importance of medicinal plants – role in human health care – health and balanced diet (Role of proteins, carbohydrates, lipids and vitamins).								15
III	Tribal medicine – methods of disease diagnosis and treatment – Plants in folk religion – <i>Aegle marmelos</i> , <i>Ficus benghalensis</i> , <i>Curcuma domestica</i> , <i>Cynodon dactylon</i> and <i>Sesamum indicum</i> .								15

IV	Traditional knowledge and utility of some medicinal plants in Tamil Nadu – <i>Solanumtrilobatum</i> , <i>Cardiospermumhalicacabum</i> , <i>Vitexnegundo</i> , <i>Adathodavasica</i> , <i>Azadirachtaindica</i> , <i>Gloriosasuperba</i> , <i>Eclipta alba</i> , <i>Aristolochiaindica</i> and <i>Phyllanthusfraternus</i> .	15
V	Plants in day today life – <i>Ocimum sanctum</i> , <i>Centellaasiatica</i> , <i>Cassia auriculata</i> , <i>Aloe vera</i> . Nutritive and medicinal value of some fruits (Guava, Sapota, Orange, Mango, Banana, Lemon, Pomegranate) and Vegetables - Greens (Moringa, <i>Solanumnigrum</i> Cabbage).	15
<b>Total</b>		75
<b>Text Books</b>		
1	R.K.Sinha&ShwetaSinha (2001), Ethnobiology. Surabhe Publications – Jaipur.	
2	D.C. Pal & S.K. Jain NayaPrakash, (1998), Tribal medicine, BidhanSarani, Calcutta	
3	S.K. Jain (2001) Contribution to Indian Ethnobotany – S.K. Jain, 3rd edition, scientificpublishers, B.No.91, Jodhpur, India.	
4	Andrew Chevallie, (2000) Encyclopedia of Herbal Medicine	
5	James Green (2000). The Herbal Medicine-Maker's Handbook: A Home Manual	
<b>Reference Books</b>		
1	Steven Horne and Thomas Easley (2016), Modern Herbal Dispensatory: A MedicineMaking Guide	
2	M.C. Joshi (2007) Handbook of Indian Medicinal Plants Hardcover.	
3	NeeleshMalviya and SapnaMalviya (2019). <i>Herbal Drug Technology</i> , (1st Edition), CBS Publishers and Distributors, ISBN: 9789387964334.	
4	Rageeb Md. Usman, Vaibhav M. Darvhekar, Vijay Kumar D, and Akhila S.A, (2019). <i>Practical Book of Herbal Drug Technology</i> , (1st Edition), NiraliPrakashan Publishers, ISBN: 9789388108002.	
5	Pragi and Varun Arora (2019). <i>Herbal Drug Technology</i> , (1st Edition), S.Vikas and	

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	<b>3</b>	<b>2</b>	<b>-</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO2</b>	<b>3</b>	<b>2</b>	<b>-</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO3</b>	<b>3</b>	<b>2</b>	<b>-</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO4</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO5</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>TOTAL</b>	<b>15</b>	<b>10</b>	<b>4</b>	<b>8</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>
<b>Average</b>	<b>3</b>	<b>2</b>	<b>0.8</b>	<b>1.6</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

### FC- Good Laboratory Practice

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BTN1	4	1			2	2	100	-	100
<b>Learning Objective</b>									
<b>LO1</b>	The student obtains adequate information to setup Biotechnology Laboratory								
<b>LO2</b>	Learn to prepare solutions and maintenance of lab								
<b>LO3</b>	Can demonstrate the working of lab equipments								
<b>LO4</b>	Learns about Biotechnology lab standards								
<b>LO5</b>	Gains knowledge about Safety measures								
<b>UNIT</b>	<b>Contents</b>								<b>No. of Hours</b>
I	Biotechnology lab organization - Types of labs associated with Biotechnology (General lab, microbial culture lab, plant tissue culture lab, Fermentation lab, computational stimulation lab), Health hazards (how to use UV-illuminator), Fumigation technique.								15
II	Types of Chemical: Types-Analytical grade, molecular grade and its various arrangements (Arrangement of basic chemicals, solvent, acid and base, fine chemicals like dyes, protein and enzyme storage units), Physical chemical characteristics: hygroscopic, corrosive, volatile properties; Fire and explosion hazard data.								15
III	Lab ethics - Regulatory affairs: Methods and types of documentation (pre-lab writes, result recording and post lab report: interpretation of result), Dilution factor calculation, Molarity, percentage, dilution of concentrated solution, metric units (kg to gms and vice -versa).								15
IV	Instrument calibration and importance - Principles, use and maintenance								15

	of laboratory instruments like Autoclave, hot air oven, Incubators, Water bath, Refrigerator, Centrifuge, Calorimeter, pH meter, Haemocytometer, Microtome, Electronic balances, Bio safety cabinets. SOP preparation for instrumentation.	
V	Types of wastes and safe disposal methods - Definition of waste, types of waste: Biological and chemical waste, methods of Safe Disposal of biological and chemical waste: Awareness and training for personnel.	15
<b>Total</b>		<b>75</b>
<b>Text Books</b>		
1	Milton A. Anderson GLP Essentials: A Concise Guide to Good Laboratory Practice, Second Edition 2nd Edition, Published by CRC press.	
2	2nd Edition GLP Essentials A Concise Guide to Good Laboratory Practice, Second Edition By Milton A. Anderson Copyright Year 2002	
3	Principles of Good Laboratory Practice Paperback – 1 January 2020 by Pradeep Deshmukh (Author)	
<b>Reference Books</b>		
1	Good Laboratory Practice: Nonclinical Laboratory Studies Concise Reference Paperback – Import, 18 October 2010 by <u>Mindy J Allport-Settle</u> (Author)	
2	Good Laboratory Practice Standards: Applications for Field and Laboratory Studies (ACS Professional Reference Book) 1st Edition by <u>Willa Y. Garner</u> (Editor), <u>Maureen S. Barge</u> (Editor), <u>James P. Ussary</u> (Editor)	
<b>Web Resources</b>		
1	<a href="https://www.oecd.org/chemicalsafety/testing/overview-of-good-laboratory-practice.htm">https://www.oecd.org/chemicalsafety/testing/overview-of-good-laboratory-practice.htm</a>	
2	<a href="https://www.intechopen.com/chapters/22127">https://www.intechopen.com/chapters/22127</a>	

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC  
OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO4</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO5</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>13</b>	<b>9</b>	<b>13</b>	<b>10</b>	<b>15</b>	<b>15</b>	<b>15</b>
<b>Average</b>	<b>3</b>	<b>3</b>	<b>2.6</b>	<b>1.8</b>	<b>2.6</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>

# *SEMESTER – II*



## CORE II - GENETICS

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT202	4	1			5	5	25	75	100
<b>Learning Objective</b>									
LO1	Learn about the classical genetics and transmission of characters from one generation to the next.								
LO2	Obtain a strong foundation for the advanced genetics.								
LO3	Explain the properties of genetic materials and storage and processing of genetic information.								
LO4	Acquire knowledge about the Mutagens, Mutations, DNA Repairs and Genetic disorders in human.								
LO5	Categories Eugenics, Euphenics and Euthenics and indepth Knowledge on population Genetics.								
UNIT	Contents								No. of Hours
I	Mendel's experiments, Monohybrid cross, Dihybrid cross, Backcross or Testcross, Mendel's laws. Incomplete dominance. Interaction of Genes- Epistasis -lethal genes. Multiple alleles – In Drosophila, Rabbit and Blood group inheritance in man.								15
II	Linkage - linkage in Drosophila- Morgan's experiments, factors affecting linkage. Crossing over- types, mechanism, significance of crossing over. Mapping of Chromosomes, interference and coincidence. Cytoplasmic inheritance -Carbon dioxide sensitivity in Drosophila and milk factor in mice. Sex –Linked Inheritance and Sex- Determination in Man.								15

III	Fine structure of the gene and gene concept, Operon Concept. Identification of the DNA as the genetic material- Griffith experiments, Avery, McLeod, McCarty and Hershey Chase experiment. Microbial Genetics- bacterial recombination, Conjugation, Transformation, Transduction and sex duction	15
IV	Mutation – types of mutation, mutagens, DNA damage and Repair Mechanism. Chromosomal aberrations- Numerical and Structural, Pedigree Analysis-Mendelian inheritance in human. (Cystic Fibrosis, Muscular Dystrophy)	15
V	Population Genetics– Hardy Weinberg principle, gene frequency, genotype frequency and factors affecting gene frequency. Eugenics, Euphenics and Euthenics.	15
<b>Total</b>		75
<b>Text Books</b>		
1	Dr. Veer BalaRastogi, 2020, Elements of Genetics, 11 th Revised & Enlarged Edition, KedarNath Ram	
2	Nath Publications, Meerut, 250001. www.knrnpublications.com, ISBN-978-81-907011-2-9	
3	Verma, P.S. and Agarwal, V.K., 1995. Genetics, 8 <sup>th</sup> edition, S.Chand& Co., New Delhi – 10055.	
4	Verma, P.S., and Agarwal, V.K., 1995. Cell and Molecular Biology, 8 <sup>th</sup> edition, S.Chand and Co., New Delhi, 110055.	
<b>Reference Books</b>		
1	Gardener E.J. Simmons M.J. Slustad D. P. 2006. Principles of Genetics	
2	Lewis, R.2001. Human Genetics- Concepts and application. 4 <sup>th</sup> edition. McGraw Hill.	
3	Griffiths, Miller, J.H., An Introduction to Genetic Analysis W.H.Freeman. New York.	
4	Winter, P.C., Hickey, G.J. and Fletcher, H.L.2000. Instant notes in Genetics. Viva books, Ltd	

5	Good enough U. 1985. Genetics. Hold Saunders international.
<b>Web Resources</b>	
1	<a href="https://nptel.ac.in/courses/102/106/102106025/">https://nptel.ac.in/courses/102/106/102106025/</a>
2	<a href="http://www.ocw.mit.edu">http://www.ocw.mit.edu</a>
3	<a href="http://enjoy.m.wikipedia.org">http://enjoy.m.wikipedia.org</a>
4	<a href="https://www.acpsd.net">https://www.acpsd.net</a>

### MAPPING WITH PROGRAMME OUTCOME AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
<b>CLO1</b>	3	3	3	3	2	3	3	2	2
<b>CLO2</b>	3	3	3	3	3	3	3	2	2
<b>CLO3</b>	3	3	3	3	3	3	3	3	3
<b>CLO4</b>	3	2	3	3	3	3	3	3	3
<b>CLO5</b>	3	3	2	3	2	2	2	3	3
<b>TOTAL</b>	15	14	14	15	13	14	14	13	13
<b>AVERAGE</b>	3	2.8	2.8	3	2.6	2.8	2,8	2.6	2.6

### Core Practical II – GENETICS LAB

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT2P2			4		3	3	40	60	100
<b>Learning Objective</b>									
LO1	Demonstrate the basic principles of important techniques in Molecular biology and Genetics.								
LO2	Analyze the Polytene chromosome of the organisms								
LO3	Identify Barr bodies from Buccal smear								
LO4	Demonstrate the Preparations and maintenance of culture medium								
LO5	Demonstrate Human karyotyping								
UNIT	Contents								No. of Hours
I	Mitotic stages of onion ( <i>Allium cepa</i> ) root tip Meiotic stages of cockroach testes/ Flower bud								9
II	Giant chromosomes from Chironomus larvae/ Drosophila salivary glands								9
III	Identification of Barr bodies from Buccal smear								9
IV	Preparations of culture medium and culture of Drosophila – methods of maintenance Identifications of mutants of Drosophila								9
V	Human karyotyping (Demo)								9

<b>Total</b>		<b>45</b>
<b>Text Books</b>		
1	Practical Manual on "Fundamentals of Genetics" (PBG-121). 2019, Edition: First Publisher: Odisha University of Agriculture & Technology. Editor: Kaushik Kumar Panigrahi	

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC  
OUTCOME**

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
<b>CLO1</b>	3	3	3	3	3	3	3	3	3
<b>CLO2</b>	3	3	3	3	3	3	3	3	3
<b>CLO3</b>	3	3	3	3	2	3	3	3	3
<b>CLO4</b>	3	3	3	2	3	2	3	3	2
<b>CLO5</b>	3	3	2	3	3	3	3	2	3
<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>15</b>	<b>14</b>	<b>14</b>
<b>AVERAGE</b>	<b>3</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>

**Allied Paper II - FUNDAMENTALS OF MICROBIOLOGY**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT2Y2	3	1			3	3	25	75	100
<b>Learning Objective</b>									
LO1	Understand the classification of Microorganisms and structure of bacteria								
LO2	Understand the various microbiological techniques, different types of media, and techniques involved in culturing microorganisms.								
LO3	Categorize the methods of sterilization and identify the significance of culture media in the growth of different microbes.								
LO4	Exhibit knowledge in analyzing the importance of Bio insecticides, Bio fertilizers prebiotics and probiotics.								
LO5	Distinguish between normal flora and pathogens and describe the role of microbes in food intoxications.								
UNIT	Contents								No. of Hours
I	History of Microbiology, Classification of bacteria, fungi, virus, protozoa and algae – classical and molecular approaches. Scope of microbiology – Role of microbes in biotechnology.								15
II	Structure of bacteria - Bacterial growth and measurement of growth, Media – types and preparation- plating methods - staining methods (Gram's, capsule, spore, LCB mount)- methods of preservation and storage of microbes. Culture of fungi, virus and algae.								15
III	Sterilization methods - physical and chemical methods- Mode of action –								15

	Antibiotic in clinical use - Resistance to antibacterial agents - MRSA, ESBL.	
IV	Bioinsecticides - <i>Bacillus thuringiensis</i> , Baculoviruses- Biofertilizers - <i>Azospirillum</i> and blue green algae - single cell protein – prebiotics and probiotics - Dairy products (Cheese and Yoghurt).	15
V	Microbial Disease- host -pathogen interaction, clinical features, lab diagnosis and treatment of Airborne disease (Pneumonia, Chicken pox), food borne disease (Typhoid, Aspergillosis), Water borne disease (Cholera, Amoebiasis), Sexually transmitted disease (AIDS, Trichomoniasis), Vector borne disease (Dengue, Malaria).	15
<b>Total</b>		<b>75</b>
<b>Text Books</b>		
1	Pelczar.M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7th Edition.,McGraw – Hill, New York.	
2	Dubey R.C. and Maheswari, S. (2003). A textbook of Microbiology, New Delhi: S. Chand & Co.	
3	Ananthanarayanan, Paniker, Kapil, Textbook book of Microbiology, 9th edition, Orient BlackSwan, 2013.	
4	Prescott, Harley, Klein, Microbiology, 10 <sup>th</sup> Edition, McGraw – Hill, 2016.	
5	Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (Editions) (1994) Methods for General and Molecular Bacteriology. ASM Press, Washington, DC	
<b>Reference Books</b>		
1	Madigan, Martinko, Bender, Buckley, Stahl, Brock Biology of Microorganisms, 14 <sup>th</sup> edition, 2017.	
2	Gillespie, Bamford, Medical Microbiology and Infection at a Glance, 4 <sup>th</sup> edition, 2012.	
3	Boyd, R.F. (1998). General Microbiology,2 <sup>nd</sup> Edition., Times Mirror, Mosby CollegePublishing, St Louis.	

4	Tortora, G.J., Funke, B.R., Case, C.L. (2013). Microbiology. An Introduction 11 <sup>th</sup> Edition., A La Carte Pearson.
5	Salle. A.J (1992). Fundamental Principles of Bacteriology. 7 <sup>th</sup> Edition., McGraw Hill Inc. New York.
<b>Web Resources</b>	
1	<a href="#"><u>Horst W. Doelle (2004). Microbial Metabolism and Biotechnology. Proceedings of an E-seminar organized by the International organization for Biotechnology and Bioengineering (IOBB)</u></a>
2	<a href="http://www.ejb.org/content"><u>http://www.ejb.org/content.</u></a>
3	<a href="http://www.biotech.kth.se"><u>www. Biotech.kth.se Electronic Journal of biotechnology</u></a>
4	<a href="https://www.cliffsnotes.com/study-guides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology"><u>https://www.cliffsnotes.com/study-guides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology</u></a>
5	<a href="https://bio.libretexts.org/@go/page/9188"><u>https://bio.libretexts.org/@go/page/9188</u></a>

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
<b>CLO1</b>	3	3	3	3	3	3	3	3	3
<b>CLO2</b>	3	3	3	3	3	3	3	3	3
<b>CLO3</b>	3	3	3	3	2	3	3	3	3
<b>CLO4</b>	3	3	3	2	3	2	3	3	2
<b>CLO5</b>	3	3	2	3	3	3	3	2	3
<b>TOTAL</b>	15	15	14	14	14	14	15	14	14
<b>AVERAGE</b>	3	3	2.8	2.8	2.8	2.8	3	2.8	2.8



**ALLIED PRACTICAL II -FUNDAMENTALS OF MICROBIOLOGY LAB**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BTYP2			4		2	3	40	60	100
<b>Learning Objective</b>									
LO1	Describe the general Laboratory safety & Sterilization Techniques								
LO2	Develop Skills in Media Preparation, Isolation & Serial Dilution Techniques and Pure Culture Techniques								
LO3	Microscopically analyze the morphological features of Bacteria and fungi and define various Staining Techniques.								
LO4	Perform the Motility of organisms.								
LO5	Able to characterize and identify bacteria using Biochemical tests.								
UNIT	Contents								No. of Hours
I	Sterilization techniques – Preparation of Media								9
II	Inoculation techniques- Pour plate, spread plate Isolation of bacteria from various sources and dilution techniques.								9
III	Staining techniques: Simple, Gram's, Capsule (Negative), Spores, Preparation of temporary mounts- Lacto phenol cotton blue staining.								9
IV	Motility tests: Hanging drop technique.								9
V	Biochemical characterization - catalase, oxidase, IMVIC test and								9

	TSI. Antibiotic sensitivity test (demonstration).	
<b>Total</b>		<b>45</b>
<b>Text Books</b>		
1	James G Cappucino and N. Sherman MB(1996). A lab manual Benjamin Cummins, New York 1996.	
2	Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications.	
3	Sundararaj T (2005). Microbiology Lab Manual (1 <sup>st</sup> edition) publications.	
4	Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ld., Publishers, New Delhi.	
5	R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishing.	
<b>Reference Books</b>		
1	Atlas.R (1997). Principles of Microbiology, 2 <sup>nd</sup> Edition, Wm.C.Brown publishers.	
2	Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1 <sup>st</sup> Edition). Elsevier India.	
3	Talib VH (2019). Handbook Medical Laboratory Technology. (2 <sup>nd</sup> Edition). CBS.	
4	Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication.	
5	Lim D. (1998). Microbiology, 2 <sup>nd</sup> Edition, WCB McGraw Hill Publications.	
<b>Web Resources</b>		
1	<a href="http://www.biologydiscussion.com/micro-biology/sterilisation-and-disinfection-methods-and-principles-microbiology/24403">http://www.biologydiscussion.com/micro-biology/sterilisation-and-disinfection-methods-and-principles-microbiology/24403</a> .	
2	<a href="https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635">https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635</a>	
3	<a href="https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf">https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf</a>	

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	3	2	2	2	1	2	3	3	3
<b>CLO2</b>	3	2	2	2	1	1	3	3	3
<b>CLO3</b>	3	2	1	1	-	1	3	3	3
<b>CLO4</b>	3	2	1	2	3	2	3	3	2
<b>CLO5</b>	3	3	2	3	3	2	3	2	3
<b>TOTAL</b>	<b>15</b>	<b>11</b>	<b>8</b>	<b>10</b>	<b>8</b>	<b>8</b>	<b>15</b>	<b>14</b>	<b>14</b>
<b>AVERAGE</b>	<b>3</b>	<b>2.2</b>	<b>1.6</b>	<b>2</b>	<b>1.6</b>	<b>1.6</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>

**SEC II NMEC-II ORGANIC FARMING AND HEALTH MANAGEMENT**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT2E2	4	1			2	2	25	75	100
<b>Learning Objective</b>									
LO1	The student will value the concepts of ecology and environment								
LO2	To know the techniques of Vermicomposting and enjoying the cultivation of common Medicinal Herbs								
LO3	To gain the knowledge about Principles and Policies in Organic forming and Certification agencies								
LO4	To realize the Concept of Health and importance of well being								
LO5	To appreciate the Role of exercise and nutrition in Health related fitness								
UNIT	Contents								No. of Hours
I	Ecology and Environment – Principles of ecology – Ecosystem - Biotic and abiotic components and interaction – Energy flow –Nutrient cycle – Biodiversity – Endemic – Exotic - Interrelationships.								15
II	Composting – Microbial Compost – Vermicompost – Setup for vermicompost unit - Nutrition garden – Ring garden – Double digging – Cultivating vegetables – Common medicinal herbs – Identification and Cultivation.								15
III	Organic farming – Principles and Policies – Certification agencies – AGMARK, FSSAI, HALAL certification – Participatory grading system (PGS) – Storage – Packing – Transportation – Marketing. Micro-enterprises – Self Help Groups – Economics of cultivations – Sustainability.								15
IV	Health: Concept of Health, changing concepts definitions of health, dimensions of health, concept of well being, spectrum of health, determinants of health, ecology of health, right to health, responsibility for								15

	health, indicators of health.	
V	Exercise and Health related fitness: Health related fitness, health promotion, physical activity for health benefits. Sports related fitness: Role of nutrition in sports, nutrition to athletic performance.	15
<b>Total</b>		<b>75</b>
<b>Text Books</b>		
1	G.K. Veeresh, 2006. Organic farming , First edition, New Delhi, India Foundation Books in association with Centre for Environment Education.	
2	Mangalarai, 2012.Hand Book of Agriculture, Sixth Edition, ICAR New Delhi.	
3	B.B. Sharma , 2007. A Guide to Home Gardening, Second Edition, MIB India, New Delhi.	
4	Adrienne E. Hardman, 2009. Physical Activity and Health – The evidence explained, Second edition, Taylor and Francis Group.	
5		
<b>Reference Books</b>		
1	Farmers of Forty Centuries: Permanent Organic Farming in China, Korea, and Japan Hardcover – 10 June 2011 by <u>F. H. King</u> (Author)	
2	Organic Farming: Components And ManagementEdition: 1Author/s:Gehlot D , Publisher: M/s AGROBIOS (INDIA) ISBN: 9788177544008	

**SEC III SBEC I – CLINICAL NUTRITION AND DIETARY MANAGEMENT**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT2S3	4	1			2	2	25	75	100
<b>Learning Objective</b>									
LO1	To be aware of the need for a balanced diet								
LO2	To gain insight on nutrition requirement for different stages of life.								
LO3	To appreciate the importance of dietary management in different diseases								
LO4	To acquire knowledge on different modes of nutrition								
LO5	To appreciate the Role of diet and nutrition to enhance health								
UNIT	Contents								No. of Hours
I	Definition of Nutrition, Overview of Balanced diet, Collecting and analyzing Nutritional information – Physical examination, Anthropometric measurements.								10
II	Common food allergies, food intolerance – lactose intolerance. Cardiovascular diseases-atherosclerosis, and myocardial infarction, foods that increase LDL and HDL.								10
III	Bulimia and Anorexia Nervosa. Dietary management with reference to Constipation, Diarrhoea, Dehydration, Peptic Ulcer, Hepatitis, Gall bladder diseases and Renal failure.								10
IV	Dietary management with reference to Hypertension, Diabetes Mellitus, AIDS and								10

Cancer, Surgery and Nutritional support, outline of Enteral Nutrition and Parenteral Nutrition.	
<b>Total</b>	<b>40</b>
<b>Reference Books</b>	
<ol style="list-style-type: none"> <li>1. Garrow, JS , James WPT and Ralph A (2000) . Human nutrition and Dietetics (10th ed) Churchill Livingston.</li> <li>2. PiareyLal Mehta, NeenaVerma, P I Mehta (1999) Human Rights Under the Indian</li> <li>3. Constitution. Deep &amp; Deep Publications Pvt. Ltd.</li> <li>4. Handbook of Food and Nutrition –Dr. M. Swaminathan, BappcoPubisher,2014.</li> <li>5. Nutrition Science- B.Srilakshmi,7<sup>th</sup> edition, New age International Publisher, 2017.</li> <li>6. William’s Basic Nutrition and Diet Therapy – Staci Nix McIntosh,First South Asian Edition, Elsevier Publisher, 2016.</li> <li>7. Nutrition essentials and diet therapy-Packenpaugh,11<sup>th</sup>edition,Saunders Publishers, 2009.</li> <li>8. Davidson’s Principles and Practice of Medicine – Sir Stanley Davidson, 21st edition, Elsevier Publishers, 2010</li> </ol>	

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO4</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO5</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>
<b>AVERAGE</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

## *SEMESTER – III*



**Core III - IMMUNOLOGY AND IMMUNOTECHNOLOGY**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT303	4	1			5	5	25	75	100
<b>Learning Objective</b>									
LO1	Explain the role of immune cells and their mechanism in body defense mechanism.								
LO2	Demonstrate the antigen –antibody reactions in various immune techniques.								
LO3	Gain new insights into Antigen -Antibody interactions and to demonstrate immunological techniques.								
LO4	Gain knowledge of production of vaccines.								
LO5	Apply the knowledge of immune associated disease, hypersensitivity reactions.								
UNIT	Contents								No.of Hours
I	Introduction to Immunology. Cells involved in immune response. Primary and Secondary lymphoid organs – Thymus, Bone marrow, Lymph nodes and Spleen. Hematopoiesis – development of B and T lymphocytes. Types of immunity – Innate and acquired.								15
II	Antigen: Characteristics and types. Antibody – Structure, Types, Properties and their Biological Function. Production of antibodies- Hybridoma technology: Applications of Monoclonal antibodies in biomedical research.								15

III	Antigen – Antibody interactions, Immunodiffusion and Immuno electrophoresis. Principle and application of ELISA and RIA and Flourescent antibody technique and Western Blotting. Purification of antibodies.	15
IV	The complement system and activation and regulation. Types – Classical, alternative and Lectin pathway. Biological function of C’ proteins. Cytokines- Structure and Function. Vaccines – Types, Production and application.	15
V	Hypersensitivity Reactions and Types. Major Histocompatibility Complex – MHC genes, MHC in immune responsiveness, Structure and function of Class I and Class II MHC molecules. HLA tissue typing.	15
<b>Total</b>		<b>75</b>
<b>Text Books</b>		
1	Thomas J. Kindt, Barbara A. Osborne and Richard A Goldsby, 2006. Kuby Immunology. 6th edition, W. H . Freeman and Company.	
2	Kannan, I., 2010. Immunology. MJP Publishers, Chennai	
3	Abbas, A.K., A.H.L., Lihtman and S. Pillai, 2010. Cellular and Molecular Immunology, 6th Edition. Saunders Elsevier Publications, Philadelphia	
4	NandiniShetty, 1996, Immunology : introductory textbook – I. New Age International, New Delhi.	
5	Fahim Halim K.,2009. The Elements of Immunology. Pearson Education.	
<b>Reference Books</b>		
1	Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, 2011. Roitt.s Essential Immunology, 12th edition, Wiley- Blackwell. USA.	
2	Janeway Travers. (1997). Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York. 3 <sup>rd</sup> Edition.	
3	William R Clark. (1991). The Experimental Foundations of Modern Immunology. 3 <sup>rd</sup> Edition. John Wiley and Sons Inc. New York.	

4	Frank C. Hay, Olwyn M. R. Westwood. (2002). Practical Immunology, 4 <sup>th</sup> Edition., Wiley-Blackwell.
5	Noel R. Rose, Herman Friedman, John L. Fahey. (1986). Manual of Clinical Laboratory Immunology. ASM.3 <sup>rd</sup> Edition
<b>Web Resources</b>	
1	<a href="https://www.ncbi.nlm.nih.gov/books/NBK279395/">https://www.ncbi.nlm.nih.gov/books/NBK279395/</a>
2	<a href="https://med.stanford.edu/immunol/phd-program/ebook.html">https://med.stanford.edu/immunol/phd-program/ebook.html</a>
3	<a href="https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/">https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/</a>
4	Immunology Overview - Medical Microbiology - NCBI Bookshelf (nih.gov)
5	Immunology - an overview   Science Direct Topics

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
<b>CLO1</b>	3	3	3	3	3	3	3	3	3
<b>CLO2</b>	3	3	3	3	3	3	3	3	3
<b>CLO3</b>	3	3	3	3	2	3	3	3	3
<b>CLO4</b>	3	3	3	2	3	2	3	3	2
<b>CLO5</b>	3	3	2	3	3	3	3	2	3
<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>15</b>	<b>14</b>	<b>14</b>
<b>AVERAGE</b>	<b>3</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>

**Core Practical III - IMMUNOLOGY AND IMMUNOTECHNOLOGY LAB**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT3P3	4	1			3	3	40	60	100
<b>Learning Objective</b>									
LO1	Perform blood grouping and determine blood type.								
LO2	Able to count WBC and RBC.								
LO3	Conduct serological diagnostic tests such as ASO, CRP, RA and Widal test.								
LO4	Acquire technical skills required for immunodiffusion and know the principle behind the techniques.								
LO5	Able to Demonstrate ELISA, Handling of Laboratory animals.								
UNIT	Contents								No. of Hours
I	Separation of Serum and Plasma. Blood grouping and Rh typing.								9
II	WBC counting RBC counting Differential blood count								9
III	WIDAL Slide test ASO test								9
IV	Double Immunodiffusion								9

	Single Radial Immunodifusion	
V	ELISA – Demonstration Handling of Laboratory animals - Demonstration Skin test – Demonstration	9
<b>Total</b>		<b>45</b>
<b>Text Books</b>		
1	Talwar. (2006). Hand Book of Practical and Clinical Immunology, Vol. I, 2nd edition, CBS.	
2	Asim Kumar Roy. (2019). Immunology Theory and Practical, Kalyani Publications.	
<b>Reference Books</b>		
1	Frank C. Hay, Olwyn M. R. Westwood. (2008). Practical Immunology, 4th Edition, Wiley-Blackwell.	
2	Rose. (1992). Manual of Clinical Lab Immunology, ASM.	
3	Wilmore Webley. (2016). Immunology Lab Manual, LAD Custom Publishing.	
4	Janeway Travers. (1997). Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York. 3 <sup>rd</sup> Edition.	
5	Peter J. Delves, Seamus Martin, Dennis R. Burton, Ivan M. Roitt. (2006). Roitt's Essential Immunology, 11 <sup>th</sup> Edition., Wiley-Blackwell.	
<b>Web Resources</b>		
1	<a href="https://www.researchgate.net/publication/275045725_Practical_Immunology-_A_Laboratory_Manual">https://www.researchgate.net/publication/275045725_Practical_Immunology-_A_Laboratory_Manual</a>	
2	<a href="https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/labs/frelinger-lab/documents/Immunology-Lab-Manual.pdf">https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/labs/frelinger-lab/documents/Immunology-Lab-Manual.pdf</a>	
3	<a href="https://webstor.srmist.edu.in/web_assets/downloads/2021/18BTC106J-lab-manual.pdf">https://webstor.srmist.edu.in/web_assets/downloads/2021/18BTC106J-lab-manual.pdf</a>	
4	Immunology Overview - Medical Microbiology - NCBI Bookshelf (nih.gov)	

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	3	3	3	3	3	3	3	3	3
<b>CLO2</b>	3	3	3	3	3	3	3	3	3
<b>CLO3</b>	3	3	3	3	2	3	3	3	3
<b>CLO4</b>	3	3	3	2	3	2	3	3	2
<b>CLO5</b>	3	3	3	3	3	3	3	2	3
<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>15</b>	<b>14</b>	<b>14</b>
<b>AVERAGE</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>

### Allied Paper III - BIOINSTRUMENTATION

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CI A	External	Total
U23BT3Y3	3	1			3	3	25	75	100
<b>Learning Objective</b>									
LO1	Practice, experiment with and apply the basic instruments in the laboratory.								
LO2	Predict the functionality of Beer – Lambert’s law in identifying and quantifying a biomolecule.								
LO3	Employ the separation techniques for separating biomolecules based on chromatography and electrophoretic techniques.								
LO4	Understand the clinical important isotopes and detection of isotopes.								
LO5	Employ the separation techniques for separating biomolecules based on centrifugal force by centrifugation.								
<b>UNIT</b>	<b>Contents</b>								<b>No.of Hours</b>
I	pH – Definition – pH meter. Measurement of pH and calibration of pH meter - Buffers – Preparation of Buffers. Microscopy: Principle and applications of Compound, Bright field, Phase contrast and								15

	Fluorescence Microscope.	
II	Spectra – Absorption and Emission Spectra – Beer Lambert’s law – Colorimeter, UV-Visible Spectrophotometer. Mass spectroscopy - Atomic absorption spectrometer (AAS) - Nuclear magnetic resonance spectrometer (NMR).	15
III	Chromatography - Principles – Paper Chromatography, TLC, Gel filtration, Ion-Exchange, Affinity Chromatography Gas Liquid Chromatography and HPLC. Electrophoresis: Principle, Paper Electrophoresis – Cellulose Acetate Electrophoresis - Agarose Gel Electrophoresis – SDS- PAGE and Iso-electric focusing.	15
IV	Radioactivity – Isotopes – Clinically important isotopes – Measurement of Radioactivity – GM Counters, Scintillation Counters – Autoradiography – Applications. SOPs for Radioactive materials.	15
V	Centrifugation – Principles - RCF, Sedimentation concept - - Different types of centrifuge – Types of rotors – Centrifugation types: Differential and Density gradient centrifugation – Ultra Centrifuge.	15
<b>Total</b>		<b>75</b>
<b>Text Books</b>		
1	Upadhyay and UpadhyayNath. (2009). “Biophysical Chemistry”, Principles and Techniques. Himalaya Publishing House.	
2	L.Veerakumari, (2006) “Bioinstrumentation” MJP publishers , Kindle Edition.	
3	SkoogD.A.F.James Holler and Stanky,R.Crouch, (2007) “Instrumental Methods of Analysis” Cengage Learning.	
4	Palanivelu P, 2000. Analytical Biochemistry & Separation Techniques, 4th edition, Twenty first century publications.	
5	Prakash M, 2009. Understanding Bioinstrumentation, 1st edition, Discovery Publishing House Pvt Ltd	



<b>Reference Books</b>	
1	Keith Wilson, John Walker, (2010). Principles and techniques of Biochemistry and Molecular Biology” (7 <sup>th</sup> edition). Cambridge University Press.
2	David L. Nelson, Michael M Cox. Lehninger (2008).”Principles of Biochemistry”, Fifth edition W.H. Freeman, New York.
3	Khandpur R S, 2014. Handbook of Biomedical Instrumentation, 3rd edition, McGraw Hill Education (India).
4	L.A Geddes and L.E. Baker (2008) “Principles of Applied Biomedical Instrumentation” Wiley India Third Edition.
5	Sharma B K, 2005. Instrumental Methods of Chemical Analysis, 24th Edition, GOEL Publishing House.

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	3	3	3	3	3	3	3	3	3
<b>CLO2</b>	3	3	3	3	3	3	3	3	3
<b>CLO3</b>	3	3	3	3	2	3	3	3	3
<b>CLO4</b>	3	3	3	2	3	2	3	3	2
<b>CLO5</b>	3	3	3	3	3	3	3	2	3
<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>15</b>	<b>14</b>	<b>14</b>
<b>Average</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>

**Allied Practical III – BIOINSTRUMENTATION LAB**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BTYP3	4	1			2	3	40	60	100
<b>Learning Objective</b>									
LO1	Practice, experiment with and apply the basic instruments in the laboratory such as weighing balance, pH meter, shaker, incubator etc. in various research processes.								
LO2	Predict the functionality of Beer – Lambert’s law in identifying and quantifying biomolecules.								
LO3	Employ the separation techniques for separating biomolecules based on paper chromatography.								
LO4	Employ the separation techniques for separating biomolecules based on Thin layer chromatography.								
LO5	Employ the separation techniques for separating biomolecules based on centrifugal force by centrifugation.								
UNIT	Contents								No. of Hours
1	Preparation of Buffer (Phosphate Buffer)								9

	Determination of pH of biological samples using pH meter	
II	UV spectra of Nucleic acids and proteins.	9
III	Chromatography analysis of sugar, amino acids, lipids by paper chromatography.	9
IV	Chromatography analysis of sugar, amino acids, lipids by Thin layer chromatography.	9
V	Fractionation of biological material into its various components by Centrifuge.	9
<b>Total</b>		45
<b>Text Books</b>		
1	Sharda University Abstract Laboratory Manual for Bio-instrumentation, Biochemistry, Microbiology, Cell Biology and Enzyme Technology.2018	
2	Bhomwik (2011), <i>Analytical techniques in Biotechnology– A complete laboratory manual</i> , MGH Publisher, ISBN-13 : 978-0070700130	
<b>Reference Books</b>		
1	P. Palanivelu (2017), <i>Analytical Biochemistry and Separation techniques – A laboratory manual</i> , (5 <sup>th</sup> Edition), Twentyfirst century publishers, ISBN: 978-81-908489-0-9	

### MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
<b>CLO1</b>	3	3	3	3	3	3	3	3	3
<b>CLO2</b>	3	3	3	3	3	3	3	3	3
<b>CLO3</b>	3	3	3	3	2	3	3	3	3

<b>CLO4</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>2</b>
<b>CLO5</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>
<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>14</b>	<b>14</b>	<b>15</b>	<b>14</b>	<b>14</b>
<b>AVERAGE</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>

**SEC IV – MUSHROOM CULTIVATION**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT3S4	4	1			1	1	100	-	100
<b>Learning Objective</b>									
LO1	To demonstrate the various types of mushroom cultivating methods								
LO2	To enhance the scope of Mushroom cultivation in small scale Industry								
LO3	To value the economic factors associated with mushroom cultivation								
LO4	To enhance the management system of harvesting and marketing of mushrooms								
LO5	To be aware of the pest control and disease management systems in mushroom cultivation								
UNIT	Contents								No. of Hours
I	Introduction: Morphology, Types of Mushroom, identification of edible and poisonous mushroom, Nutritive values, life cycle of common edible mushrooms.								4
II	Mushroom cultivation, prospects and scope of Mushroom cultivation in small scale Industry.								4
III	Life cycle of Pleurotus spp and Agaricus spp.								4
IV	Spawn production, growth media, spawn running and harvesting of mushrooms and marketing.								4

V	Diseases and post harvest technology, Insect pests, nematodes, mites, viruses, fungal competitors and other important diseases.	4
<b>Total</b>		<b>20</b>
<b>Reference Books</b>		
<p>1. Handbook of Mushroom Cultivation. 1999. TNAU publication.</p> <p>2. Marimuthu, T., Krishnamoorthy, A.S., Sivaprakasam, K. and Jayarajan. R. (1991). Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.</p> <p>3. Swaminathan, M. 1990. Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.</p> <p>4. Nita Bahl. 2002. Handbook on Mushroom 4th edition Vijayprimlani for oxford &amp; IBH publishing co., Pvt., Ltd., New Delhi. 5. Dr.C. Sebastian Rajesekaran Reader in Botany Bishop Heber College, Trichy – 17.</p> <p>5. Suman. 2005. Mushroom Cultivation Processing and Uses, M/s. IBD Publishers and Distributors, New Delhi.</p> <p>6. Sing. 2005. Modern Mushroom Cultivation, International Book Distributors, Dehradun.</p> <p>7. Handbook of Edible Mushroom Today and Tomorrows printers and publishers.</p> <p>8. Sharma V.P. 2006. Diseases and Pests of Mushrooms, M/s. IBD Publishers and Distributors, New Delhi.</p> <p>9. Tewari, P and Kapoor, S.C.1988. Mushroom cultivation, Mittal Publications New Delhi.</p> <p>10. Bahl, N. (1984-1988). Hand book of Mushrooms, II Edition, Vol. I &amp; Vol. II.</p>		

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

<b>CLO4</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO5</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>
<b>AVERAGE</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

**SEC V – SBEC II VERMITECHNOLOGY**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT3S5	4	1			2	2	25	75	100
<b>Learning Objective</b>									
LO1	To gain knowledge on types of the earthworm and culture methods								
LO2	To enhance the culturing techniques of earthworms and composting materials								
LO3	To be aware of the Small scale techniques of Vermicomposting								
LO4	To be aware of the Large scale techniques of Vermicomposting								
LO5	To gain knowledge on vermicomposting and its economical benefits.								
UNIT	Contents								No. of Hours
I	Types, Collection and Preservation of earthworms - Types and basic characteristics of species suitable for vermicomposting; Role of earth worms in soil fertility, Biology of <i>Lampito maruitti</i> ; Collection and Preservation of Earthworms; Flow sheet for vermi technology.								8
II	Culturing techniques of earthworms and composting materials General method; Pot method; Wooden box method; Propagation; Factor affecting								8

	culturing of earthworm; Vermicomposting materials; Preliminary treatment of composting materials.	
III	Small scale techniques of Vermicomposting - Indoor dual bin method; Bed method; Pit method; Heap method; Expandable worm tower assembly method; Hanging basket method; Physical, chemical and biological properties of vermicompost.	8
IV	Large scale techniques of Vermicomposting Outdoor dual bin; Raised cage; Dual pit; Commercial model; Trickling filter vermicomposting; Keep it simple and save plan.	8
V	Vermiwash and Economics - Chemical composition of vermiwash; Techniques of vermiwash production: Advantages of Vermicomposting; Prospects of vermi-culture as self employment venture.	8
<b>Total</b>		<b>40</b>

#### Reference Books

1. The Earthworm book, Ismail, S.A., other India Press, Goa
2. Somani, L.L. 2008. Vermicomposting and vermiwash. Agrotech Publishing Academy, Udaipur.
3. Talashilkar and Dosani, 2005. Earthworm in Agriculture. Agrobios (India), Jodhpur.
4. Ranganathan, L.S. 2006. Vermibiotechnology from soil health to human health – Agrobios, India.

#### MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
<b>CLO1</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO4</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO5</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>
<b>AVERAGE</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

## *SEMESTER – IV*



**Core Paper IV- GENETIC ENGINEERING AND rDNA TECHNOLOGY**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT40 4	5	1			5	5	25	75	100
<b>Learning Objective</b>									
LO1	Demonstrate the basic principles of genetic engineering techniques and illustrate the specificity of vectors for cloning and advantages.								
LO2	Enumerate various recombinant techniques and gene probes and molecular markers identification.								
LO3	Understand Gene transfer techniques by Viral and Non viral mediated gene transfer mechanisms.								
LO4	Exhibit knowledge in sequencing technologies and protein engineering techniques.								
LO5	Explore the strategies of Recombinant DNA Technology in r medicine, Industry and agriculture.								
<b>UNIT</b>	<b>Contents</b>								<b>No. of Hours</b>
I	Genetic Engineering – Introduction. Tools in recombinant DNA technology – recombinant DNA – cloning strategies (enzymes, vectors, host) – introduction of rDNA into host cells.								15

II	Identification of recombinants, selection and screening for Recombinants. DNA sequencing – Construction of Genomic DNA library and cDNA library), Chromosome walking. Human Genome Project. Polymerase Chain reaction- Methodology and its Types.	15
III	Gene transfer techniques – Viral mediated gene transfer, Selectable markers and reporter genes - Non viral mediated gene transfer - Physical methods: Microinjection - Electroporation - Particle Bombardment, Chemical methods: Calcium phosphate - DEAE dextran - Liposomes.	15
IV	Gene Expression – Expression system and their applications - protein based products – Protein engineering– production of protein from cloned genes. Site directed Mutagenesis, Restriction Fragment Length Polymorphism (RFLP).	15
V	Application of Recombinant DNA technology in medicine, industry, agriculture and r-DNA technology - merits and demerits.	15
<b>Total</b>		<b>75</b>
<b>Text Books</b>		
1	Brown T.A, 2015. Gene Cloning and DNA Analysis: An Introduction, 7th edition, Wiley - Blackwell.	
2	Desmond S.T. Nicholl, 2008. An Introduction to Genetic Engineering, 3rd edition, Cambridge university press.	
3	R.W. Old & S.B. Primrose, Principles of Gene Manipulation, Fifth Edition, Blackwell Science.	
4	Genetic Engineering Principles and Methods by Setlow, Jane K. (Volume 24).	
5	Keya Chaudhuri, 2012. Recombinant DNA Technology.	
<b>Reference Books</b>		
1	David Clark Nanette Pazdernik Michelle McGehee (2018), <i>Molecular Biology techniques</i> ,( 3 <sup>rd</sup> edition).	
2	<u>Anton Byron</u> (2019), <i>Introduction to Gene Cloning</i> , Publisher: Oxford Book Company	

3	Monika Jain (2012), <i>Recombinant DNA technology</i> , (I edition), Alpha Science International. ISBN-13 : 978-1842656679.
4	Primrose.S.B (2014), <i>Principles of gene manipulation</i> , (7th edition), Blackwell Scientific limited, Germany. ISBN: 978-1-405-13544-3
<b>Web Resource</b>	
1	<a href="https://www.britannica.com/recombinant-DNA-technology">https://www.britannica.com/recombinant-DNA-technology</a>
2	<a href="https://www.le.ac.uk/recombinant-dna-and-genetic-techniques">https://www.le.ac.uk/recombinant-dna-and-genetic-techniques</a>
3	<a href="https://www..ncbi.nlm.nih.gov">https://www..ncbi.nlm.nih.gov</a>

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
<b>CLO1</b>	3	3	3	3	3	3	3	3	3
<b>CLO2</b>	3	3	3	3	3	3	3	3	3
<b>CLO3</b>	3	3	3	3	2	3	3	3	3
<b>CLO4</b>	3	3	3	2	3	2	3	3	2
<b>CLO5</b>	3	3	3	3	3	3	3	2	3
<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>15</b>	<b>14</b>	<b>14</b>
<b>AVERAGE</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>

**Core Practical IV- GENETIC ENGINEERING AND rDNA TECHNOLOGY LAB**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT4P4	4	1			3	3	40	60	100
<b>Learning Objective</b>									
LO1	Isolate the Plasmid DNA and Genomic DNA. and predict the molecular weight of DNA by agarose gel electrophoresis.								
LO2	Demonstrate working principles of PCR, RFLP and other important Genetic Engineering techniques.								
LO3	Prepare the competent cells and perform bacterial transformation.								
LO4	Determine the restriction digestion of DNA								
LO5	Determine the restriction fragment length polymorphism.								
UNIT	Contents						No. of Hours		
I	Isolation of genomic DNA Isolation of plasmid DNA						9		
II	Isolation of RNA						9		
III	Production of competent cells for transformation Bacterial transformation						9		

IV	Restriction Digestion of DNA	9
V	Restriction Fragment Length Polymorphism(DEMO) PCR(Demonstration)	9
<b>Total</b>		<b>45</b>
<b>Text Books</b>		
<b>1</b>	Laboratory Manual for GENETIC ENGINEERING 1st Edition, Kindle Edition byS. JOHN VENNISON (Author) 2009.	

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC  
OUTCOME**

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
<b>CLO1</b>	3	3	3	3	3	3	3	3	3
<b>CLO2</b>	3	3	3	3	3	3	3	3	3
<b>CLO3</b>	3	3	3	3	2	3	3	3	3
<b>CLO4</b>	3	3	3	2	3	2	3	3	2
<b>CLO5</b>	3	3	3	3	3	3	3	2	3
<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>15</b>	<b>14</b>	<b>14</b>
<b>AVERAGE</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>

**Allied Paper IV - BIOINFORMATICS AND BIOSTATISTICS**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT4Y4	3	1			3	3	25	75	100
<b>Learning Objective</b>									
LO1	Acquire knowledge about the Developments and Applications of Bioinformatics.								
LO2	Gain knowledge about the importance of the bioinformatics, databases, tools and software of bioinformatics and explain different types of Biological Databases.								
LO3	Understand the basics of sequence alignment, sequence analysis and Protein structure prediction method.								
LO4	Demonstrate the basic methods of data collection, graph construction and sampling techniques and Calculate measures of central tendency								
LO5	Correlate and analyze biological data through various statistical methods and interpret biological data via various probabilistic distribution methods.								
UNIT	Contents								No. of Hours
I	Introduction to Bioinformatics – Genome, Transcriptome and Proteome, Gene prediction rules and software. Nucleic acid Databases – Primary and Secondary Databases – Structure Database – CATH, SCOP – Data base								15

	Searching – BLAST and FASTA, BLOSSUM.	
II	Sequence analysis (Proteins and Nucleic acids), Protein Database: Comparison of Protein sequences and Database searching – methods for protein structure prediction - Homology modeling of proteins, visualization tools (RASMOL).	15
III	Multiple Sequences alignment – method of multiple sequences alignment- Evolutionary analysis, clustering methods Phylogenic trees - Methods to generate phylogenetic tree- Tools for multiple sequences alignment and phylogenetic analysis - History of Drug Discovery, Steps in Drug design - Chemical libraries – Role of molecular docking in drug design.	15
IV	Statistics – collection, classification, tabulations of Statistical Data – Diagrammatic representation – Graphs – Sampling method and standard error. Measures of central tendency – measures of dispersion.	15
V	Correlations and regression. Probability distribution-Binomial, Negative binomial, multinomial distribution, Poisson distribution. Tests of significance – t tests – F tests – Chi square test. Analysis of variance – Statistical Soft wares.	15
<b>Total</b>		<b>75</b>
<b>Text Books</b>		
1	Pennington, S.R. and Punn, M.J. 2002. Proteomics: from protein sequence to function. Viva books Pvt. Ltd.	
2	Shuba G., 2010. Bioinformatics., Tata McGraw Hill publishing. India.	
3	Rastogi, S.C, Mendiratta, N, Rastogi, P., 2004. Bioinformatics methods and application. Prentice-Hall of India private limited, New Delhi.	
4	N.Gurumani (2011) "An Introduction to Biostatistics" MJP Publishers	
5	Verbala Rastogi .(2011). "Fundamentals of Biostatistics", Ane books Pvt Ltd Publishers, Chennai.	
<b>Reference Books</b>		
1	Attwood, T.K. and Parry-Smith, D.J. 2008. Introduction to Bioinformatics. Pearson Education.	

2	David Mount., Bioinformatics: sequence and genome analysis, second edition., Taylor & Francis, UK; 2009.
3	D.R.Westhead. Instant Notes in Bioinformatics., second edition., Taylor & Francis, UK; 2009.
4	Zar,(J.H.2010).”Biostatistical Analysis” Fifth Edition, Pearson Education Pvt Ltd, Indian Branch,NewDelhi.
5	P.N.Arora and P.K. Malhan.(2013)"Biostatistics"Himalaya publishing House.

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
<b>CLO1</b>	3	3	3	3	3	3	3	3	3
<b>CLO2</b>	3	3	3	3	3	3	3	3	3
<b>CLO3</b>	3	3	3	3	2	3	3	3	3
<b>CLO4</b>	3	3	3	2	3	2	3	3	2
<b>CLO5</b>	3	3	3	3	3	3	3	2	3
<b>TOTAL</b>	15	15	15	14	14	15	15	14	14
<b>AVERAGE</b>	3	3	3	2.8	2.8	3	3	2.8	2.8



**Allied Practical IV- BIOINFORMATICS AND BIOSTATISTICS LAB**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BTYP4			4		2	2	40	60	100
<b>Learning Objective</b>									
LO1	Analyse the Biological databases								
LO2	Able to perform BLAST and FASTA								
LO3	Represent data in to graphical form								
LO4	Test the level of significance of biological data and interpret the results.								
LO5	Determine averages of the biological data								
<b>UNIT</b>	<b>Contents</b>								<b>No. of Hours</b>
I	Biological databases (NCBI, Swissprot and PDB)								9
II	BLAST FASTA								9
III	Identification of functional domains in nucleotide binding proteins using								9

	a domain analysis server like SMART	
IV	Preparation of bar diagram, line diagram and pie diagram using MS EXCEL.  Calculation of Central tendency- mean, geometric mean, median using MS EXCEL	9
V	Calculation of dispersion – Mean deviation, quartile deviation and standard deviation using MS EXCEL  Calculation of student's t test using MS EXCEL	9
<b>Total</b>		<b>45</b>
<b>Text Books</b>		
1	Pennington, S.R. and Punn, M.J. 2002. Proteomics: from protein sequence to function. Viva books Pri. Ltd.	
2	Maleolm and Goosfship. J. 2001. Genotype to phenotype, 2nd edition. Bios Scientific Publishers Ltd	
3	Misener, S. and Krawetz. S.A. 2000. Bioinformatics: Methods and Protocols. Humana press.	
4	Attwood, T.K. and Parry-Smith, D.J. 1999. Introduction to Bioinformatics. Pearson Education Asia.	
5	Primrose, S.B. 1998. Principle of genome analysis. 2nd edition. Blackwell Science.	
<b>Reference Books</b>		
1	Durbin, R., Eddy, S., Krogh, A. and Mitchison, G. 1998. Biological sequence analysis. Cambridge University Press.	
2	riedman, C.P. and Wyatt. J.C. 1997. Computers and Machine: Evaluation methods in medicinal information. Springer-verlag, New York.	

<b>Web Resources</b>	
1	ishop, M.J. and Rawhings. C.J. 1997. DNA and protein sequence analysis: A practical approach. Oxford University press. New press. Kolodne
2	Kolodner, R.M. 1997. Computer in Health care: Computerizing large integrated health networks. Springer – Verlag, New York

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	3	3	3	3	3	3	3	3	3
<b>CLO2</b>	3	3	3	3	3	3	3	3	3
<b>CLO3</b>	3	3	3	3	2	3	3	3	3
<b>CLO4</b>	3	3	3	2	3	2	3	3	2
<b>CLO5</b>	3	3	3	3	3	3	3	2	3
<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>15</b>	<b>14</b>	<b>14</b>
<b>AVERAGE</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>

**SEC VII - SBEC II STARTUP DESIGN IN BIOTECHNOLOGY AND SKILL DEVELOPMENT**

Semester: IV

Code: U23BT4S7

Credits : 2

Hours: 2 hours/week

1. Course Outcomes

<b>CO No.</b>	<b>Course Outcomes</b>	<b>K – Level</b>	<b>Unit</b>
CO1	To comprehend the key concepts of S-L and differentiate the community service and Service-Learning	K2	1
CO2	Identify the possible start up ideas in biotechnology	K2	2
CO3	Demonstrate biotechnological concepts for effective waste management	K3	3
CO4	Analyze the natural resources and living parameters prevailing in the community	K3	4
CO5	Apply the expertise and skills gained by basic principles in biotechnology	K4	5

## 2 a Syllabus

<b>Unit 1 Concepts of Service-Learning:</b>
Service-Learning – Definition, difference between community service and service-learning, Principles; Whole Person Education. Identifying Community Needs, Community Partners, Reflection, Reciprocity. Public Dissemination; Understanding of community dynamics. Project Planning Stages and report preparation
<b><u>Classroom Activity:</u></b>
<ol style="list-style-type: none"><li>i. Group discussion about Civic/Social responsibility (Display of Video/Documentary film (Through this activity Students should recognize civic responsibility of the society)</li><li>ii. Conduct a role play/games/drawing to provide problem solving skill and ignites critical thinking.</li><li>iii. Group activity to frame questionnaire for identify community needs</li><li>iv. Reflection on identify the need of the community (Students go to the community for identify the community needs and reflect their experience)</li></ol>
<b>Unit 2 Conceptions of Entrepreneurship in Biotechnology</b>
Biotechnology as a part in everyday life –Possible startups of biotechnology in small and large scales – Biotechnology Industries in context to national and International Prospects of biotechnology as a boon to economy and commercialization
Classroom Activity:
<ol style="list-style-type: none"><li>i. Activity on creative thinking skills (The envelope exercise) to stimulate ways of increasing investment in biotechnology</li><li>ii. Practice to articulate a value proposition for a proposed business <u>product or idea</u></li><li>iii. Conduct reverse brainstorming exercises to reinstate a business problem or loss</li><li>iv. Playing short motivating videos and success stories of entrepreneurs</li></ol>
<b>Unit 3 Biotechnology for environmental sustainability</b>

Biotechnology in monitoring and controlling environmental pollution. Biological methods - bioremediation, biomonitoring, biotreatment and biodegradation in solid waste management. Methods to Convert biomass waste into value-added products- Thermal transformation techniques-pyrolysis, hydrothermal processing, gasification, anaerobic digestion, and torrefaction; Microbial Technology-Fermentation process, microbial cell factories

**Classroom Activity:**

- i Sharing success stories on environmental policies and biotechnological practices to reduce snags in pollution control
- ii. Discussing the difficulties and challenges faced by littering of waste
- iii. Discussing case studies and review articles related to the snags in environmental pollution
- iv. Student presentation to propose solution for effective waste management using the concepts of biotechnology

**Unit 4 Reaching and Scrutinizing the needs of Community**

Analyzing the foremost source of livelihood – Identifying the sources of income -Analyzing the favorable parameters to improve their living standards –Water ,Soil ,Waste management ,Level of utilizing their resources- Surveying the potential herbs and evaluate the medicinal benefits

**Field Activity**

- i. Demographic Survey
- ii Secondary data collection (eg. statistical analysis from rural health care centres/Panchayat office)
- iii Performing structural interviews; Building up interactive Focus Groups
- iv Developing plant database specifically available in the community

**Unit 5 :Developing Bioproducts for waste management**

Propagating the skill sets of biotechnology to develop bioproducts -Enhancing agricultural practices –Effective soil fertility management – Development of efficient organic manure from waste generation -vermicompost –Biochar- Unveil the medicinal importance of distinct herbs and plants –Formulating their novelty and highlighting their commercial benefits

**Field Activity**

- i Performing ethnobotanical studies to the vegetation specific to the community
- ii Dissipating the skills of producing bioproducts which are explicit to the resources of village
- iii Experimental analysis of the agricultural parameters of the community (soil fertility, salinity, Pest, agricultural revenue generated)
- iv Formulation business and entrepreneurship modules specific to the resources of the community

b. Text Books

1. Craig Shimasaki Biotechnology Entrepreneurship (2020) 2nd Edition, Elsevier Science Publishing Co. UK
2. Willis, R. 2002, The Economic Approach to Service Learning: Ten Simple Guidelines. In McGoldrick, M. and A. Ziegert, (Eds.) Putting the Invisible Hand to Work: Concepts and Models for Service Learning in Economics. Ann Arbor: The University of Michigan Press.

c. References

1. Bruce E Rittman and Perry L McCarty (2020) Environmental Biotechnology, Principles and Applications , McGrawhill Higher education.
2. Pedro J JAlvarage and Walter A Illman (2005) Bioremediation and Natural Attenuation ,Wiley Interscience.
3. Environmental Biotechnology, Vol 10 (2010) Handbook of Environmental Engineering, Edited by L K Wang et al, Humana Press
4. Rehan Ahmad (2020) CBCS Skill Enhancement Course ,Vermicompost Production,Nithya Publications,India.
5. Zull, James E (2002) The Art of Changing the Brain: Enriching the Practice of Teaching by Exploring the Biology of Learning. Sterling, VA, Stylus Publications.

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Bloom Taxonomic
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			<b>Transaction</b>
1	Service-Learning – Definition, difference between community service and service-learning	Understanding the difference between S-L and other community services	K2
	Principles – Whole Person Education.	Comprehend the Whole Person education	K2
	Identifying Community Needs, Community Partners	Linking discipline specific knowledge and community needs  Collaboration with community partners	K2
	Reflection, Reciprocity	Reflection about field exposure and highlighting the benefits of the recipients and provider through service-learning	K2
	Public Dissemination; Understanding of community dynamics	Recognize and celebrate the contribution of students and community	K2
	Project Planning Stages and report preparation	Apply the S-L principles, analyze the community intervention,	K2



		assess the community benefits present the reflection.	
2	Meaning and concept of Entrepreneurship –Parameters necessary for building Entrepreneurship - Social,Economic,Legal,Technical ,Psychological -Entrepreneurial skills	Define the concepts of entrepreneurship and propagate its skills	K1
	Creativity,problem solving,decision making,Leadership,Communication-	Outline the significance of interpersonal skills required in entrepreneurship	K1
	Biotechnology as a part in everyday life –Possible startups of biotechnology in small and large scales –Prospects of biotechnology as a boon to economy and commercialization –	Associating the prospects of biotechnology to promote entrepreneurship	K2
3	Pits and falls of crop cultivation in Agricultural practices and production.	Analyzing the snag in the existing agricultural practices	K4
	–Molecular biology of abiotic stress management-Cold and high temperature, salinity and drought	Relating the molecular aspects of plant biotechnology to combat agricultural practices	K2
	Molecular biology of plant –pathogen interactions –Viral, Bacterial and Pest Management –Defense mechanism –	Implementing biotechnological approaches for	K3

	Applying the concept of programme cell death	agricultural management	
4	Analyzing the fore most source of livelihood – Identifying the sources of income -Analyzing the favorable parameters to improve their living standards –Water ,Soil ,Waste management ,Level of utilizing their resources	Grading the potential resources for livelihood of the community	K5
	Assaying the intensity of crop protection and management – Identifying the recurring plant diseases	Assessing the issues in crop cultivation and management	K5
	Surveying the potential herbs and evaluate the medicinal benefits	Illustrating the significant herbs that has medicinal benefits	K4
5	Propagating the skill sets of biotechnology to develop bioproducts- Establishing -SCP as the predominant product in microalgal biotechnology- Rearing silkworms and instituting bioreactors- Mushroom cultivation and farm designing	Infer the basic idea of establishing entrepreneurship in biotechnology	K4
	Enhancing agricultural practices – Effective soil fertility management – Development of efficient organic manure from waste generation - vermicompost –Biochar	Solve the agricultural issues through biotechnology to get better commercial useful products.	K6

	–Unveil the medicinal importance of distinct herbs and plants –Formulating their novelty and highlighting their commercial benefits	Formulating plant derived herbal products to facilitate commercial profits	K6

### EVALUATION

#### Continuous Internal Assessment (CIA)

S. No.	Classroom Activities	Marks
1.	Class participation and Discussion	10
2.	Problem Identification (Community Needs)	10
3.	Journal (Reflection)	20
4.	Attendance	10
<b>Total</b>		<b>40</b>

S. No.	Community Activities	Marks
1	Field work report / Mini Project	40
2	Student presentation and Viva-voce	20

	<b>Total</b>	<b>60</b>
	<b>Grand Total 40 + 60</b>	<b>100</b>

## *SEMESTER – V*

**Core V PLANT BIOTECHNOLOGY**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT505	4	1			4	5	25	75	100
<b>Learning Objective</b>									
LO1	Explore the history of Biotechnology and state the importance of organization of plant genome								
LO2	Be acquainted with the molecular basis of action of plant hormones and gene expression								
LO3	Illustrate about various culture medium preparations, haploid, triploid plant production and its applications								
LO4	Exploit symbiotic organisms as a vector for gene transfer to produce transgenic plants								

LO5	Develop molecular technique skills for crop improvement.	
<b>UNIT</b>	<b>Contents</b>	<b>No.of Hours</b>
I	History of plant biotechnology, Conservation of Plant using Biotechnology. Plant genome organization: structural features of a representative plant gene, gene families in plants. Organization of chloroplast genome and mitochondrial genome.	15
II	Auxins, cytokinins and gibberlins – molecular basis of action – phytochrome – role in photomorphogenesis – abscisic acid – and stress – induced promoter switches in the control of gene expression – Ethylene and fruit ripening.	15
III	Media composition (MS media) - Micropropagation techniques - direct and indirect organogenesis - somoclonal variation - somatic embryogenesis - haploid and triploid - Protoplast isolation, fusion and culture - hybrid and cybrid production, Synthetic seed production. Secondary metabolite production.	15
IV	Agrobacterium and crown gall tumors – Mechanism of T-DNA transfer to plants, Ti and Ri Plasmid vectors and their utility – Plant viral vectors. Symbiotic nitrogen fixation in Rhizobia, nif gene.	15
V	Crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors. Transgenic plants- plant vaccines, genetically modified food - future perspectives & ecological impact of transgenic plants.	15
<b>Total</b>		<b>75</b>
<b>Text Books</b>		
1	Sudhir, M. 2000. Applied Biotechnology and plant Genetics. Dominant publishers and distributors.	
2	Trivedi, P.C.2000. Applied Biotechnology: Recent Advances. PANIMA Publishing corporation.	
3	Ignacimuthu. 1996. Applied Plant Biotechnology. Tata McGraw – Hill.	
4	Narayanaswamy S. 1994. Plant cell and tissue culture. Tata McGraw Hill Publishing Company limited, New Delhi.	
5	Chawla, H.S., “Introduction to Plant Biotechnology”, 3rd Edition, Science Publishers, 2009.	

<b>Reference Books</b>	
1	Kojima, Lee, H. and Kun, Y. 2001. Photosynthetic microorganisms in Environmental Biotechnology. Springer – Verlag.
2	Stewart Jr., C.N., “Plant Biotechnology and Genetics: Principles, Techniques and Applications” Wiley-Interscience, 2008.
3	Heldt HW. Plant Biochemistry & Molecular Biology, Oxford University Press. 1997.
4	Trigiano, R.N. and Gray, D.J. 1996. Plant tissue culture concepts and laboratory exercise. CRC Press. BocaRatin, New York.
5	Street, H.E. 1977. Plant tissue culture. Blackwell Scientific Publications, oxford, London.
<b>Web Resources</b>	
1	<a href="https://nptel.ac.in/courses/102103016">https://nptel.ac.in/courses/102103016</a>
2	<a href="https://science.umd.edu/classroom/bsci124/lec41.html">https://science.umd.edu/classroom/bsci124/lec41.html</a>
3	<a href="https://www.nifa.usda.gov/grants/programs/biotechnology-programs/plant-biotechnology">https://www.nifa.usda.gov/grants/programs/biotechnology-programs/plant-biotechnology</a>
4	<a href="http://mydunotes.blogspot.com/p/plant-biotechnology.html">http://mydunotes.blogspot.com/p/plant-biotechnology.html</a>
5	<a href="https://nptel.ac.in/courses/102103016">https://nptel.ac.in/courses/102103016</a>

**MAPPING WITH PROGRAMME OUTCOME AND PROGRAMME SPECIFIC OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	3	2	3	1	1	2	3	3	3

<b>CLO2</b>	3	3	3	2	1	3	3	3	3
<b>CLO3</b>	3	3	3	3	2	2	3	3	3
<b>CLO4</b>	3	2	2	1	3	2	3	3	2
<b>CLO5</b>	3	3	3	2	3	3	3	2	3
<b>TOTAL</b>	<b>15</b>	<b>13</b>	<b>14</b>	<b>9</b>	<b>10</b>	<b>12</b>	<b>15</b>	<b>14</b>	<b>14</b>
<b>AVERAGE</b>	<b>3</b>	<b>2.6</b>	<b>2.8</b>	<b>1.8</b>	<b>2</b>	<b>2.4</b>	<b>3</b>	<b>2.8</b>	<b>2.8</b>

### Core Paper VI - ANIMAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT506	4	1			4	5	25	75	100
<b>Learning Objective</b>									
LO1	Understand the basic concepts of Animal cell culture and cell laboratory								
LO2	Describe the media preparation, preservation, trypsinization, counting, maintenance and application of cell lines.								
LO3	Discuss the strategies for gene transfer and gene expressions with their applications.								
LO4	Be acquainted with genetic modification and stem cell technology in production of transgenic animals.								



LO5	Learn the Assisted reproductive technology and its applications.	
<b>UNIT</b>	<b>Contents</b>	<b>No.of Hours</b>
I	Animal cell culture – History and development, Pluripotency, Media, balanced salt solutions, Physical, chemical and metabolic functions of constituents of culture media, Role of carbon dioxide, Serum, growth factors and amino acids in media. Serum containing and serum free media. Constitution of a media for cell line. Essential equipments required for animal cell culture.	15
II	Types of cell culture- Primary, Secondary, Organ culture and cell lines. Role of feeder layers in cell culture, Cell separation techniques, cell synchronization, Cell counting methods, cryopreservation, Cell banking procedures. Biology of cultured cells- Apoptosis and cell death.	15
III	Transfection of cells in culture- Animal viral vectors for transfection, Physical methods of transfection, HAT selection, selectable markers. Micro manipulation of cells, Gene targeting, gene silencing and Gene knockout and their applications.	15
IV	Protein production by genetically engineered mammalian cell lines, Stem cells and their applications-; Cell culture as a source of valuable products -Transgenic Animals.	15
V	Collection and preservation of embryos, Semen banking, AI, IVF and ICSI. Case Study-any two relevant studies.	15
<b>Total</b>		<b>75</b>
<b>Text Books</b>		
1	Ramasamy.P. 2002.Trends in Biotechnology, University of Madras of Publications, Pearl Press	
2	Ignacimuthu. 1996. Basic Biotechnology. Tata McGraw-Hill.	
3	K. Srivastava <i>et al.</i> , 2009, Animal Biotechnology, Oxford & IBH Publishing Co. Pvt. Ltd.	
4	B.C. Currellet <i>al.</i> , 1994, In vitro Cultivation of Animal Cells (Biotol), Butterworth-	

	Heinemann Ltd.
5	Jenkins, N. (ed). 1999 Animal cell Biotechnology: Methods and protocols. Humana press, New Jersey.
<b>Reference Books</b>	
1	R. Ian Freshney, Culture of Animal cells – A Manual of Basic Technique Fourth Edition, WILEY LISS & Publications.
2	Glick, B.R. and Pasternak. 2002. Molecular Biotechnology: Principle and applications of recombinant DNA.
3	Kreuzer, H. and Massey, A. 2001. Recombinant DNA and Biotechnology: A guide for teachers, 2nd edition. ASM Press Washington.
4	Traven. 2001. Biotechnology. Tata McGraw – Hill.
5	Walker, J.M. and Gingold, E.B. 1999. Molecular biology and Biotechnology, 3 <sup>rd</sup> edition. Panima Publishing Corporation.
<b>Web Resources</b>	
1	<a href="http://ecoursesonline.iasri.res.in/course/view.php?id=350">http://ecoursesonline.iasri.res.in/course/view.php?id=350</a>
2	<a href="https://microbenotes.com/animal-cell-culture/">https://microbenotes.com/animal-cell-culture/</a>
3	<a href="https://biocyclopedia.com/index/biotechnology/animal_biotechnology/manipulation_of_reproduction_and_transgenic_animals/biotech_in_vitro_fertilization_technology.php">https://biocyclopedia.com/index/biotechnology/animal_biotechnology/manipulation_of_reproduction_and_transgenic_animals/biotech_in_vitro_fertilization_technology.php</a>
4	<a href="https://thebiologynotes.com/embryo-transfer/">https://thebiologynotes.com/embryo-transfer/</a>
5	<a href="https://people.ucalgary.ca/~browder/transgenic.html">https://people.ucalgary.ca/~browder/transgenic.html</a>

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CLO1	3	2	3	3	3	2	3	3	3
CLO2	3	3	3	2	1	3	3	3	3

<b>CLO3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO4</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO5</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>TOTAL</b>	<b>15</b>	<b>13</b>	<b>14</b>	<b>10</b>	<b>12</b>	<b>12</b>	<b>15</b>	<b>15</b>	<b>15</b>
<b>AVERAGE</b>	<b>3</b>	<b>2.6</b>	<b>2.8</b>	<b>2</b>	<b>2.4</b>	<b>2.4</b>	<b>3</b>	<b>3</b>	<b>3</b>

#### **CORE PRACTICAL V- PLANT BIOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY LAB**

<b>Subject Code</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>S</b>	<b>Credits</b>	<b>Instructional Hours</b>	<b>Marks</b>		
							<b>CIA</b>	<b>External</b>	<b>Total</b>
U23BT5P5	-	-	4		4	6	40	60	100
<b>Learning Objectives</b>									
LO1	Explain plant tissue culture and Illustrate Callus development.								
LO2	Develop technical skills in Protoplast isolation and Nucleus localization.								
LO3	Make use of the techniques used in preparing tissue culture medium and membrane filtration in culturing animal cells and prepare single cell suspension and evaluate cell counting and viability.								
LO4	Develop technical skills in isolation of DNA and RNA from plants and microorganisms.								

LO5	Examine the importance of trypsinization in monolayer and subculture and cryopreservation.	
<b>UNIT</b>	<b>Contents</b>	<b>No. of Hours</b>
I	Plant tissue culture media preparation & sterilization techniques. Callus induction	9
II	Isolation of plant protoplast & viability test. Localization of nucleus using nuclear stain.	9
III	Preparation of Animal Tissue culture medium and membrane filtration Preparation of Single Cell Suspension & Cell counting Cell viability Test	9
IV	Isolation of plant DNA and plant RNA(Demo) Isolation of Agrobacterium plasmid DNA (Demo)	9
V	Trypsinization of monolayer and subculturing (Demo) Measurement of phagocytic activity (Demo) MTT Assay (Demo) Cryopreservation and thawing (Demo)	9
<b>Total</b>		<b>45</b>
<b>Text Books</b>		
1	MadhaviAdhav, 2009, Practical Biotechnology and Plant Tissue Culture, S.Chand& Company Ltd.	
2	C. C. Giri, ArchanaGiri, 2007, Plant Biotechnology: Practical Manual, I.K. International Pvt Ltd.	
3	Karl-Hermann Neumann, Ashwani Kumar, Jafargholi Imani, 2009, Plant Cell and Tissue Culture - A Tool in Biotechnology: Basics and Application, Springer.	
4	Debajit Borah(2018), <i>Environmental Biotechnology Theory and Lab Practices</i> , (2nd edition), Hardcover – Global Vision Publishing House,ISBN: 9788182205840	

<b>Reference Books</b>	
1	S. Lal, Vikas. (2018), <i>Public Health Management Principles And Practice</i> , (2nd Edition), CBS Publishers and Distributors PvtLtd,ISBN 13: 9789387742932
2	S. Harisha. (2012), <i>Biotechnology procedures and experiments handbook</i> ,ISBN13 9781934015117
<b>Web Resources</b>	
1	<a href="https://www.plantcelltechnology.com/pct-blog/different-types-of-tissue-culture-processes/">https://www.plantcelltechnology.com/pct-blog/different-types-of-tissue-culture-processes/</a>
2	<a href="https://www.thermofisher.com/in/en/home/references/gibco-cell-culture-basics.html">https://www.thermofisher.com/in/en/home/references/gibco-cell-culture-basics.html</a>

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	3	3	3	2	-	2	3	3	3
<b>CLO2</b>	3	2	2	2	-	2	3	3	3
<b>CLO3</b>	3	3	2	2	-	2	3	3	3
<b>CLO4</b>	3	2	3	2	-	2	3	3	3
<b>CLO5</b>	3	3	2	1		2	3	3	3
<b>TOTAL</b>	15	13	12	9	-	10	15	15	15
<b>AVERAGE</b>	3	2.6	2.5	1.9	-	2	3	3	3

### Elective I - NANO BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT5:A	3	1			3	4	25	75	100
<b>Learning Objective</b>									
LO1	The students will get an outline about Nano biotechnology and its research in India.								
LO2	To know about nanoparticles and their analysis using Advanced Instrumentation.								
LO3	To get an insight about Nano devices								
LO4	The students will know about the Applications of Nano biotechnology								
LO5	The students will know about the Nano Biosensors and their applications.								

UNIT	Contents	No. of Hours
I	Glimpse of Nanotechnology based material in ancient India: Wootz steel (iron carbide) and the Delhi iron pillar (anticorrosive nanomaterial), Bhasma (nanomaterial as medicine). Contributions of Indian Research Institutes in the field of nanobiotechnology.	15
II	Metals: Silver nanoparticle synthesis and its analyses by UV-spectroscopy and FTIR. Self-Assembly nanomaterial: Cell membrane and its analyses by SEM	15
III	Nano-thin films: Chitosan thin film, Nanodevices (nanorobots), Nanotubes: Microtubules assembly and its importance, Nano shells- Dendrimers: Liposomes, Nanofibers: Collagen, Fibronectin& elastin, nano fluidics: Extracellular matrix assembly and its importance.	15
IV	Agriculture: Crop production- Nano fertilizers technology, Biomaterial to improve shelf life of vegetables. Medicine: Collagen thin films in wound healing mechanism, Nanoscale devices – DNA microarray for disease diagnosis, Antibodies and Targeted drug delivery system.	15
V	Nano biosensors (Firefly-luciferase) and its applications, Introduction to Biomimetics (Gecko foot effect, Lotus leaf effect: Paint and fabrics, Box fish based Car).	15
<b>Total</b>		<b>75</b>
<b>Text Books</b>		
1	VasanthaPattabhi and N. Gautham (2009), Biophysics, NarosaPublishmg House, New Delhi.	
2	Narayanan.P (2010), Essentials of Biophysics, New Age International (P) Ltd. Publishers, New Delhi.	
3	Rai, Mahendra, and Clemens Posten (2013). <i>Green biosynthesis of nanoparticles: Mechanisms and applications</i> , CABI, ISBN: 9781780642246.	

4	Shanmugam.S, "Nanotechnology", MJP publishers, 2010.
5	Pradeep T (2012). <i>Textbook of Nanoscience and Nanotechnology</i> , McGraw Hill publications, ISBN: 9781259007323.
<b>Reference Books</b>	
1	D.Voet&J.G.Voet (2010), <i>Biochemistry</i> , John Wiley & Sons, New York.
2	<i>Biochemistry</i> by Lubert Stryer, 4 <sup>th</sup> Ed., WH.Freeman, 1995.
3	David S. Goodsell, "Bionanotechnology", John Wiley & Sons Inc., publications, 2004.
4	Guozhong Cao (2004). <i>Nanostructures and Nanomaterials, synthesis, properties and applications</i> , Imperial College Press, ISBN: 978-1860944802.
5	C.M.Niemeyer, C.A. Mirkin (2007). <i>Nanobiotechnology</i> , WILEY-VCH Verlag GmbH & Co. KG, Weinheim, ISBN: 9783527306589.
<b>Web Resources</b>	
1	<a href="http://vvm.org.in/study_material/ENG%20-20Indian%20Contributions%20to%20Science">http://vvm.org.in/study_material/ENG%20-20Indian%20Contributions%20to%20Science</a> .
2	<a href="https://www.jabonline.in/admin/php/uploads/16_pdf.pdf">https://www.jabonline.in/admin/php/uploads/16_pdf.pdf</a>
3	<a href="https://www.youtube.com/watch?v=gSpHINVmgoE">https://www.youtube.com/watch?v=gSpHINVmgoE</a>
4	<a href="https://www.youtube.com/watch?v=ITtGJUGXFKc">https://www.youtube.com/watch?v=ITtGJUGXFKc</a>
5	<a href="https://www.youtube.com/watch?v=4cGROrskvLM">https://www.youtube.com/watch?v=4cGROrskvLM</a>

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
<b>CLO1</b>	3	2	2	2	2	2	3	3	3
<b>CLO2</b>	3	3	3	2	3	3	3	3	3
<b>CLO3</b>	3	3	3	3	2	3	3	3	3
<b>CLO4</b>	3	2	2	-	-	2	3	2	3
<b>CLO5</b>	3	3	3	2	3	3	3	3	3



<b>TOTAL</b>	<b>15</b>	<b>13</b>	<b>13</b>	<b>9</b>	<b>10</b>	<b>13</b>	<b>15</b>	<b>15</b>	<b>15</b>
<b>AVERAGE</b>	<b>3</b>	<b>2.6</b>	<b>2.6</b>	<b>1.8</b>	<b>2</b>	<b>2.6</b>	<b>3</b>	<b>3</b>	<b>3</b>

### Elective I - CANCER BIOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT5:B	3	1			3	4	25	75	100
<b>Learning Objective</b>									
LO1	The students will understand the Basics of Cancer Biology.								
LO2	The students will comprehend the Cancer at the Molecular level.								
LO3	The students will learn about the types of Cancer.								
LO4	The students will realize the different techniques of Detection and Treatment of Cancer.								

LO5	The students will know about the Prevention of Cancer.	
<b>UNIT</b>	<b>Contents</b>	<b>No.of Hours</b>
I	Cancer: Introduction; Origin of Cancer- The Mutation Concept, The Epigenetic Concept, Viral Concept, Unified genetic concept of cancer; Difference between Normal and Cancer cells; Signs and symptoms.	15
II	Cancer as a genetic disease; Genetic Alterations in Cancer cells, Point mutation, splice mutation, alternate splicing; Mutation in regulatory sequences, deletions, Insertion, Chromosome abnormalities, Genetic defects and the time course of hereditary cancer.	15
III	Types of Cancer: - Blood & Lymph – Leukemia, Malignant lymphoma, Bone- Soft tissue Sarcoma, Thorax- Breast cancer, Male genitalia- Prostate cancer, Female genitalia- Cervical cancer; Tumor suppressor genes; Classification of Tumor suppressor genes.	15
IV	Detection and Treatment:- Early detection, Molecular detection of Carcinomas, Cancer warning signals; Markers in blood urine; Therapies- Chemotherapy, Gene therapy, Radiotherapy, Biological therapy( Immuno therapy).	15
V	Prevention:- Tobacco smoking, sunlight, diet, ionizing radiation, alcohol drugs, promiscuity, lifestyle and cancer prevention, Environmental factors and cancer, potentially carcinogenic substances for humans.	15
<b>Total</b>		<b>75</b>
<b>Text Books</b>		
1	A. Sarkar, 2011, Biology of Cancer, Discovery Publishing House, New Delhi.	
2	Ranajit Sen,2004, Principles and Management of Cancer, B.I. Publications Pvt Ltd, New Delhi.	
3	DrM.R.Ahuja, 1997, Cancer- Causes and Prevention, UBS Publishers Distributors Pvt. Ltd.	
4	A. Sarkar, 2011, Biology of Cancer, Discovery Publishing House, New Delhi.	

5	Ranjit Sen,2004, Principles and Management of Cancer, B.I. Publications Pvt Ltd, New Delhi.
<b>Reference Books</b>	
1	Francesco Pezzella, MahvashTavassoli, David J. Kerr, 2019, Oxford Textbook of Cancer Biology, Oxford University Press
2	Albert DeNittis, MD, Joel W. Goldwein, MD, and Thomas J. Dilling, MD, 2002, The Biology of Cancer.
3	Robin Hesketh, 2012, Introduction to Cancer Biology, Cambridge University Press
4	Francesco Pezzella, MahvashTavassoli, David J. Kerr, 2019, Oxford Textbook of Cancer Biology, Oxford University Press
5	Albert DeNittis, MD, Joel W. Goldwein, MD, and Thomas J. Dilling, MD, 2002, The Biology of Cancer.
<b>Web Resources</b>	
1	<a href="http://csbl.bmb.uga.edu/mirrors/JLU/DragonStar2017/download/introduction-to-cancer-biology.pdf">http://csbl.bmb.uga.edu/mirrors/JLU/DragonStar2017/download/introduction-to-cancer-biology.pdf</a>
2	<a href="http://webserver1.oneonta.edu/faculty/bachman/cancer/207lectures.htm">http://webserver1.oneonta.edu/faculty/bachman/cancer/207lectures.htm</a>

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	3	3	3	3	3	3	3	3	3
<b>CLO2</b>	3	3	3	3	3	3	3	3	3
<b>CLO3</b>	3	3	3	3	3	3	3	3	3
<b>CLO4</b>	3	3	3	3	2	3	3	3	3
<b>CLO5</b>	3	3	3	3	3	3	3	3	3
<b>TOTAL</b>	15	15	15	15	14	15	15	15	15
<b>AVERAGE</b>	3	3	3	3	2.8	3	3	3	3

**Elective II ENVIRONMENT MANAGEMENT IN INDUSTRIES**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT5:C	4	1			3	4	25	75	100
<b>Learning Objective</b>									
LO1	The student understands the need of Instruments for Medical field								
LO2	Can examine the setup of Dairy Industry								
LO3	learn the Management skills for Agri Industry								
LO4	understanding of hazards in Workplace								
LO5	Gains knowledge about Industrial hazards and its prevention								

<b>UNIT</b>	<b>Contents</b>	<b>No. of Hours</b>
I	Introduction to life science, computer in life science-Medical imaging, Genomics and phylogenetics, Drug design and discovering, Assistive robotics, Brain-computer interfaces, Simulation of biological systems and Medical treatment optimization.	15
II	Introduction to Dairy industries, The Structure of Dairying in Developing Countries, Application of Computer in Dairy Industry, Milk Procurement & Billing, Plant Automation, Computerized Accounting System, Applications of Management Information System (MIS), Packaging, Supply Chain Integration and Traceability.	15
III	Agribusiness - Application of marketing and decision making in contemporary agribusiness firms. Marketing strategies, marketing research and information, segmentation and targeting, Professional selling skills and knowledge – Rural Development – NABARD.	15
IV	Hazards in the workplace: Pressure, Biological, Chemical, Electricity, Fire, Heat & Cold, Indoor Air Quality, Lighting, Noise, ergonomics, Radiation (ionizing & non ionizing), Vibrations, hours of work, violence in work place, Understanding of Material Safety Data Sheets, Accidents and Safety Management: Accident Prevention methods, Safety Management and audit, Personal Protection Approaches.	15
V	Occupational Health & Industrial Hygiene: Scientific and engineering basis for occupational health, biological monitoring (e.g. BEI), Occupational Hygiene, Concept of First Aid, Preventive Measures, and Occupational Health & Safety Management System: OHSAS – 18000.	15
<b>Total</b>		<b>75</b>
<b>Text Books</b>		
1	Multi-Criteria Decision Analysis for Risk Assessment and Management, Editors JingzhengRen, Series Title <u>Industrial Ecology and Environmental Management</u> Publisher Springer Cham, DOI <a href="https://doi.org/10.1007/978-3-030-78152-1">https://doi.org/10.1007/978-3-030-78152-1</a>	
2	Environmental Management,	

	Butterworth-Heinemann, Editor(s): Iyyanki V. Muralikrishna, Valli Manickam, 2017, Page iv, ISBN 9780128119891, <a href="https://doi.org/10.1016/B978-0-12-811989-1.12001-9">https://doi.org/10.1016/B978-0-12-811989-1.12001-9</a> . ( <a href="https://www.sciencedirect.com/science/article/pii/B9780128119891120019">https://www.sciencedirect.com/science/article/pii/B9780128119891120019</a> )
3	Life Cycle Sustainability Assessment for Decision-Making Methodologies and Case Studies Book • 2020 Editors Jingzheng Ren & Sara Toniolo
<b>Reference Books</b>	
1	Lalat Chander, 2010. Text book of Dairy Plant Layout and Design, ICAR, New Delhi.
2	Larry R. Collins, 2001. Physical Hazards of the Workplace, CRC Press, Taylor & Francis group.
3	Andrew Barkley, 2013, Principles of Agricultural Economics, Taylor & Francis group.
4	Mishra R.K., 2015. Occupational health management, Aitbs Publishers and Distributors- Delhi.

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

<b>CLO4</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO5</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>13</b>	<b>15</b>	<b>15</b>	<b>15</b>
<b>Average</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2.6</b>	<b>3</b>	<b>3</b>	<b>3</b>

### Elective II -MARINE BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT5:D	3	1			3	4	25	75	100
<b>Learning Objective</b>									
LO1	Students will gain knowledge about Marine Ecosystem and Resources.								
LO2	Will learn about bioactive compounds from Marine sources								
LO3	Will learn about medicinal seaweeds								
LO4	Will know about culture of seaweeds and Aquaculture								

LO5	Will know about Marine biotech products	
<b>UNIT</b>	<b>Contents</b>	<b>No. of Hours</b>
I	Marine Ecosystems & Its functioning, Ocean currents, Physical & chemical properties of seawater, Ecological divisions of the Sea- Euphotic-Mesopelagic- Bathopelagic- Benthos-Intertidal, Estuarine- Salt Marsh- Mangrove- Coral Reef.	15
II	Marine microbial habitats- Screening for Secondary metabolites from marine microbes (Bacteria, Fungi, Actinomycetes and marine microalgae). Biofouling, Biofilm, Antifouling, Anticorrosion. Probiotic bacteria and their importance in aquaculture.	15
III	Definitions- Medicinal compounds from flora (Seaweeds, Seagrass and Mangrove) and fauna (Sponges, Sea anemone and Corals)- marine toxins- antiviral and antimicrobial agents.	15
IV	Culture aspect-Seaweed ( <i>Kappaphycusalvarezii</i> ), Fish chromosome manipulation in aquaculture- Hybridization- Gynogenesis- Androgenesis- Polyploidy, Artificial Insemination, Eyestalk ablation- Transgenesis and Cryopreservation.	15
V	Agar- Agarose - Alginate- Carrageenan- Chitin- Chitosan- Heparin.	15
<b>Total</b>		<b>75</b>
<b>Text Books</b>		
1	Italy, E (Eds). 1998, New Developments in Marine Biotechnology, Plenum Pub. Corp.	
2	Milton Fingerman and RachakondaNagabhushanam, 1996, Molecular Genetics of Marine Organisms, Science Pub Inc.	
3	Y. Le Gal and H.O.Halvorson 1998, New Developments in Marine Biotechnology. Springer.	
4	David H. Attaway, 2001. Marine Biotechnology, Volume 1,	



	Pharmaceutical and Bioactive Natural Products.
5	Rita R. Colwell 1984. <i>Biotechnology in the Marine Sciences (Advances in Marine Science &amp; Biotechnology)</i> Wiley Interscience
<b>Reference Books</b>	
1	Scheupr, P.J. (Ed.), 1984. <i>Chemistry of Marine Natural Products, Chemical and Biological Perspectives. Vol. I III</i> , Academic Press, New York
2	Marine Biology- Lalli C.M. and T.R. Parsons., 1997. <i>Biological Oceanography - An Introduction</i> , Elsevier, 314 pp
3	Marine Pollution- Clark, R. B. 2001. <i>Marine pollution</i> , Fifth edition. Oxford University press, New York Inc., 231pp
4	Gloria Sanchez, Elizabeth Hernandez,(2019), <i>Environmental Biotechnology and cleaner Bioprocess</i> , (1 <sup>st</sup> edition), CRC Press, ISBN 9780367455552
5	Kirchman, D.L.Gasol, J.M. (2018), <i>Microbial ecology of the oceans</i> , (3 <sup>rd</sup> edition), Wiley –Blackwell.
<b>Web Resources</b>	
1	<a href="http://coe.genomics.org.cn/">http://coe.genomics.org.cn/</a>
2	<a href="http://www.bcb.iastate.edu/">http://www.bcb.iastate.edu/</a>
3	<a href="http://www.nwfsc.noaa.gov/protocols/bioinformatics.html">http://www.nwfsc.noaa.gov/protocols/bioinformatics.html</a>
4	<a href="http://www.ebi.ac.uk/ ExPASy.org/">http://www.ebi.ac.uk/ ExPASy.org/</a>
5	<a href="http://www.expasy.org/">http://www.expasy.org/</a>

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
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<b>CLO1</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO4</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO5</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>13</b>	<b>5</b>	<b>10</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>
<b>Average</b>	<b>3</b>	<b>3</b>	<b>2,6</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

# *SEMESTER – VI*

## **Core Paper VIII - BIOENTREPRENEURSHIP**

<b>Subject Code</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>S</b>	<b>Credits</b>	<b>Instructional Hours</b>	<b>Marks</b>		
							<b>CIA</b>	<b>External</b>	<b>Total</b>
U23BT607	<b>4</b>	<b>1</b>			<b>4</b>	<b>6</b>	<b>25</b>	<b>75</b>	<b>100</b>
<b>Learning Objective</b>									
LO1	Students will be able to identify the challenges of being a Bioentrepreneur								

LO2	Will understand the Business proposal for starting a company	
LO3	Will learn about Vermicomposting and Sericulture	
LO4	Will aspire to set up Mushroom Cultivation	
LO5	Will learn the technique of Single cell protein Cultivation	
<b>UNIT</b>	<b>Contents</b>	<b>No.of Hours</b>
I	Basics of Bio entrepreneurship -Biotechnology in a Global scale; types of Bio-industries – Biopharma, Bioagri and Bioservice innovations – Successful Entrepreneur – Creativity, Leadership, Managerial skills, Team building, Decision making; Public and private funding agencies (MSME, DBT, BIRAC, Startup & Make in India)	<b>15</b>
II	Business plan preparation; business feasibility analysis by SWOT, business plan proposal for virtual startup company; statutory and legal requirements for starting a company/venture; basics in accounting practices. Market Conditions, Identifying the need of the customers.	<b>15</b>
III	Vermicomposting–Earthworms-Ecologicaltypes-Vermiculture-Compostpit-Vermibed-applications. Sericulture-Mulberrycultivation-SilkwormRearing-Economicsofsilkworm Production-Chawki Rearing-Sericulture in India.	<b>15</b>
IV	Phases of Mushroom Cultivation; Selection of an acceptable mushroom species/strains, Management of mushroom development, Mushroom harvesting; Mushroom diseases, Medicinal and Nutritional properties of mushroom. Aquaponics- Systems-Fish and Vegetables-Nutrients and Biofilters-Advantages and Disadvantages.	<b>15</b>
V	Single Cell Protein Production: Source: Algae, Bacteria, Yeast – Cultivation of Single Cell protein: SPIRULINA Cultivation – Production site, Microorganism, Experimental design; harvesting and Drying.	<b>15</b>
<b>Total</b>		<b>75</b>
<b>Text Books</b>		
1	Shimasaki, C. D. (2014). Biotechnology entrepreneurship: Starting, managing, and leading biotech companies. Amsterdam: Elsevier. Academic Press is an imprint of	

	Elsevier.
2	Onetti, A., & Zucchella, A. (n.d.). Business modeling for life science and biotech companies: Creating value and competitive advantage with the milestone bridge. Routledge.
3	The Earthworm book, Ismail, S.A., other India Press, Goa
4	An Introduction to sericulture by G. Ganga, J. Sulochana Chetty.
5	Silk: Processing, Properties and Applications Book by K. Murugesh Babu
<b>Reference Books</b>	
1	Adams, D. J., & Sparrow, J. C. Enterprise for life scientists: Developing innovation and entrepreneurship in the biosciences. Bloxham: Scion.
2	Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
3	Desai, V. The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.
4	The Essential Guide to Cultivating Mushrooms: Simple and Advanced Techniques for Growing Shiitake, Oyster, Lion's Mane, and Maitake Mushrooms at Home by Stephen Russell
5	Neutraceuticals spirulina: Commercial cultivation using rural technology in india by Pushpa Srivastava
<b>Web Resources</b>	
1	<a href="https://archive.india.gov.in/citizen/agriculture">https://archive.india.gov.in/citizen/agriculture</a>
2	<a href="http://www.recirculatingfarms.org/resources/">http://www.recirculatingfarms.org/resources/</a>
3	<a href="https://academy.vertical-farming.net/intro-to-mushroom-growing/">https://academy.vertical-farming.net/intro-to-mushroom-growing/</a>

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
<b>CLO1</b>	3	3	2	3	2	2	3	3	3
<b>CLO2</b>	3	2	2	3	2	2	3	3	3
<b>CLO3</b>	3	2	2	2	2	3	3	3	3
<b>CLO4</b>	3	2	2	2	2	3	3	3	3
<b>CLO5</b>	3	2	2	2	2	3	3	3	3
<b>TOTAL</b>	15	13	10	14	10	13	15	15	15
<b>Average</b>	3	2.6	2	2.8	2	2.6	3	3	3

**Core Paper IX - PHARMACEUTICAL BIOTECHNOLOGY**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT608	4	1			4	6	25	75	100

<b>Learning Objective</b>		
LO1	Students will understand the series of processes involved in drug development, patenting and drug approval.	
LO2	Will learn about Biopharmaceuticals	
LO3	Will become familiar with Biotech protein drugs	
LO4	Will understand about management of drugs	
LO5	Will be familiar with Pharmaceutical sectors	
<b>UNIT</b>	<b>Contents</b>	<b>No.of Hours</b>
I	Objectives of Pharmaceutical Biotechnology - Generic and Biogeneric drugs. Stages in the drug development process -Drug discovery - Drug designing - Drug production - Preclinical trials - Clinical trials - Pharmacokinetics and Pharmacodynamics - Patenting & Drug Approval - Drug Marketing - Post clinical trials.	<b>15</b>
II	Production of recombinant proteins - Development of Nucleic acid based therapies - Biopharmaceutical considerations - Pharmaceutical regulations - Formulation of Biotechnology products - Drug delivery - Pharmacognosy .	<b>15</b>
III	Human Insulin (Humulin), Growth hormones (Humatrope) - Blood coagulating factor (factor VIII - Kogenate) - Erythropoietin - (Epogen) Granulocyte colony stimulating factors (Neulasta) - Interferons (Avonex) - Antimicrobial peptides ( $\beta$ - defensin 2) - Vaccines (Pentavac), Biologics (Humira - Adalimumab), - Cancer based biologics (rituximab).	<b>15</b>
IV	Drug toxicity analysis - Common side effects of drugs and managements - Drugs of abuse - Life changing complications - Prevention and management	<b>15</b>
V	National and International Drug approval agencies - Top National and International pharmaceutical industries - Scope and career opportunities in pharmaceutical sectors.	<b>15</b>
<b>Total</b>		<b>75</b>
<b>Text Books</b>		

1	ChandrakantKokate and Pramod H.J 1 <sup>st</sup> Edition (2011), Text Book of Pharmaceutical Biotechnology, Elsevier
2	Crommelin, Dean J. A., Sindelar, Robert, Meobohm, Bernd (Eds.) (2019), Pharmaceutical Biotechnology: Fundamentals and Applications, Springer.
3	Ashish Dixit, Pawan Tiwari and VivekanandKishanChatap (2015), Textbook of Pharmaceutical Biotechnology, Studium Press (India) Pvt. Ltd.
4	John F. Corpenter, Mark C. Manning (2012). <i>Rational Design of stable formulation Theory and Practice</i> , (1st edition), US: Springer Science, ISBN: 9781461351313.
<b>Reference Books</b>	
1	Gary Walsh (2003), Biopharmaceuticals ; biochemistry and Biotechnology, John Wiley & Sons Ltd.
2	Oliver Kayser and HeribertWarzecha (2012), Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, Wiley - Blackwell.
3	Simon Wills, 2 <sup>nd</sup> Edition (2005), Drugs of abuse, Pharmaceutical Press
4	Hiten J. Gutka, Harry Yang, ShefaliKakar (2018). <i>Biosimilars: Regulatory, Clinical, and Biopharmaceutical Development</i> , (1st ed), USA: Springer, ISBN: 978-3-319-99679-0.
5	Yui-Wing F. L. and Stuart S. (2019). <i>Pharmacogenomics: Challenges and Opportunities in Therapeutic Implementation</i> , (2nd Ed), TX, USA: Academic Press,ISBN: 9780128126264.
<b>Web Resources</b>	
1	<a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5178364/">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5178364/</a>
2	<a href="https://www.patentdocs.org/biotech_news/">https://www.patentdocs.org/biotech_news/</a>
3	<a href="https://www.pharmamanufacturing.com/">https://www.pharmamanufacturing.com/</a>
4	<a href="https://www.parexel.com/">https://www.parexel.com/</a>
5	<a href="https://nptel.ac.in/courses/102/103/102103013/">https://nptel.ac.in/courses/102/103/102103013/</a>

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC  
OUTCOME**



	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
<b>CLO1</b>	3	3	3	3	3	3	3	3	3
<b>CLO2</b>	3	3	3	3	3	3	3	3	3
<b>CLO3</b>	3	3	3	3	3	3	3	3	3
<b>CLO4</b>	3	3	3	3	3	3	3	3	3
<b>CLO5</b>	3	3	3	3	3	3	3	3	3
<b>TOTAL</b>	15	15	15	15	15	15	15	15	15
<b>Average</b>	3	3	3	3	3	3	3	3	3

**CORE PRACTICAL VI - ENVIRONMENTAL AND INDUSTRIAL BIOTECHNOLOGY  
LAB**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT6P6	-	-	4	-	4	6	40	60	100

<b>Learning Objective</b>		
LO1	Students can able to isolate the microorganisms and determine their growth curve, generation time.	
LO2	To analyze the water samples, perform immobilization and production of Wine, Biogas and compost.	
LO3	Develop skills in bio fertilizer production and microbial identification.	
LO4	Gain basic skills to analyze raw milk and determine the pasteurization efficacy.	
LO5	Develop skills to perform efficiency tests of biofertilizers and biopesticides, microbial polysaccharide production.	
<b>UNIT</b>	<b>Contents</b>	<b>No.of Hours</b>
I	Isolation of Air borne Pathogens Study of Growth Curve and Generation time of Bacteria/ Yeast using turbidometry.	9
II	Water analysis – MPN and BOD. Immobilization of whole yeast cells/ enzyme by Alginate beads. Production of wine Production of Biogas – <i>In vitro</i> & Compost Making.	9
III	Biofertilizer production/Spirulina production - field visit. (Report should be included in the record) Isolation and identification of starter organisms from Idli batter/ curd	9
IV	Grading of raw milk (Dye reduction test). Determination of efficiency of Pasteurization by quantitative phosphatase test.	9
V	Preparation and Efficiency testing of Biofertilizer/ Biopesticide. (Demo) Production of microbial Polysaccharide. (Demo)	9
<b>Total</b>		45
<b>Text Books</b>		

1	Aneja K R, <i>Laboratory Manual of Microbiology and Biotechnology</i> , MEDTECH, 2014.ISBN-13 : 978-9381714553
2	Vijaya Ramesh, (2007), <i>Food Microbiology</i> , MJP Publishers, Chennai, ISBN-13 : 978-8180940194
<b>Reference Books</b>	
1	Raghuramulu, N., Madhavan Nair, K., and Kalyanasundaram, S. Ed., (1983), <i>A Manual of Laboratory Techniques</i> , National Institute of Nutrition, ICMR, Hyderabad.
<b>Web Resources</b>	
1	<a href="https://www.youtube.com/watch?v=3UafRz3QeO8">https://www.youtube.com/watch?v=3UafRz3QeO8</a>
2	<a href="https://www.youtube.com/watch?v=jpuNYpvBmDM">https://www.youtube.com/watch?v=jpuNYpvBmDM</a>
3	<a href="https://www.youtube.com/watch?v=tUCfkNKyQyc">https://www.youtube.com/watch?v=tUCfkNKyQyc</a>

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME**

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
<b>CLO1</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>

<b>CLO2</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO4</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO5</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>TOTAL</b>	<b>15</b>	<b>10</b>	<b>15</b>	<b>8</b>	<b>10</b>	<b>10</b>	<b>15</b>	<b>15</b>	<b>15</b>
<b>Average</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>1,6</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>

### Elective III -MEDICAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT6:A	3	1			3	5	25	75	100
<b>Learning Objective</b>									
LO1	Student will be able to obtain knowledge on Vaccines, Antibody therapy and diagnostics								
LO2	Will know the Molecular basis of diseases								
LO3	Will know about cytokines and interferons								
LO4	Will learn about clinical trials								
LO5	Will learn about ethics in clinical trials								
UNIT	Contents								No. of Hours
I	Antibodies and vaccines - Therapeutic production of antibodies, antibody mediated drug delivery of vaccines, different kind of vaccines and applications of recombinant vaccines. Diagnosis - Biochemical diagnostics, inborn errors of metabolism, haemoglobinopathies.								15
II	Molecular basis of disease, Recombinant DNA Technology in medicine, gene probes as molecular diagnostic reagents. Polymerase Chain Reaction in clinical diagnostics, DNA sequencing of representative clones to detect mutations.								15
III	Diagnosis of infectious diseases, Viral diseases – HIV, influenza; bacterial diseases - enteric diseases, mycobacterium diseases; immune arrays. FACs immunocytochemical staining, ELISA, FISH techniques.								15
IV	Immunoblot analysis of antigens and allergens. Production of therapeutic agents – Productions and application of therapeutic agents, Production of cytokines and interferons.								15

V	Principles of project management in Clinical trials and its application. Principles of research ethics; Ethical issues in clinical trials; Animal rights and use of animals in the advancement of medical technology. Use of humans in Scientific Experiments; Introduction to ethical codes and conduct.	15
<b>Total</b>		75
<b>Text Books</b>		
1	Roli, M. (2017). <i>National Ethical Guidelines for Biomedical and Health Research Involving Human Participants</i> , ISBN: 978-81-910091-94	
2	Lela, B. and Maribeth, L. F. (2011). <i>Molecular Diagnostics: Fundamentals, Methods and Clinical Applications</i> , (1st Edition) . Philadelphia, USA. F A Davis Company. ISBN-13: 978-0803626775	
3	<i>Clinical Applications</i> , (1st Edition) . Philadelphia, USA. F A Davis Company. ISBN-13: 978-0803626775	
<b>Reference Books</b>		
1	Bernard, R. G. Terry, L.D. and Cheryl, L.P. (2014). <i>Medical Biotechnology</i> , (2 <sup>nd</sup> edition).	
2	Patrick, R.M. Kenneth, S.R. and Michael, A.P. (2016). <i>Medical Microbiology</i> , (8 <sup>th</sup> edition). USA. Elsevier Publishers, eBook ISBN: 9780323388504	
3	Pamela, G. Michelle, M, (2009). <i>Molecular Therapeutics: 21st century medicine</i> , (1st Edition). Hoboken, New Jersey. Wiley Publishers.	
<b>Web Resources</b>		
1	<a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2881260/">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2881260/</a>	
2	<a href="https://www.nature.com/articles/s41577-021-00542-x">https://www.nature.com/articles/s41577-021-00542-x</a>	
3	<a href="https://www.ncbi.nlm.nih.gov/books/NBK26837/">https://www.ncbi.nlm.nih.gov/books/NBK26837/</a>	
4	<a href="https://www.sciencedirect.com/topics/medicine-and-dentistry/dna-sequencing">https://www.sciencedirect.com/topics/medicine-and-dentistry/dna-sequencing</a>	
5	<a href="http://aquafind.com/articles/Elisa.php">http://aquafind.com/articles/Elisa.php</a>	

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC  
OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO4</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO5</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>
<b>Average</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

### Elective III- FORENSIC SCIENCE

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT6:B	3	1			3	5	25	75	100
<b>Learning Objective</b>									
LO1	Students will gain insight into Forensic Biotechnology.								
LO2	Will know about various investigations protocol								
LO3	Will know about blood related issues								
LO4	Will know the use of molecular approaches to investigation								
LO5	Will understand DNA fingerprinting								
UNIT	Contents								No.of Hours
I	Definition and scope of Forensic Biotechnology, History and development, Forensic genetics, Forensic agriculture.								15
II	Crime scene investigation; collection, preservation, packing and forwarding of physical and trace evidence. Questioned documents – identification of handwriting, signature and detection of forgery.								15
III	Serology - Fresh blood grouping and typing, stains of bloods. Identification of blood stains, collection and storage of allied body fluids (semen, saliva and blood). Case studies.								15
IV	PCR, RFLP, AFLP, Microscopy (Electron, Fluorescent) and Chromatography (Paper, TLC & HPLC) in forensic investigation.								15
V	DNA Profiling, Isolation of DNA from blood samples, DNA testing in cases of disputed paternity and maternity.								15
<b>Total</b>								<b>75</b>	
<b>Text Books</b>									



1	Nageshkumar G Rao, Textbook of Forensic Medicine & Toxicology, Jaypee, 2013.
2	K.S. Narayan reddy and O.P. Murty, The Essentials of Forensic Medicine & Toxicology, 35th Edition, Jaypee, 2017.
3	Nanda, B.B. and Tiwari R. K. (2014). Forensic Science in India: A Vision for the Twenty First Century, (2 <sup>nd</sup> edition), Select Publishers, New Delhi, ISBN: 9788190113526.
4	Barbara H. Stuart(2013). Forensic Analytical Techniques (Analytical Techniques in the Sciences (AnTs), (1 <sup>st</sup> edition), UK, Wiley, ISBN: 978-0-470-68727-7.
5	C. Champod, C. Lennard, C. Margot, P. and Stoilovic (2015). Fingerprints and other Ridge Skin Impressions, (7 <sup>th</sup> edition), Boca Raton, CRC Press, ISBN: 9781498728959.
<b>Reference Books</b>	
1	Jim Fraser, " Forensic Science: A very short introduction", Oxford university press, 2010.
2	William Goodwin, Adrian Linacre, SibteHadi, "An introduction to Forensic Genetics", John Wiley & Sons Ltd 2007.
3	Harralson H. and Miller S. (2017). <i>Huber and Headrick's Handwriting Identification: Facts and Fundamentals</i> , (2nd Edition), Boca Raton, CRC Press, ISBN: 9781498751308.
4	Ghosal S. and Avasthi A.S. (2018). <i>Fundamentals of Bioanalytical Techniques and Instrumentation</i> , (2nd Edition), Delhi, PHI, ISBN: 9789387472396.
<b>Web Resources</b>	
1	<a href="http://www.forensicssciencesimplified.org">http://www.forensicssciencesimplified.org</a>
2	<a href="http://www.nfstc.org">www.nfstc.org</a>
3	<a href="https://archive.org/details/FBI_Handbook_of_ForensicScience">https://archive.org/details/FBI_Handbook_of_ForensicScience</a>
4	<a href="https://www.soinc.org/forensics-notes">https://www.soinc.org/forensics-notes</a>

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC  
OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO4</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CLO5</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>
<b>Average</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

### Elective IV- BIOETHICS & BIOSAFETY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT6:C	3	1			3	5	25	75	100
<b>Learning Objective</b>									
LO1	The students will understand the concepts of Bioethics and Biosafety.								
LO2	The students will realize the impact of Gene cloning in societal problems and also understand the need of the Bioethics.								
LO3	The students will know about the importance of Ethical Clearance.								
LO4	The students will get knowledge about Patents Rights in the field of Research.								
LO5	The students will know about Biosafety and GLP.								
UNIT	Contents								No. of Hours
I	Human Rights: Definition, Classification and Scope of Human Rights. United Nations Commission for Human Rights, National and State Human Rights Commission. Article 21 of Indian Constitution – UDHR. Social issues of Human rights.								15
II	Impact of gene cloning & Bioethics-Issues concerning reproduction, Birth, life and Death (Artificial insemination, egg donation, IVF, embryo transplants, Prenatal diagnosis and sex selection & Abortion).								15
III	Bioethics of IPR - ethical criteria in biotechnology- animal ethics; Licensing of animal house - Human cloning - Ethical issues - Ethical clearance norms for conducting studies on human subjects.								15
IV	Patents - Introduction -Treaties and Conventions of Patents, Patent Cooperation Treaty - TRIPS Basis of Patentability – Non Patentable Inventions - Patent Application Procedure in India. Other Forms of IP: Copyright - Trade Mark – Industrial designs – Farmer’s Rights. Patenting of Biotechnology products and								15

	processes.	
V	Biosafety - General guidelines - DBT guidelines on biosafety in conducting research in biology / biotechnology - Risk assessment studies- Hazardous materials used in Biotechnology- Handling and Disposal - Good manufacturing practices & Good Laboratory practices, Containment facilities and Biosafety practices - Regulation on field experiments and release of GMO's - Labelling of GM foods - Guidelines for research in transgenic plants and Animals.	15
<b>Total</b>		75
<b>Text Books</b>		
1	Ignacimuthu, S (2009), <i>Bioethics</i> , Narosa Publication house, ISBN: 978-81-7319-966-0	
2	V. Sree Krishna . V (2007), <i>Bioethics and Biosafety in Biotechnology</i> , (1st ed.), New Age International Private Limited.	
3	Rhona Smith. (2003), <i>International Human rights</i> , Blackstone Press.	
4	Manual of patent practice and procedure. IPR India, 2005.	
5	Ministry of commerce and industry, New Delhi, pp.163.	
<b>Reference Books</b>		
1	Trayer, P.C, Fredrick.R., and Koch, M. (2002), <i>Biosafety</i> . Michigan State University	
2	Biosafety, Traylor, Fredric & Koch, 2002. Michigan state University pub., USA.	
3	Contemporary issues in Bioethics, Beauchamp & Leroy, 1999. Wardsworth Pub. Co. Belmont, California.	
4	Biotechnology and safety assessment, John.A.Thomas, 2004. pp.333	
<b>Web Resources</b>		
1	<a href="http://www.ipr-helpdesk.org/">www.ipr-helpdesk.org/</a>	

2	<a href="http://www.patentoffice.nic.in/ipr/patent/patents.htm">www.patentoffice.nic.in/ipr/patent/patents.htm</a>
3	<a href="http://www.bangalorebio.com/GovtInfo/ipr.htm">www.bangalorebio.com/GovtInfo/ipr.htm</a>

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC  
OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	3	3	3	3	3	3	3	3	3
<b>CLO2</b>	3	3	3	3	3	3	3	3	3
<b>CLO3</b>	3	3	3	3	3	3	3	3	3
<b>CLO4</b>	3	3	3	3	3	3	3	3	3
<b>CLO5</b>	3	3	3	3	3	3	3	3	3
<b>TOTAL</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>
<b>AVERAGE</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

### ELECTIVE IV- AQUACULTURE

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
U23BT6:D	3	1			3	5	25	75	100
<b>Learning Objective</b>									
LO1	To be able to understand aquaculture systems conditioning factors, fish feeding behaviour and breeding and rearing techniques.								
LO2	To gain knowledge on Culture of marine prawns, edible and pearl oysters, adaptive management								
LO3	To learn about the consequences of artificial feeding; Natural, supplementary and artificial breeding								
LO4	To gain knowledge on the diseases and pest control and management systems in aquaculture								
LO5	To enhance the importance of aquaculture in small scale and large scale industries.								
UNIT	Contents								No. of Hours
I	Aquaculture-Global scenario, Origins and growth of aquaculture, Present status in India and Tamil Nadu; Fish pond construction- site selection; types of ponds, water quality analyses, liming and fertilization, morphology and commercial characteristics of cultivable fishes, culture practice, predator fishes, weed fishes control, Sources of pollution, Environmental impacts.								15
II	Fin fish culture - Composite fish culture (Indian Major Carps and Murrels); Sewage fed fish culture and integrated fish culture, Marine water fish culture. Shellfish and								15

	seaweed culture - Culture of marine prawns, edible and pearl oysters, adaptive management; Seaweeds- types and their culture practices.	
III	Live feed organisms – Artemia and rotifers culture; Fish feed - types, formulation and preparation, techniques, Consequences of artificial feeding; Natural, supplementary and artificial breeding; Breeding – Bundh breeding and induced breeding; rearing of hatchlings, fry and fingerlings.	15
IV	Fungus infections. Protozoan diseases. Worm diseases. Non parasitic diseases. Transport of fish seed and Brood fish. Causes of mortality in transport. Methods for packaging and transport. Use of chemicals in live fish transport. Anesthetic drugs. Antiseptics and Antibiotics.	15
V	Applied aquaculture: Identification of cultivable fish species; Morphometry of pond (Enclosed rectangular method/Shore length/ shore area and shore line development).Fishing technology (crafts and gears). Home aquarium and agency involved in aquaculture.	15
<b>Total</b>		<b>75</b>

#### Reference Books

1. Biswas, K. P. 2000. Prevention and control of fish and prawn diseases. Narendra publishing house, New Delhi.
2. Hute, M. and Kahn, H. (2000) Textbook of fish culture, Blackwell Scientific Publication, Australia.
3. Ninawe, A. S and Khadkar, G. D. 2009. Nutrition in Aquaculture, First Edition, Narendra publishing House, New Delhi.
4. Jameson, J.D. and Santhanam. R. 1996, Manual of ornamental fishes and farming, Technologies Peejay, Thoothukkudi.
5. Jhingran, V.G. 1997. Fish and Fisheries of India. Hindustan Publishers, New Delhi.
6. Srinivasulu, M., Reddy, K.R.S., Rao, S. (1999) Text book of Aquaculture, Discovery Publishing House New Delhi

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC  
OUTCOME**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CLO1</b>	3	3	3	3	3	3	3	3	3
<b>CLO2</b>	3	3	3	3	3	3	3	3	3
<b>CLO3</b>	3	3	3	3	3	3	3	3	3
<b>CLO4</b>	3	3	3	3	3	3	3	3	3
<b>CLO5</b>	3	3	3	3	3	3	3	3	3
<b>TOTAL</b>	15	15	15	15	15	15	15	15	15
<b>AVERAGE</b>	3	3	3	3	3	3	3	3	3