U16

THIRUVALLUVAR UNIVERSITY

SERKKADU, VELLORE–632115

B.Sc. BIO TECHNOLOGY

SYLLABUS

FROM THE ACADEMIC YEAR

2023 – 2024

CHOICE BASED CREDIT SYSTEM AND LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK - B.Sc. Biotechnology	
Programme:	**B.Sc.** Biotechnology
Programme Code:	
Duration:	**3 Years (UG)**
Programme Outcomes:	**PO1: Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study **PO2: Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups. **PO3: Critical thinking:** Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. **PO4: Problem solving: Capacity** to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations. **PO5: Analytical reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints. **PO6: Research-related skills**: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation **PO7: Cooperation/Team work:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team **PO8: Scientific reasoning**: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective. **PO9: Reflective thinking**: Critical sensibility to lived experiences, with self awareness and reflexivity of both self and society. **PO10 Information/digital literacy:** Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data. **PO 11 Self-directed learning**: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion. **PO 12 Multicultural competence:** Possess knowledge of the values and beliefs

	of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups. **PO 13: Moral and ethical awareness/reasoning**: Ability toembrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstratingthe ability to identify ethical issues related to one‟s work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work. **PO 14: Leadership readiness/qualities:** Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way. **PO 15: Lifelong learning:** Ability to acquire knowledge and skills, including „learning how to learn‟, that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.
Programme Specific Outcomes:	On successful completion of Bachelor of Biotechnology programme, the student should be able to: **PSO1: Disciplinary Knowledge:** Understand the fundamental principles, concepts, and theories related to Biotechnology. Also, exhibit proficiency in performing experiments in the laboratory. **PSO2: Critical Thinking:** Analyse complex problems, evaluate information, synthesize information, apply theoretical concepts to practical situations, identify assumptions and biases, make informed decisions and communicate effectively **PSO3: Problem Solving:** Employ theoretical concepts and critical reasoning ability with biological and technical skills to solve problems, acquire data, analyze their biological significance and explore new design possibilities. **PSO4: Analytical & Scientific Reasoning:** Apply scientific methods, collect and analyse data, test hypotheses, evaluate evidence, apply statistical techniques and use computational models. **PSO5: Research related skills:** Formulate research questions, conduct literature reviews, design and execute research studies, communicate research findings and collaborate in research projects. **PSO6: Self-directed & Lifelong Learning:** Set learning goals, manage their own learning, reflect on their learning, adapt to new contexts, seek out new knowledge, collaborate with others and to continuously improve their skills and knowledge, through ongoing learning and professional development, and contribute to the growth and development of their field.

PO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
PO1	✓					
PO2		✓				
PO3			✓			
PO4				✓		
PO5					✓	
PO6						✓

2. Highlights of the Revamped Curriculum:

- Student-centric, meeting the demands of industry & society, incorporating industrial components, hands-on training, skill enhancement modules, industrial project, project with viva-voce, exposure to entrepreneurial skills, training for competitive examinations, sustaining the quality of the core components and incorporating application oriented content wherever required.
- The Core subjects include latest developments in the education and scientific front, advanced programming packages allied with the discipline topics, practical training, devising statistical models and algorithms for providing solutions to industry / real life situations. The curriculum also facilitates peer learning with advanced statistical topics in the final semester, catering to the needs of stakeholders with research aptitude.
- The General Studies and Statistics based problem solving skills are included as mandatory components in the 'Training for Competitive Examinations' course at the final semester, a first of its kind.
- The curriculum is designed so as to strengthen the Industry-Academia interface and provide more job opportunities for the students.
- The Statistical Quality Control course is included to expose the students to real life problems and train the students on designing a mathematical model to provide solutions to the industrial problems.
- The Internship during the second year vacation will help the students gain valuable work experience, that connects classroom knowledge to real world experience and to narrow down and focus on the career path.
- Project with viva-voce component in the fifth semester enables the student, application of conceptual knowledge to practical situations. The state of art technologies in conducting a Explain in a scientific and systematic way and arriving at a precise solution is ensured. Such innovative provisions of the industrial training, project and internships will give students an edge over the counterparts in the job market.
- State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature are incorporated as Elective courses, covering conventional topics to the latest DBMS and Computer software for Analytics.

Value additions in the Revamped Curriculum:

Semester	Newly introduced Components	Outcome / Benefits
I	**Foundation Course** To ease the transition of learning from higher secondary to higher education, providing an overview of the pedagogy of learning abstract Statistics and simulating mathematical concepts to real world.	• Instil confidence among students • Create interest for the subject
I, II, III, IV	**Skill Enhancement papers** (Discipline centric / Generic / Entrepreneurial)	• Industry ready graduates • Skilled human resource • Students are equipped with essential skills to make them employable
		• Training on Computing / Computational skills enable the students gain knowledge and exposure on latest computational aspects
		• Data analytical skills will enable students gain internships, apprenticeships, field work involving data collection, compilation, analysis etc.
		• Entrepreneurial skill training will provide an opportunity for independent livelihood • Generates self – employment • Create small scale entrepreneurs • Training to girls leads to women empowerment
		• Discipline centric skill will improve the Technical knowhow of solving real life problems using ICT tools
III, IV, V & VI	Elective papers- An open choice of topics categorized under Generic and Discipline Centric	• Strengthening the domain knowledge • Introducing the stakeholders to the State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature • Students are exposed to Latest topics on Computer Science / IT, that require strong statistical background • Emerging topics in higher education / industry / communication network / health sector etc. are introduced with hands-on-training, facilitates designing of statistical models in the respective sectors
IV	DBMS and Programming skill, Biostatistics, Statistical Quality Control, Official Statistics, Operations Research	• Exposure to industry moulds students into solution providers • Generates Industry ready graduates • Employment opportunities enhanced
V	Internship / Industrial	• Practical training at the Industry/ Banking Sector /

semester Vacation activity	Training	Private/ Public sector organizations / Educational institutions, enable the students gain professional experience and also become responsible citizens.
VI Semester	Project with Viva – voce	• Self-learning is enhanced • Application of the concept to real situation is conceived resulting in tangible outcome
	Introduction of Professional Competency component	• Curriculum design accommodates all category of learners; 'Statistics for Advanced Explain' component will comprise of advanced topics in Statistics and allied fields, for those in the peer group / aspiring researchers; • 'Training for Competitive Examinations' –caters to the needs of the aspirants towards most sought - after services of the nation viz, UPSC, ISS, CDS, NDA, Banking Services, CAT, TNPSC group services, etc.
Extra Credits: For Advanced Learners / Honors degree		• To cater to the needs of peer learners / research aspirants
Skills acquired from the Courses	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	

Credit Distribution for UG Programmes

Sem I	C	H	Sem II	C	H	Sem III	C	H	Sem IV	Credit	H	Sem V	C	H	Sem VI	C	H
Part 1. Language – Tamil	3	6	Part.1. Language – Tamil	3	6	Part..1. Language – Tamil	3	6	Part.1. Language – Tamil	3	6	5.1 Core Course –CC IX	4	5	6.1 Core Course – CC XIII	4	6
Part.2 English	3	6	Part.2 English	3	6	Part.2 English	3	6	Part..2 English	3	6	5.2 Core Course – CC X	4	5	6.2 Core Course – CC XIV	4	6
1.3 Core Course – CC I	5	6	2..3 Core Course – CC III	5	5	3.3 Core Course – CC V	5	5	4.3 Core Course – CC VII Core Industry Module	5	5	5. 3.Core Course CC -XI	4	5	6.3 Core Course – CC XV	4	6
1.4 Core Course – CC II	5	5	2.4 Core Course – CC IV	5	5	3.4 Core Course – CC VI	5	5	4.4 Core Course – CC VIII	5	5	5. 4.Core Course –/ Project with viva-voce CC -XII	4	5	6.4 Elective -VII Generic/ Discipline Specific	3	5
1.5 Elective I Generic/ Discipline Specific	3	5	2.5 Elective II Generic/ Discipline Specific	3	6	3.5 Elective III Generic/ Discipline Specific	3	5	4.5 Elective IV Generic/ Discipline Specific	3	6	5.5 Elective V Generic/ Discipline Specific	3	4	6.5 Elective VIII Generic/ Discipline Specific	3	5
1.6 Skill Enhancement Course SEC-1	2	2	2.6 Skill Enhancement Course SEC-2	2	2	3.6 Skill Enhancement Course SEC-4, (Entrepreneurial Skill)	1	1	4.6 Skill Enhancement Course SEC-6	2	2	5.6 Elective VI Generic/ Discipline Specific	3	4	6.6 Extension Activity	1	-
1.7 Skill Enhancement - (Foundation Course)	2	2	2.7 Skill Enhancement Course SEC-3	2	2	3.7 Skill Enhancement Course SEC-5	2	2	4.7 Skill Enhancement Course SEC-7	2	2	5.7 Value Education	2	2	6.7 Professional Competency Skill	2	2
						3.8 E.V.S.	2	2				5.8 Summer Internship /Industrial Training	2	-			
	23	**32**		**23**	**32**		**24**	**32**		**23**	**32**		**26**	**30**		**21**	**30**
Total – 140 Credits																	

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF)
Guideline Based Credit and Hours Distribution System
for all UG courses including Lab Hours

First Year – Semester-I

Part	List of Courses	Credit	No. of Hours
Part-1	Language – Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses [in Total]	13	16
Part-4	Skill Enhancement Course SEC-1	2	2
	Foundation Course	2	2
		23	**32**

Semester-II

Part	List of Courses	Credit	No. of Hours
Part-1	Language – Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses including laboratory [in Total]	13	16
Part-4	Skill Enhancement Course -SEC-2	2	2
	Skill Enhancement Course -SEC-3 (Discipline / Subject Specific)	2	2
		23	**32**

Second Year – Semester-III

Part	List of Courses	Credit	No. of Hours
Part-1	Language - Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses including laboratory [in Total]	13	15
Part-4	Skill Enhancement Course -SEC-4 (Entrepreneurial Based)	1	1
	Skill Enhancement Course -SEC-5 (Discipline / Subject Specific)	2	2
	E.V.S	2	2
		24	**32**

Semester-IV

Part	List of Courses	Credit	No. of Hours
Part-1	Language - Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses including laboratory [in Total]	13	16
Part-4	Skill Enhancement Course -SEC-6 (Discipline / Subject Specific)	2	2
	Skill Enhancement Course -SEC-7 (Discipline / Subject Specific)	2	2
		23	**32**

Third Year

Semester-V

Part	List of Courses	Credit	No. of Hours
Part-3	Core Courses including including Project/ Elective Based	22	26
Part-4	Value Education	2	2
	Internship / Industrial Visit / Field Visit	2	2
		26	**30**

Semester-VI

Part	List of Courses	Credit	No. of Hours
Part-3	Core Courses / Elective Based & LAB	18	28
Part-4	Extension Activity	1	-
	Professional Competency Skill	2	2
		21	**30**

Consolidated Semester wise and Component wise Credit distribution

Parts	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Total Credits
Part I	3	3	3	3	-	-	12
Part II	3	3	3	3	-	-	12
Part III	13	13	13	13	22	18	92
Part IV	4	4	5	4	4	1	22
Part V	-	-	-	-	-	2	2
Total	23	23	24	23	26	21	**140**

***Part I. II, and Part III components will be separately taken into account for CGPA calculation and classification for the under graduate programme and the other components. IV, V have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the UG degree.**

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate	
	between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

FIRST SEMESTER

Course Content	Name of the Course	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part – I	Language- Tamil Paper – I	6	3	25	75	100
Part - II	English Paper – I	6	3	25	75	100
Part III	Core Course I - Cell and Molecular Developmental Biology	6	5	25	75	100
	Core Course II - Cell and Molecular Developmental Biology - Practical	5	5	25	75	100
	Elective I - Biological Chemistry	3	2	25	75	100
	Elective I - Biological Chemistry - Practical	2	1	25	75	100
Part IV	SEC-1 *Public Health & Hygiene	2	2	25	75	100
	SEC- Foundation Course	2	2	25	75	100
		32	**23**			

* **Non major elective: Choose any one from the other department**

SECOND SEMESTER

Course Content	Name of the Course	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part – I	Language- Tamil – II	6	3	25	75	100
Part - II	English Paper – II	6	3	25	75	100
Part - III	Core course III - Genetics	5	5	25	75	100
	Core Course IV - Genetics - practical	5	5	25	75	100
	Elective II - Fundamentals of Microbiology	4	2	25	75	100
	Elective II - Fundamentals of Microbiology - Practical	2	1	25	75	100
Part IV	*SEC-2 - Organic Farming and Health Management	2	2	25	75	100
	SEC-3 - Vermitechnology	2	2	25	75	100
		32	**23**			

*** Non major elective: Choose any one from the other department**

THIRD SEMESTER

Course Content	Name of the Course	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part – I	Language- Tamil III	6	3	25	75	100
Part - II	English Paper – III	6	3	25	75	100
Part - III	CC V - Immunology and Immunotechnology	5	5	25	75	100
	CC VI - Immunology and Immunotechnology - Practical	5	5	25	75	100
	Elective III - Bioinstrumentation	3	2	25	75	100
	Elective III – Bioinstrumentation Practical	2	1	25	75	100
PART IV	SEC-4 - Herbal Medicine	1	1	25	75	100
	SEC-5 – Mushroom Cultivation	2	2	25	75	100
	• Environmental Studies	2	2	-	-	-
		32	**24**			

- **Examination will be held in IV Semester**

FOURTH SEMESTER

Course Content	Name of the Course	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part – I	Language- Tamil – IV	6	3	25	75	100
Part - II	English Paper – IV	6	3	25	75	100
Part - III	CC VII - Genetic Engineering and rDNA Technology	5	5	25	75	100
	CC VIII - Genetic Engineering and rDNA Technology - Practical	5	5	25	75	100
	Elective IV - Bioinformatics and Biostatistics	4	2	25	75	100
	Elective IV - Bioinformatics and Biostatistics – Practical	2	1	25	75	100
Part-IV	SEC-6 - Food and Nutrition	2	2	25	75	100
	SEC-7 – Aquaculture	2	2	25	75	100
	Environmental Studies	–	–	25	75	100
		32	**23**			

FIFTH SEMESTER

Course Content	Name of the Course	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part - III	CC IX - Plant Biotechnology	5	4	25	75	100
	CC X - Animal Biotechnology	5	4	25	75	100
	CC XI - Environmental and Industrial Biotechnology	5	4	25	75	100
	CC XII- Project with viva- voce	5	4	25	75	100
	Elective V - Nano Biotechnology / Enzymology / Bioethics and Biosafety / Cancer Biology	4	3	25	75	100
	Elective VI - Plant Biotechnology and Animal Biotechnology – Practical	4	3	25	75	100
Part- IV	■ Summer Internship /Industrial Training	-	2	-	-	-
	Value Education	2	2	25	75	100
		30	**26**			

* Choose any one Elective; ■Students undergo summer vacation after IV Semester for 2 weeks.

SIXTH SEMESTER

Course Content	Name of the Course	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part-III	CC XIII – Bioentrepreneurship	6	4	25	75	100
	CC XIV – Pharmaceutical Biotechnology	6	4	25	75	100
	CC XV - Environmental and Industrial Biotechnology - Practical	6	4	25	75	100
	* Elective -VII - Marine Biotechnology / Food Technology	5	3	25	75	100
	* 5 Elective VIII - Medical Biotechnology / Forensic science / Good Laboratory Practices	5	3	25	75	100
Part IV	Preparation for Competitive Exam	2	2	25	75	100
Part V	Extension Activities	0	1			
		30	**21**			

Remarks: English Soft Skill Two Hours Will be handled by English Teachers (4+2 = 6 hours for English).

MANDATORY SUBJECTS

1) Cell and Molecular Developmental Biology
2) Biological Chemistry
3) Genetics
4) Fundamentals of Microbiology
5) Immunology and Immunotechnology
6) Bioinstrumentation
7) Genetic Engineering and r-DNA Technology
8) Bioinformatics and Biostatistics
9) Plant Biotechnology
10) Animal Biotechnology
11) Environmental and Industrial Biotechnology
12) Nano Biotechnology
13) Enzymology
14) Bioethics and Biosafety
15) Cancer Biology
16) Bio entrepreneurship
17) Pharmaceutical Biotechnology
18) Marine Biotechnology
19) Food Technology
20) Forensic science
21) Good Laboratory Practices

FIRST YEAR - SEMESTER – I

CORE COURSE- I: CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			5	6	25	75	100

Learning Objective: On successful completion of the course, students will be able to

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).	15
II	Biomacromolecules and Biomicromolecules (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.	20
IV	Cell cycle - Cell cycle checkpoints - Cell division - Mitosis and Meiosis - Cellular differentiation - Cell junctions - Cell Adhesion – Extra Cellular Matrix - Cell to cell communications.	20
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
Total		**90**

Text Books

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, 11th edition. Sinauer Associates Inc. Publishers, MA. USA.
4	Bruce Alberts, 6th 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.
Reference Books	
1	Karp's Cell and Molecular Biology: Concepts and Experiments. 8th Edition (2015). Wiley Publications.
2	James D. Watson, 7th Edition (2014), Molecular Biology of the Gene, Pearson Publications.
3	Geoffrey M. Cooper, 7th Edition (2015). The Cell: A Molecular Approach, Sinauer Associates, Qxford University Press.
4	Lodish Harwey, 6th Edition (2016), Molecular Cell Biology, W. H. Freeman Publications.
5	Wolpert L, Tickle C, 2015. Principles of Development, 5th edition, Oxford University Press.
Web Resources	
1	http://www.cellbiol.com/education.php
2	https://global.oup.com/uk/orc/biosciences/cellbiology/wang/student/weblinks/ch16/
3	https://dnalc.cshl.edu/websites/
4	https://www.cellsignal.com/contents/science/cst-pathways/science-pathways
5	https://nptel.ac.in/courses/102/106/102106025/11.

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

ELECTIVE I- BIOLOGICAL CHEMISTRY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			2	3	25	75	100

Learning Objective		
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 sand 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**
1	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 - Definition with examples- electrophiles, nucleophiles and free radicals. Types of reactions with an example: addition, substitution, elimination, condensation and polymerization.	10
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.	10
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. Metabolism of Carbohydrates – Glycolysis, TCA cycle, bioenergetics of carbohydrate metabolism. Glycogenesis.	10
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.	10
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. ATP production. Oxidative phosphorylation, Electron transport chain and Photophosphorylation.	5
Total		45
Text Books		

1	P.L. Soni , A Text-book of Inorganic Chemistry, 11th Edition, S. Chand & Sons publications
2	Abhilasha Shourie, Shilpa S, Chapadgoankar & Anamika Singh (2020) Textbook of Biochemistry 1st 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 3rd edition (2006).
Reference Books	
1	Lehninger (2013) Principles of Biochemistrty 4 th edition WH Freeman and Company NY
2	Murray *et al.,* (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	Lubert Stryer (2007) Biochemistry –Stanford University 5 th Edition-W H Freemann and company San Francisco
5	Bahl Arun, Bahl B. S. (2016), A Textbook of Organic Chemistry, 22nd Edition, S. Chand & Sons publications
Web Resources	
1	http/dwb4.unl.edu/chem869p/chem869plinks/s
2	www.longwood.edu/staff/buckalewdw/C3%20Biomolecules.pp
3	https://www.britannica.com › science › biochemistry
4	https://]ww.sciencedirect.com › topics › agricultural-and-biological-sciences
5	https://biochemistry.org › education › careers › becoming-a-bioscientist › w

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

CORE COURSE II - CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY - Practical

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
			3		5	5	25	75	100

Learning Objective		
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.	10
II	Blood smear preparation and Identification of Blood cells Buccal smear preparation and Identification of squamous epithelial cells.	20
III	Isolation and Identification of plant cells.	15
IV	Observation of sperm & Egg Mounting of chick Embryo - 24 hrs, 48 hrs, 72 hrs, 96 hrs. Types of placenta in mammals.	25
V	Cell fractionation and Identification of cell organelles (Demo)	5
Total		**75**

Text Books	
1	K.V. Chaitanya, (2013), *Cell and molecular biology*: Lab manual, PHI publishers,. ISBN 978-81-203-800-4

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

ELECTIVE I - BIOLOGICAL CHEMISTRY - Practical

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
			2		1	2	25	75	100

Learning Objective	
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 Sorenson's formal titration method.
LO5	Estimate Glucose, Cholesterol and Proteins.

UNIT	Contents	No. of Hours
1	**Systematic analysis of Organic compounds** Functional group tests (Carboxylic acid (Benzoic acid, phthalic acid), Phenol, Urea, Benzaldehyde, Aniline (Aniline not to be given for exam)	5
II	**Qualitative Analysis** Qualitative analysis of carbohydrates - Glucose, Fructose, Lactose, maltose, sucrose, starch & glycogen. Qualitative analysis of amino acids - Tyrosine, Tryptophan, Arginine, Proline and Cysteine.	10
III	**Volumetric Analysis**: 1. Estimation of Glycine- Formal Titration. 2. Determination of Ascorbic acid – DCPIP method. 3. Estimation of Ferrous sulphate using standard Mohr's salt	5
IV	Colorimetric Analysis 1. Estimation of glucose 2. Estimation of Cholesterol- Zak's method 3.Estimation of proteins – Bradford's method	10
Total		**30**

Text Books	
1	J. Jayaraman, Laboratory Manual in Biochemistry, New Age International Pvt Ltd Publishers, 2011.
2	S. K. Sawhney Randhir, Singh, Introductory Practical Biochemistry, Alpha Science International Ltd, 2nd edition, 2005.
3	Irwin H.Segel, Biochemical calculations,Liss, Newyork,1991.

Reference Books	
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
CLO1	3	3	3	3	3	3	3	3	3
CLO2	3	3	3	3	3	3	3	3	3
CLO3	3	3	3	3	2	3	3	3	3
CLO4	3	3	3	2	3	2	3	3	2
CLO5	3	3	2	3	3	3	3	2	3
TOTAL	15	15	14	14	14	14	15	14	14
AVERAGE	3	3	2.8	2.8	2.8	2.8	3	2.8	2.8

SKILL ENHANCEMENT COURSE – 1

PUBLIC HEALTH AND HYGIENE

Subject Code	**L**	**T**	**P**	**S**	**Credits**	**Instructional Hours**	**Marks**		
							CIA	**External**	**Total**
	2				**2**	**2**	**25**	**75**	**100**
Learning Objective									
LO1	can explain the importance of health and hygiene								
LO2	can analyze the importance of food and malnutrition								
LO3	can understand the cause of diseases								
LO4	Will get know about lifestyle diseases								
LO5	Will get awareness about various Health Services Organizations								
UNIT	**Contents**								**No. of Hours**
1	Scope health and hygiene – Concept of health and disease - Pollution and health hazards; water and airborne diseases. Radiation hazards: Mobile Cell tower and electronic. Role of health education in environment improvement and prevention of diseases. Personal hygiene, oral hygiene and sex hygiene.								5
II	Classification of food into micro and macro nutrients. Balanced diet, Importance of dietary fibres.Significance of breast feeding. Malnutrition anomalies – Anaemia, Kwashiorkar, Marasmus, Rickets, Goiter (cause, symptoms, precaution and cure).								5
III	Communicable viral diseases- measles, chicken pox, poliomyelitis, swine flu, dengue, chickungunya, rabies, leprosy and hepatitis. Communicable bacterial diseases- tuberculosis, typhoid, cholera, tetanus,plague, whooping cough, diphtheria, leprosy. sexually transmitted diseases- AIDS, syphilis and gonorrhoea. Health education and preventive measures for communicable diseases.								5
IV	Non-communicable diseases such as hypertension, stroke, coronary heart disease, myocardial infarction.Osteoporosis, osteoarthritis and rheumatoid arthritis-cause, symptom, precautions. Diabetes- types and their effect on human health. Gastrointestinal disorders- acidity, peptic ulcer, constipation, piles. (cause, symptoms, precaution and remedy) Obesity (Definition and consequences). Mental illness(depression and anxiety). Oral and lung cancer and their preventive measures.								10

V	Health Services Organizations: World Health Organization (WHO), United Nations International Children's Emergency Fund (UNICEF) and Indian Red Cross (IRC).	5
Total		**30**
Text Books		
1	Mary Jane Schneider (2011) Introduction to Public Health.	
2	Muthu, V.K. (2014) A Short Book of Public Health.	
3	Detels, R. (2017) Oxford Textbook of Public Health (6th edition).	
4	Gibney, M.J. (2013) Public Health Nutrition.	
5	Wong, K.V. (2017) Nutrition, Health and Disease.	
Reference Books		
1	S. Lal, (2018), Vikas. *Public Health Management Principles And Practice*, 2nd Edition, CBS Publishers and Distributors Pvt Ltd, ISBN: 978-93-87742-93-2.	
2	Mary-Jane Schneider (2016), *Introduction to Public Health*,(5th Edition), Jones & Bartlett Learning,. ISBN-13: 978-1284197594	
3	Carolyn D. Berdanier, Johanna T. Dwyer, David Heber (2013), *Handbook of Nutrition and Food*, (3rd Edition), CRC Press,. ISBN 9781466505711	
4	Sue Reed, Dino Pisaniello, GezaBenke, Kerrie Burton. (2013), *Principles of Occupational Health and Hygiene: An Introduction, (* 2nd Revised ed. Edition), Allen &Unwin,	
5	V. Kumaresan, R. Sorna Raj*, (*2012) *Public Health and Hygiene*,(1st Edition), Saras Publication.	

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CLO1	**3**	**3**	**-**	**2**	**3**	**3**	**3**	**3**	**3**
CLO2	**3**	**3**	**-**	**2**	**3**	**3**	**3**	**3**	**3**
CLO3	**3**	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**3**
CLO4	**3**	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**3**
CLO5	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**3**
TOTAL	**14**	**15**	**4**	**11**	**15**	**15**	**14**	**14**	**15**
Average	**2.8**	**3**	**0.8**	**2.2**	**3**	**3**	**2.8**	**2.8**	**3**

SKILL ENHANCEMENT COURSE - BASICS OF BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	2				2	2	25	75	100
Learning Objectives:									
LO1	**The student can understand the basics of biotechnology.**								
LO2	**Able to explain the basic concept of biotechnology.**								
LO3	**Can differentiate various types of biotechnology.**								
LO4	**Can outline various biotech based products used in day to day life.**								
LO5	**Apply the concepts of biotechnology in various fields.**								

Unit I: Introduction to Biotechnology – Definition – History of Biotechnology – Scope of Biotechnology –Advantages and Disadvantages of Biotechnology. **6 hrs**

Unit II: Basic concept of biotechnology (r – DNA technology) - Isolation of the DNA from the donor organism - DNA fragmentation using the restriction endonucleases - Ligation of the desired DNA fragment into the vector- Transfer of Recombinant DNA to the host - Culture of transformed cells in a nutrient medium - Extraction of the desired product. **6 hrs**

Unit III: Types of Biotechnology: Blue Biotechnology – Green Biotechnology – Red Biotechnology – White Biotechnology – Grey Biotechnology – Yellow Biotechnology – Gold Biotechnology – Black Biotechnology. **6 hrs**

Unit IV: Biotechnology in daily life – Dairy Products – Bakery Products –Beverages – Cosmetics – Detergents – Genetically Modified Crops – Antibiotics – Vaccines – Biofuels. **6 hrs**

Unit V: Applications of Biotechnology – Plant Biotechnology – Animal Biotechnology – Industrial Biotechnology – Medical Biotechnology – Herbal Biotechnology – Marine Biotechnology – Enzyme Technology. **6 hrs**

SEMESTER – II

COURSE CORE III - GENETICS

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			5	5	25	75	100

Learning Objective	
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
1	Mendel's experiments, Monohybrid cross, Dihybrid cross, Backcross or Testcross, Mendel's laws. Incomplete dominance, Codominance. Interaction of Genes- Epistasis -lethal genes. Multiple alleles. 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. Sex –Linked Inheritance and Sex- Determination in Man.	15
III	Fine structure of the gene and gene 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), Karyotyping.	15

V	Population Genetics– Hardy Weinberg principle, gene frequency, genotype frequency and factors affecting gene frequency. Eugenics, Euphenics and Euthenics. Penetrance and Expressivity.	15
Total		75
Text Books		
1	Dr. Veer Bala Rastogi, 2020, Elements of Genetics, 11 th Revised & Enlarged Edition, Kedar Nath 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, 8th edition, S.Chand & Co., New Delhi – 10055.	
4	Verma, P.S., and Agarwal, V.K., 1995. Cell and Molecular Biology, 8th edition, S.Chand and Co., New Delhi, 110055.	
Reference Books		
1	Gardener E.J. Simmons M.J. Slustad D. P. 2006. Principles of Genetics	
2	Lewis, R.2001. Human Genetics- Concepts and application. 4th 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.	
Web Resources		
1	https://nptel.ac.in/courses/102/106/102106025/	
2	http://www.ocw.mit.edu	
3	http://enjoy.m.wikipedia.org	
4	https://www.acpsd.net	

MAPPING WITH PROGRAMME OUTCOME AND PROGRAMME SPECIFIC OUTCOME

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

ELECTIVE II - FUNDAMENTALS OF MICROBIOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			2	4	25	75	100

Learning Objective	
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.	10
II	Structure of bacteria - Bacterial growth and measurement of growth, Factors affecting 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 – Antibiotic in clinical use - Resistance to antibacterial agents - MRSA, ESBL.	10
IV	Bioinsecticides - *Bacillus thuringiensis*, Baculoviruses- Biofertilizers - *Azospirillum* and blue green algae - single cell protein – prebiotics and probiotics - Dairy products (Cheese and Yoghurt).	10
V	Microbial Disease- host -pathogen interaction, clinical features, lab diagnosis and treatment of Airborne disease (Pneumonia, Influenza), food borne disease (Shigellosis, Aspergillosis), Water borne disease (Cholera, Amoebiasis), Sexually transmitted disease (HPV, Trichomoniasis), Vector borne disease (Dengue, Malaria).	15
Total		**60**

Text Books	
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, 10th 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
Reference Books	
1	Madigan, Martinko, Bender, Buckley, Stahl, Brock Biology of Microorganisms, 14th edition, 2017.
2	Gillespie, Bamford, Medical Microbiology and Infection at a Glance, 4th edition, 2012.
3	Boyd, R.F. (1998). General Microbiology,2nd Edition., Times Mirror, Mosby CollegePublishing, St Louis.
4	Tortora, G.J., Funke, B.R., Case,C.L. (2013). Microbiology. An Introduction 11th Edition., A La Carte Pearson.
5	Salle. A.J (1992). Fundamental Principles of Bacteriology. 7th Edition., McGraw Hill Inc.New York.

Web Resources	
1	Horst W. Doelle (2004). Microbial Metabolism and Biotechnology. Proceedings of an E-seminar organized by the International organization for Biotechnology and Bioengineering (IOBB)
2	http://www ejb.org/content.
3	www. Biotech.kth.se Electronic Journal of biotechnology
4	https://www.cliffsnotes.com/study guides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology
5	https://bio.libretexts.org/@go/page/9188

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

CORE COURSE IV – Genetics - Practical

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
			3		5	5	25	75	100

Learning Objective	
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**
1	Mitotic stages of onion (*Allium cepa*) root tip Meiotic stages of cockroach testes/ Flower bud	30
II	Giant chromosomes from Chironomus larvae/ Drosophila salivary glands	15
III	Identification of Barr bodies from Buccal smear	10
IV	Preparations of culture medium and culture of Drosophila – methods of maintenance Identifications of mutants of Drosophila	15
V	Human karyotyping (Demo)	5
Total		**75**

Text Books	
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
CLO1	3	3	3	3	3	3	3	3	3
CLO2	3	3	3	3	3	3	3	3	3
CLO3	3	3	3	3	2	3	3	3	3
CLO4	3	3	3	2	3	2	3	3	2
CLO5	3	3	2	3	3	3	3	2	3
TOTAL	15	15	14	14	14	14	15	14	14
AVERAGE	3	3	2.8	2.8	2.8	2.8	3	2.8	2.8

ELECTIVE II -FUNDAMENTALS OF MICROBIOLOGY - Practical

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
			2		1	2	25	75	100

Learning Objective	
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	5
II	Inoculation techniques- Pour plate, spread plate and streaking plate. Isolation of bacteria from water by dilution technique.	10
III	Staining techniques: Simple positive, simple negative, Gram's staining. Lacto phenol cotton blue staining.	5
IV	Motility tests: Hanging drop technique.	5
V	Biochemical characterization - IMVIC test and TSI. Antibiotic sensitivity test (demonstration).	5
Total		**30**

Text Books

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 (1st 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.

Reference Books	
1	Atlas.R (1997). Principles of Microbiology, 2nd Edition, Wm.C.Brown publishers.
2	Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India.
3	Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS.
4	Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication.
5	Lim D. (1998). Microbiology, 2nd Edition, WCB McGraw Hill Publications.
Web Resources	
1	http://www.biologydiscussion.com/micro-biology/sterilisation-and-disinfection-methods-and-principles-microbiology/24403.
2	https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635
3	https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf
4	https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

SKILL ENHANCEMETN COURSE II -

ORGANIC FARMING AND HEALTH MANAGEMENT

Subject Code	**L**	**T**	**P**	**S**	**Credits**	**Instructional Hours**	**Marks**		
							CIA	**External**	**Total**
	2				**2**	**2**	**25**	**75**	**100**

Learning Objective		
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**
1	Ecology and Environment – Principles of ecology – Ecosystem - Biotic and abiotic components and interaction – Energy flow –Nutrient cycle – Biodiversity – Endemic – Exotic - Interrelationships.	5
II	Composting – Microbial Compost – Vermicompost – Setup for vermicompost unit - Nutrition garden – Ring garden – Double digging – Cultivating vegetables – Common medicinal herbs – Identification and Cultivation.	5
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.	5
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 health, indicators of health.	10
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.	5
Total		**30**

Text Books	
1	G.K. Veeresh, 2006. Organic farming , First edition, New Delhi, India Foundation Books in association with Centre for Environment Education.
2	Mangala rai, 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	Adrianne E. Hardman, 2009. Physical Activity and Health – The evidence explained, Second edition, Taylor and Francis Group.
5	
Reference Books	
1	Farmers of Forty Centuries: Permanent Organic Farming in China, Korea, and Japan Hardcover – 10 June 2011 by F. H. King (Author)
2	Organic Farming: Components And Management Edition: 1 Author/s:Gehlot D , Publisher: M/s AGROBIOS (INDIA) ISBN: 978817754400

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CLO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
TOTAL	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

SKILL ENHANCEMENT COURSE III - VERMITECHNOLOGY

Course outcome:

Students will gain knowledge on types of the earthworm culture methods, vermicomposting and its economical benefits.

Subject Code	**L**	**T**	**P**	**S**	**Credits**	**Instructional Hours**	**Marks**		
							CIA	**External**	**Total**
	2				**2**	**2**	**25**	**75**	**100**

Learning Objective		
LO1	To know the techniques of Vermicomposting and role of earthworms in soil fertility.	
LO2	To practice the culturing techniques of earthworms and composting materials	
LO3	To gain the knowledge about Small scale techniques of Vermicomposting	
LO4	To realize the Concept of Large scale techniques of Vermicomposting	
LO5	To appreciate the impact of Vermiwash and Economics	
UNIT	**Contents**	**No. of Hours**
1	Types, Collection and Preservation of earthworms - Types and basic characteristics of species suitable for vermicomposting; Role of earth worms in soil fertility, Biology of *Lampito maruitti*; Collection and Preservation of Earthworms; Flow sheet for vermi technology	5
II	Culturing techniques of earthworms and composting materials General method; Pot method; Wooden box method; Propagation; Factor affecting culturing of earthworm; Vermicomposting materials; Preliminary treatment of composting materials	5
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	5
IV	Large scale techniques of Vermicomposting Outdoor dual bin; Raised cage; Dual pit; Commercial model; Trickling filter vermicomposting; Keep it simple and save plan	10
V	Vermiwash and Economics - Chemical composition of vermiwash; Techniques of vermiwash production: Advantages of Vermicomposting; Prospects of vermi-culture as self employment venture	5
Total		**30**

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
3	Ranganathan, L.S. 2006. Vermibiotechnology from soil health to human health – Agrobios, India

SEMESTER – III

CORE COURSE V- IMMUNOLOGY AND IMMUNOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			5	5	25	75	100

Learning Objective		
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
1	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.	15
IV	The complement system and activation and regulation. Types – Classical, alternative and Lectin pathway. Biological function of C' proteins. Cytokines and its Function. Vaccines – Types, Production and application.	15
V	Hypersensitivity Reactions and Types. Major Histocompatability Complex – MHC genes, MHC in immune responsiveness, Structure and function of Class I and Class II MHC molecules. HLA tissue typing.	15
Total		**75**
Text Books		

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.
Reference Books	
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. 3rd Edition.
3	William R Clark. (1991). The Experimental Foundations of Modern Immunology. 3rdEdition. John Wiley and Sons Inc. New York.
4	Frank C. Hay, Olwyn M. R. Westwood. (2002). Practical Immunology, 4thEdition., Wiley-Blackwell.
5	Noel R. Rose, Herman Friedman, John L. Fahey. (1986). Manual of Clinical Laboratory Immunology. ASM.3rd Edition
Web Resources	
1	https://www.ncbi.nlm.nih.gov/books/NBK279395/
2	https://med.stanford.edu/immunol/phd-program/ebook.html
3	https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/
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
CLO1	3	3	3	3	3	3	3	3	3
CLO2	3	3	3	3	3	3	3	3	3
CLO3	3	3	3	3	2	3	3	3	3
CLO4	3	3	3	2	3	2	3	3	2
CLO5	3	3	2	3	3	3	3	2	3
TOTAL	15	15	14	14	14	14	15	14	14
AVERAGE	3	3	2.8	2.8	2.8	2.8	3	2.8	2.8

ELECTIVE III – BIOINSTRUMENTATION

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			2	3	25	75	100

Learning Objective	
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.

UNIT	Contents	No.of Hours
1	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 Fluorescence Microscope.	10
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).	10
III	Chromatography - Principles – Paper Chromatography, TLC, Gel filtration, Ion-Exchange, Affinity Chromatography Gas Liquid Chromatography and HPLC. Electrophoresis: Principle, Paper Electrophoresis. Agarose Gel Electrophoresis – SDS- PAGE and Iso-electric focusing.	10
IV	Radioactivity – Isotopes – Clinically important isotopes – Measurement of Radioactivity – GM Counters, Scintillation Counters – Autoradiography – Applications. SOPs for Radioactive materials.	10
V	Centrifugation – Principles - RCF, Sedimentation concept - - Different types of centrifuge – Types of rotors – Centrifugation types: Differential and Density gradient centrifugation – Ultra Centrifuge.	05
Total		**45**

Text Books	
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
Reference Books	
1	Keith Wilson,John Walker,(2010).Principles and techniques of Biochemistry and Molecular Biology"(7^{th} edition).Cambridge University Press.
2	David L.Nelson, Michael M Cox.Lehninger(2008)."Principles of Biochemistry",Fifth edition W.H.Freeman,Newyork.
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"WileyIndia 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

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

CORE COURSE VI - IMMUNOLOGY AND IMMUNOTECHNOLOGY - PRACTICAL

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
			3		5	5	25	75	100

Learning Objective	
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
1	Separation of Serum and Plasma. Blood grouping and Rh typing.	10
II	WBC counting RBC counting Differential blood count Bleeding time of blood Clotting time of blood	20
III	WIDAL Slide test ASO test	20
IV	Double Immunodiffusion Single Radial Immunodiffusion	20
V	ELISA – Demonstration	5
Total		**75**

Text Books	
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.
Reference Books	
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. 3rd Edition.
5	Peter J. Delves, Seamus Martin, Dennis R. Burton, Ivan M. Roitt. (2006). Roitt's Essential Immunology, 11thEdition., Wiley-Blackwell.
Web Resources	
1	https://www.researchgate.net/publication/275045725_Practical_Immunology-_A_Laboratory_Manual
2	https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/labs/frelinger-lab/documents/Immunology-Lab-Manual.pdf
3	https://webstor.srmist.edu.in/web_assets/downloads/2021/18BTC106J-lab-manual.pdf
4	Immunology Overview - Medical Microbiology - NCBI Bookshelf (nih.gov)
5	Immunology - an overview | ScienceDirect Topics

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

ELECTIVE III – BIOINSTRUMENTATION Practical

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
			2		1	2	25	75	100

Learning Objective	
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) Determination of pH of biological samples using pH meter	5
II	Agarose gel electrophoresis of DNA Verification of Beer's Lamberts law by colorimetry.	5
III	Chromatography analysis of sugar, amino acids by paper chromatography.	10
IV	Chromatography analysis of sugar, amino acids by Thin layer chromatography.	5
V	Fractionation of cellular components by differential Centrifugation.	5
Total		**30**

Text Books	
1	Sharda University Abstract Laboratory Manual for Bio-instrumentation, Biochemistry, Microbiology, Cell Biology and Enzyme Technology.2018
2	Bhomwik (2011),*Analytical techniques in Biotechnology – A complete laboratory manual*, MGH Publisher, ISBN-13 : 978-0070700130
Reference Books	
1	P. Palanivelu (2017), *Analytical Biochemistry and Separation techniques – A laboratory manual*, (5th 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**
CLO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO3	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**
CLO4	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**2**
CLO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**
TOTAL	**15**	**15**	**15**	**15**	**14**	**14**	**15**	**14**	**14**
AVERAGE	**3**	**3**	**3**	**3**	**2.8**	**2.8**	**3**	**2.8**	**2.8**

SKILL ENHANCEMENT COURSE IV– HERBAL MEDICINE

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	2				1	1	25	75	100

Learning Objective	
LO1	The student can analyses the importance of herbal medicine
LO2	can learn the role of herbal medicines for health
LO3	Can explain about Tribal medicine
LO4	can analyses the role of traditional medicine for today's health
LO5	can demonstrate the use of medicinal herbs to health

UNIT	Contents	No. of Hours
1	Ethnomedicine – definition, history and its scope – Inter disciplinary approaches in ethnobotany – Collection of ethnic information.	3
II	Importance of medicinal plants – role in human health care – health and balanced diet (Role of proteins, carbohydrates, lipids and vitamins).	3
III	Tribal medicine – methods of disease diagnosis and treatment – Plants in folk religion – *Aegle marmelos*, *Ficus benghalensis*, *Curcuma domestica*, *Cynodon dactylon* and Sesamumindicum.	3
IV	Traditional knowledge and utility of some medicinal plants in Tamil Nadu – *Solanum trilobatum*, *Vitex negundo*, *Adathoda vasica*, *Azadirachta indica*.	3
V	Plants in day today life – *Ocimum sanctum*, *Cassia auriculata*, *Aloe vera*. Nutritive and medicinal value of some fruits (Guava, Orange, Mango, Banana, Lemon) and Vegetables - Greens (Moringa, *Solanum nigrum* Cabbage).	3
Total		**15**

Text Books

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
Reference Books	
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	Neelesh Malviya and Sapna Malviya (2019). *Herbal Drug Technology*, (1st Edition), CBS
4	Rageeb Md. Usman, Vaibhav M. Darvhekar, Vijay Kumar D, and Akhila S.A, (2019). *Practical Book of Herbal Drug Technology*, (1st Edition), Nirali Prakashan Publishers,
5	Pragi and Varun Arora (2019). *Herbal Drug Technology*, (1st Edition), S.Vikas and Company Publisher, ISBN: 9781543343687

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

SKILL ENHANCEMENT COURSE V– MUSHROOM CULTIVATION

Course outcome:

On completion of this course, the students will be able to demonstrate the various types of mushroom cultivating methods and Value the economic factors associated with mushroom cultivation.

Subject Code	**L**	**T**	**P**	**S**	**Credits**	**Instructional Hours**	**Marks**		
							CIA	**External**	**Total**
	2				**2**	**2**	**25**	**75**	**100**

Learning Objective	
LO1	The student can understand the biology and economy of mushrooms
LO2	can learn the Mushroom cultivation
LO3	Can explain Life cycle of Pleurotus spp and Agaricus spp
LO4	can analyses the Spawn production
LO5	can demonstrate the Diseases and post harvest technology

UNIT	**Contents**	**No. of Hours**
1	Introduction: Morphology, Types of Mushroom, identification of edible and poisonous mushroom, Nutritive values, life cycle of common edible mushrooms.	5
II	Mushroom cultivation, prospects and scope of Mushroom cultivation in small scale Industry	5
III	Life cycle of Pleurotus spp and Agaricus spp.	5
IV	Spawn production, growth media, spawn running and harvesting of mushrooms and marketing.	5
V	Diseases and post harvest technology, Insect pests, nematodes, mites, viruses, fungal competitors and other important diseases	10
Total		**30**

Text Books	
1	Handbook of Mushroom Cultivation. 1999. TNAU publication.
2	Marimuthu, T., Krishnamoorthy, A.S., Sivaprakasam, K. and Jayarajan. R. (1991).
3	Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
4	Swaminathan, M. 1990. Food and Nutrition. Bappco, The Bangalore Printing and
5	Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
6	Nita Bahl. 2002. Handbook on Mushroom 4th edition Vijayprimlani for oxford & IBH publishing co., Pvt., Ltd., New Delhi. 5. Dr.C. Sebastian Rajesekaran Reader in Botany Bishop Heber College, Trichy – 17.
7	Suman. 2005. Mushroom Cultivation Processing and Uses, M/s. IBD Publishers and Distributors, New Delhi.
8	Sing. 2005. Modern Mushroom Cultivation, International Book Distributors, Dehradun.
9	Handbook of Edible Mushroom Today and Tomorrows printers and publishers.

SEMESTER –IV

CORE COURSE VII- Genetic Engineering and rDNA Technology

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			5	5	25	75	100

Learning Objective	
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 Nonviral 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.

UNIT	Contents	No. of Hours
1	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
Total		**75**

Text Books	
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.
Reference Books	
1	David Clark Nanette Pazdernik Michelle McGehee (2018), *Molecular Biology techniques*,(3rd edition).
2	Anton Byron (2019), *Introduction to Gene Cloning,* Publisher: Oxford Book Company
3	Monika Jain (2012), *Recombinant DNA technology*, (I edition), Alpha Science International. ISBN-13 : 978-1842656679.
4	Primrose.S.B (2014), *Principles of gene manipulation*, (7th edition), Blackwell Scientific limited, Germany. ISBN: 978-1-405-13544-3
Web Resource	
1	https://www.britannica.com/recombinant-DNA-technology
2	https://www.le.ac.uk/recombinant-dna-and-genetic-techniques
3	https://www..ncbi.nlm.nih.gov

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

ELECTIVE IV - BIOINFORMATICS AND BIOSTATISTICS

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			2	4	25	75	100

Learning Objective		
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
1	Introduction to Bioinformatics – Genome, Transcriptome and Proteome, Gene prediction tools and software. Nucleic acid Databases – Primary and Secondary Databases – Structure Database – CATH, SCOP – Data base Searching – BLAST and FASTA, BLOSSUM.	10
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).	10
III	Multiple Sequences alignment – method of multiple sequences alignment. Clustering methods Phylogenic trees - Methods to generate phylogenetic tree. History of Drug Discovery, Steps in Drug design - Chemical libraries – Role of molecular docking in drug design.	10
IV	Statistics – collection, classification, tabulations of Statistical Data – Diagrammatic representation – Graphs – Sampling method, standard error. Measures of central tendency (Mean, median, mode). Measures of dispersion (standard deviation).	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

Total		**60**
Text Books		
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 Biostastistics" MJP Publishers	
5	VerbalaRastogi .(2011).”Fundamentals of Biostatistics”, Ane books Pvt Ltd Publishers,Chennai.	
Reference Books		
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
CLO1	3	3	3	3	3	3	3	3	3
CLO2	3	3	3	3	3	3	3	3	3
CLO3	3	3	3	3	2	3	3	3	3
CLO4	3	3	3	2	3	2	3	3	2
CLO5	3	3	3	3	3	3	3	2	3
TOTAL	15	15	15	14	14	15	15	14	14
AVERAGE	3	3	3	2.8	2.8	3	3	2.8	2.8

CORE COURSE VIII- GENETIC ENGINEERING and r DNA TECHNOLOGY PRACTICAL

Subject Code	L	T	P		Credits	Instructional Hours	Marks		
							CIA	External	Total
			3		5	5	25	75	100

Learning Objective		
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 from bacteria. Isolation of plasmid DNA from bacteria.	15
II	Ligation	10
III	Production of competent cells for transformation Bacterial transformation	20
IV	Restriction Digestion of DNA	10
V	Restriction Fragment Length Polymorphism(DEMO) PCR	10
Total		**75**
Text Books		
1	**Laboratory Manual for GENETIC ENGINEERING 1st Edition, Kindle Edition by S. JOHN VENNISON (Author) 2009.**	

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

ELECTIVE IV- BIOINFORMATICS AND BIOSTATISTICS PRACTICAL

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
			2		1	2	25	75	100

Learning Objective		
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	
UNIT	**Contents**	**No. of Hours**
I	Biological databases (NCBI, Swissprot and PDB)	6
II	BLAST and FASTA(Similarity search programme)	6
III	Identification of functional domains in nucleotide binding proteins using a domain analysis server like SMART (pfam).	6
IV	Preparation of bar diagram, line diagram and pie diagram using MS EXCEL. Calculation of Central tendency- mean, geometric mean, median using MS EXCEL	6
V	Calculation of dispersion – standard deviation using MS EXCEL Calculation of r – value. Calculation of student's t test using MS EXCEL	6
Total		**30**

Text Books	
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, 2ndedition. 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. 2ndedition. Blackwell Science.
Reference Books	
1	Durbin, R., Eddy, S., Krogh, A. and Mitchison, G. 1998. Biological sequence analysis. Cambridge University Press.
2	Friedman, C.P. and Wyatt. J.C. 1997. Computers and Machine: Evaluation methods in medicinal information. Springer-verlag, New York.
Web Resources	
1	Bishop, 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

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

SKILL ENHANCEMENT COURSE VI - FOOD AND NUTRITION

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	2				2	2	25	75	100

Learning Objective		
LO1	The student can determine the relationship between food , health and immunity	
LO2	Able to explain the classification of foods and their deficiency	
LO3	Can analyse the importance of BMR	
LO4	Can outline the basic food groups and their adulteration	
LO5	Apply the concepts of food to prepare different food plans	
UNIT	**Contents**	**No. of Hours**
1	Definition of food, Nutrition, Nutrient, Nutritional status, Dietetics, Balance diet, Malnutrition, Energy (Unit of energy-Joule, Kilocalorie). Health, Immunity by food and function of food.	5
II	Carbohydrate, Protein, Fat, Vitamin and Minerals (Calcium, Phosphorous, Sodium, Potassium, Iron, Iodine, Fluorine) -Sources, Classification, Function, Deficiencies of these nutrients. Function of water and dietary fiber.	5
III	BMR: Definition, factors affecting BMR and total energy requirements (Calculation of energy of individuals)	5
IV	Basic five food groups, nutritional significance of cereals, pulses, milk, meat, fish, vegetables, egg, nuts, oils and sugars. Food toxins, Food additives, Food quality, Safe food handling, Food adulteration, Preservatives and Packaging.	10
V	Principles and Objectives of meal planning. Diet for an infant, preschool child, School child, normal male and female of different occupations.	5
Total		**30**

Text Books	
1	Vidya & D.B. Rao, 2010. A textbook of nutrition by, Discovery Publishing house,
2	Handbook of Nutrition & Food, third edition, CRC Press (Taylor and Francis group) by Carolyn D.Berdanier

3	Food science and Nutrition, Oxford publication by Sunetra Roday
4	Janet D Ward & Larry T Ward, Principles of food science by, Good heart-Wilcox publishing.
5	Dr. M. Swaminathan, 2018. Hand Book of Food & Nutrition, Second edition Bangalore press.
Reference Books	
1	Joshi, V.K. and Singh, R.S., A. (2013), *Food Biotechnology- Principles and practices,* I.K.International Publishing House Pvt. Ltd., New Delhi,.
2	RavishankarRai, V,(2015), *Advances in Food Biotechnology*, (First edition), John Wiley & Sons, Inc, ISBN 9781118864555
3	Foster, G.N., (2020), *Food Biotechnology*, (First edition), CBS Publishers & Distributors Pvt Ltd, ISBN 9789389396348
4	Anthony Pometto, Kalidas Shetty, Gopinadhan Paliyath, Robert E. Levin (2005), *Food Biotechnology*, (2nd edition), *CRC Press,* ISBN 9780824753290
5	Perry Johnson-Green (2018), *Introduction to Food Biotechnology*, Special Indian Edition, *CRC Press*, ISBN 9781315275703

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CLO1	**3**	**2**	**1**	**1**	**3**	**2**	**3**	**3**	**3**
CLO2	**3**	**2**	**1**	**1**	**3**	**3**	**3**	**3**	**3**
CLO3	**3**	**2**	**1**	**1**	**3**	**3**	**3**	**3**	**3**
CLO4	**3**	**2**	**1**	**1**	**3**	**3**	**3**	**3**	**3**
CLO5	**3**	**2**	**1**	**1**	**3**	**3**	**3**	**3**	**3**
TOTAL	**15**	**10**	**5**	**5**	**15**	**14**	**15**	**15**	**15**
Average	**3**	**2**	**1**	**1**	**3**	**2.8**	**3**	**3**	**3**

SKILL ENHANCEMENT COURSE VII – AQUACULTURE

Course outcome:

Students will be able to understand aquaculture systems, conditioning factors, fish feeding behaviour and breeding and rearing techniques.

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	2				2	2	25	75	100

Learning Objective	
LO1	The student can understand the pond construction and commercial characteristics of fishes
LO2	Can learn the fin fish and shell fish culture techniques
LO3	Can explain Live feed organisms
LO4	Can analyses the Spawn production
LO5	Can demonstrate the Diseases caused by microbes in aquaculture

UNIT	Contents	No. of Hours
1	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	5
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 seaweed culture - Culture of marine prawns, edible and pearl oysters, adaptive management; Seaweeds- types and their culture practices	5
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	5
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	5
V	Applied aquaculture: Identification of cultivable fish species; Morphometry of pond (Enclosed rectangular method/Shore length/ shore area and shore line	10

	development).Fishing technology (crafts and gears). Home aquarium and agency involved in aquaculture	
Total		**30**
Text 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.	

SEMESTER –V

CORE COURSE IX - PLANT BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			4	5	25	75	100

Learning Objective	
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.

UNIT	Contents	No.of Hours
1	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 photomorphogeneisis – 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, Tiand 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
Total		**75**

Text Books	
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.
Reference Books	
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.
Web Resources	
1	https://nptel.ac.in/courses/102103016
2	https://science.umd.edu/classroom/bsci124/lec41.html
3	https://www.nifa.usda.gov/grants/programs/biotechnology-programs/plant-biotechnology
4	http://mydunotes.blogspot.com/p/plant-biotechnology.html
5	https://nptel.ac.in/courses/102103016

MAPPING WITH PROGRAMME OUTCOME AND PROGRAMME SPECIFIC OUTCOME

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CLO1	3	2	3	1	1	2	3	3	3
CLO2	3	3	3	2	1	3	3	3	3
CLO3	3	3	3	3	2	2	3	3	3
CLO4	3	2	2	1	3	2	3	3	2
CLO5	3	3	3	2	3	3	3	2	3
TOTAL	**15**	**13**	**14**	**9**	**10**	**12**	**15**	**14**	**14**
AVERAGE	**3**	**2.6**	**2.8**	**1.8**	**2**	**2.4**	**3**	**2.8**	**2.8**

CORE COURSE X - ANIMAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			4	5	25	75	100

Learning Objective	
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.

UNIT	Contents	No.of Hours
1	Animal cell culture – History and development, 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. Cell separation techniques, cell synchronization, Cell counting methods, cryopreservation. 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
Total		**75**

Text Books	
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 *et al.,* 2009, Animal Biotechnology, Oxford & IBH Publishing Co. Pvt. Ltd.
4	B.C. Currell *et al.,* 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 Jesey.
Reference Books	
1	R. Ian Freshney, Culture of Animal cells – A Manual of Basic Technique Fourth Edition, WILEY LISS & Publications.
2	Glick, B.R. and Pasternark. 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, 3rd edition. Panima Publishing Corporation.
Web Resources	
1	http://ecoursesonline.iasri.res.in/course/view.php?id=350
2	https://microbenotes.com/animal-cell-culture/
3	https://biocyclopedia.com/index/biotechnology/animal_biotechnology/manipulation_of_reproduction_and_transgenic_animals/biotech_in_vitro_fertilization_technology.php
4	https://thebiologynotes.com/embryo-transfer/
5	https://people.ucalgary.ca/~browder/transgenic.html

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

CORE COURSE XI- ENVIRONMENTAL & INDUSTRIAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			4	5	25	75	100

Learning Objective	
LO1	Know about the environment, its issues and management of the environment.
LO2	Explain the process of waste water treatment, drinking water treatment and solid waste management in various industries.
LO3	Illustrate the significance of bioreactors in bioprocess engineering and culture methods.
LO4	Explain Downstream processing, Fermented Products production and advanced methods
LO5	Speculate the role and importance of microorganisms behind the ore leaching, production of food products and Biofertilizers.

UNIT	Contents	No. of Hours
1	Environmental Pollution – Sources and types - Water, Air, Thermal, Industrial and Radiation - Global environmental changes. Global warming, Greenhouse effect, acid rain, ozone depletion, and photochemical smog. Environmental issues, management strategies and safety, Biotechnological approaches for management.	15
II	Waste water treatment: Aerobic and anaerobic methods (Primary, Secondary and Tertiary) –Use of aquatic plants in waste water treatment. Solid waste management. Bioenergy and SCP from waste. Drinking water treatment. Biotechnological approach to industrial effluent (Paper, Tannery, Textile) Pesticide waste disposal.	15
III	Bioprocess Engineering-Steps in bioprocess development. Design of bioreactors - Basic objective of fermenter design, aseptic operation & containment, body construction, agitator and sparger design, baffles, stirrer glands and bearings. Bioreactor configurations and types: Bubble column, airlift reactor, packed bed, fluidized bed, trickle bed, Membrane reactor, Photobioreactor, Animal and plant cell bioreactors. Factors affecting broth viscosity, Mixing in Fermenters. Fermentation systems Batch culture, Continuous culture, Fed-batch culture.	15

IV	Downstream processing Filtration, Centrifugation, Cell disruption, Liquid-liquid extraction, membrane processes, Drying, Crystallization, Whole broth processing. Different types of fermented foods produced from microorganisms- Idli, Sauerkraut - Dairy products- Cheese and Yoghurt. Microbial biomass, Microbial enzymes– Amylase & protease, Immobilization of enzymes: Methods, Properties, Applications, Advantages and Disadvantages of Immobilization, Biosensors and Biochips -Types and applications.	15
V	Ore leaching (methods and examples), Production of antibiotics – Penicillin - streptomycin. Alcoholic beverages: Wine, Beer –Biofertilizers- Rhizobium & Azotobacter. Biopesticides – *Bacillus thuringiensis* and microbial toxin production and their applications - Biosurfactants, Vitamins- Folic acid & Vitamin B12, Organic acids-Acetic Acid.	15
Total		75

Text Books

1	Chatterji, A.K., 2002. Introduction to Environmental Biotechnology, Prentice-Hall of India, New Delhi.
2	Anil Kumar De., 2000. Environmental Chemistry, 4th Edition. New Age International, New Delhi.
3	Murugesan, A G., Rajakumari, C., 2005. Environmental Science and Biotechnology Theory and Techniques., MJP publishers, Chennai.
4	T.Satyanarayana, Bhavdish Narain Johri,Anil Prakash (2012), Microorganisms in Sustainable Agriculture and Biotechnology.
5	Madigan, Michael and Martinko, John, Brock biology of microorganism, 11th edition, (2005).

Reference Books

1	Alan Scragg, 1999. Environmental Biotechnology, Pearson Education Limited, England,
2	Peter F. Stanbury, Allan Whitaker, Stephen J. Hall (2013). Principles of Fermentation Technology Second Edition, Elsevier Science Ltd
3	Michael J. Waites, Neil L. Morgan, John S. Rockey Gary Higton (2001.), Industrial Microbiology: An Introduction. . Blackwell Science Ltd
4	Nduka Okafor, Modern Industrial Biotechnology & Microbiology ((**2017**, Science Publishers, Edenbridge Ltd.
5	Waites, Morgan, Rockey and Higton, Industrial Microbiology: An Introduction, Blackwell Science (2001).

Web Resources	
1	https://nptel.ac.in/courses/120/108/120108004/
2	https://www2.hcmuaf.edu.vn/data/quoctuan/Environmental%20Biotechnology%20-%20Theory%20and%20Application,%20G%20M%20Evans%20&%20J%20C%20Furlong.pdf
3	www. Prenhall.com/Madigan
4	www.e-bug.eu/
5	www.microbeworld.org/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CLO1	**3**	**2**	**3**	**2**	**2**	**2**	**3**	**3**	**3**
CLO2	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**
CLO3	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**
CLO4	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**
CLO5	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**
TOTAL	**15**	**13**	**14**	**11**	**13**	**12**	**15**	**15**	**15**
AVERAGE	**3**	**2.6**	**2.8**	**2.2**	**2.6**	**2.4**	**3**	**3**	**3**

ELECTIVE V - NANO BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			3	4	25	75	100

Learning Objective	
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
1	Introduction to Nanotechnology-Nano particles, size, shape, bulk and nano material. 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, Green synthesis of silver nanoparticles and its analyses by UV-spectroscopy and FTIR. Self-Assembly nanomaterial: Cell membrane and its analyses by SEM, TEM.	10
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.	10
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).	10
Total		**60**

Text Books	
1	Vasantha Pattabhi and N. Gautham (2009), Biophysics, Narosa Publishmg 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). *Green biosynthesis of nanoparticles: Mechanisms and applications,* CABI, ISBN: 9781780642246.
4	Shanmugam.S, "Nanotechnology", MJP publishers, 2010.
5	Pradeep T (2012). *Textbook of Nanoscience and Nanotechnology*, McGraw Hill publications, ISBN: 9781259007323.
Reference Books	
1	D.Voet & J.G.Voet (2010), Biochemistry, John Wiley &Sons, New York.
2	Biochemistry by Lubert Stryer, 4th Ed., WH.Freeman, 1995.
3	David S. Goodsell, "Bionanotechnology", John Wiley &Sons Inc., publications, 2004.
4	Guozhong Cao (2004). Nanostructures and Nanomaterials, synthesis, properties and applications, Imperial College Press, ISBN: 978-1860944802.
5	C.M.Niemeyer, C.A. Mirkin (2007). *Nanobiotechnology*, WILEY-VCH Verlag GmbH & Co. KG, Weinheim, ISBN: 9783527306589.
Web Resources	
1	http://vvm.org.in/study_material/ENG%20-20Indian%20Contributions% 20to% 20 Science.
2	https://www.jabonline.in/admin/php/uploads/16_pdf.pdf
3	https://www.youtube.com/watch?v=gSpHINVmgoE
4	https://www.youtube.com/watch?v=ITtGJUGXFKc
5	https://www.youtube.com/watch?v=4cGROrskvLM

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CLO1	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**
CLO2	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**
CLO3	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**
CLO4	**3**	**2**	**2**	**-**	**-**	**2**	**3**	**2**	**3**
CLO5	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**
TOTAL	**15**	**13**	**13**	**9**	**10**	**13**	**15**	**15**	**15**
AVERAGE	**3**	**2.6**	**2.6**	**1.8**	**2**	**2.6**	**3**	**3**	**3**

ELECTIVE V – ENZYMOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			3	4	25	75	100

Learning Objective	
LO1	The students will learn the Fundamentals of Enzymology.
LO2	The students will study about the characteristic features of Enzymes.
LO3	The student will know about the details of Enzyme Kinetics.
LO4	The student will apply the biochemical techniques for enzyme isolation
LO5	The Student will understand the process of Immobilization of enzymes , Enzyme engineering and Designer enzymes in various Industrial purposes.

UNIT	Contents	No. of Hours
1	Nomenclature and classification of enzymes according to the International Union of Biochemistry and Molecular Biologists Convention. Properties of enzymes and factors that influence rate of enzyme action (pH, temperature, substrate concentration, enzyme concentration, activators and inhibitors). Definitions - Apoenzyme, holoenzyme, zymogens. Coenzymes – (Vitamin and Non vitamin origin).	15
II	Active site (definition, characteristic features), Enzyme specificity. ES complex formation, lock and key model and induced fit model. Enzyme units - IU & Katal. Turnover number. Isoenzymes (LDH & CPK), Definition – Ribozymes & Abzymes.	10
III	Enzyme Kinetics – Michaelis-Menten equation and its derivation, significance of Km and Vmax, Lineweaver- Burk plot. Enzyme inhibition - competitive, Non- competitive, Uncompetitive – (Derivations not included). Allosteric inhibition - sequential model, concerted model, feedback inhibition.	15
IV	Technique for enzyme isolation, separation of cellular organelles by differential centrifugation, purification of enzymes- dialysis, chromatography, electrophoresis. Intracellular localization of enzymes and marker enzymes.	10
V	Immobilization of enzymes- Clinical and industrial applications of immobilized enzymes. Enzyme engineering and Designer enzymes. Pharmaceutical, Clinical and Industrial uses of enzymes.	10
Total		60

Text Books	
1	Satyanarayana. U. 2013. Biochemistry.4th edition, Elsevier India.
2	Jain J L, 2014, Fundamentals of Biochemistry, 7th edition, S.Chand publishing.
3	Rodwell, V.W, Bender D.A, Botham K.M. 2015, Harper's Illustrated Biochemistry, 30th edition. McGraw-Hill Education.
4	Fundamentals of Enzymology - Nicholas C. Price and Lewis Stevens., Oxford University Press, New Delhi.
5	Voet, D. and Voet, J.G. 2016. Biochemistry, 5th edition. John Wiley and Sons, Inc.,
Reference Books	
1	Enzyme – Palmer, 18th edition, 2004.London: Portland Press
2	Biochemistry- Jeremy M Berg, John L Tymoczko, and LubertStryer,6th Edition, Freeman Publications, 2006.
3	Ralph A. Messing (2012) Immobilised Enzymes Academic Press, NY.
4	Nelson D.L., and Cox, M.M. 2013. Lehninger Principles of Biochemistry. 6thedition.W.H. Freeman & Company.
5	Jeremy M Berg, Stryer, L. 2015. Biochemistry, 8th edition. Macmillan Learning.
Web Resources	
1	https://www.youtube.com/watch?v=AD3-v1oKjSk
2	https://www.youtube.com/watch?v=tPCOEUo6J8s
3	https://www.youtube.com/watch?v=ALwziZSRiqM
4	https://www.youtube.com/watch?v=0ZiCqwtFMTs
5	

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CLO1	**3**	**3**	**3**	**2**	**1**	**3**	**3**	**3**	**3**
CLO2	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**
CLO3	**3**	**3**	**3**	**2**	**1**	**2**	**3**	**3**	**3**
CLO4	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**3**	**3**
CLO5	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**
TOTAL	**15**	**14**	**14**	**10**	**10**	**13**	**15**	**15**	**15**
AVERAGE	**3**	**2.8**	**2.8**	**2**	**2**	**2.6**	**3**	**3**	**3**

ELECTIVE V - BIOETHICS & BIOSAFETY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			3	4	25	75	100

Learning Objective		
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**
1	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.	**10**
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).	**10**
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.	**10**
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 processes.	**15**
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**
Total		**60**

Text Books	
1	Ignacimuthu, S (2009), *Bioethics*, Narosa Publication house, ISBN: 978-81-7319-966-0
2	V. Sree Krishna . V (2007), *Bioethics and Biosafety in Biotechnology*, (1st ed.), New Age International Private Limited.
3	Rhona Smith. (2003), *International Human rights*, Blackstone Press.
4	Manual of patent practice and procedure. IPR India, 2005.
5	Ministry of commerce and industry, New Delhi, pp.163.
Reference Books	
1	Trayer, P.C, Fredrick.R., and Koch, M. (2002), *Biosafety*. 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
Web Resources	
1	www.ipr-helpdesk.org/
2	www.patentoffice.nic.in/ipr/patent/patents.htm
3	www.bangalorebio.com/GovtInfo/ipr.htm

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CLO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
TOTAL	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**
AVERAGE	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

ELECTIVE V - CANCER BIOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			3	4	25	75	100

Learning Objective		
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.	
UNIT	**Contents**	**No.of Hours**
1	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.	10
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.	10
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.	10
IV	Detection and Treatment: - Early detection, Molecular detection of Carcinomas, Cancer warning signals; 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
Total		**60**

Text Books	
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	Dr M.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	Ranajit Sen,2004, Principles and Management of Cancer, B.I. Publications Pvt Ltd, New Delhi.
Reference Books	
1	Francesco Pezzella, Mahvash Tavassoli, 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, Mahvash Tavassoli, 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.
Web Resources	
1	http://csbl.bmb.uga.edu/mirrors/JLU/DragonStar2017/download/introduction-to-cancer-biology.pdf
2	http://webserver1.oneonta.edu/faculty/bachman/cancer/207lectures.htm

MAPPING WITH PROGRAMME OUTCOMESAND PROGRAMME SPECIFIC OUTCOME

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

ELECTIVE VI - PLANT BIOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY - PRACTICAL

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	-	-	5		3	4	25	75	100

Learning Objectives	
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.

UNIT	Contents	No. of Hours
1	Plant tissue culture media preparation & sterilization techniques. Callus induction	10
II	Isolation of plant protoplast & viability test. Localization of nucleus using nuclear stain.	15
III	Preparation of Animal Tissue culture medium and membrane filtration Preparation of Single Cell Suspension & Cell counting Cell viability Test-MTT Assay (Demo)	10
IV	Isolation of plant DNA and plant RNA Isolation of Agrobacterium plasmid DNA	15
V	Trypsinization of monolayer and subculturing (Demo) Measurement of phagocytic activity (Demo) Isolation of DNA from animal tissue Cryopreservation and thawing (Demo)	10
Total		**60**

Text Books	
1	Madhavi Adhav, 2009, Practical Biotechnology and Plant Tissue Culture, S.Chand & Company Ltd.
2	C. C. Giri, Archana Giri, 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), *Environmental Biotechnology Theory and Lab Practices*, (2nd edition), Hardcover – Global Vision Publishing House, ISBN: 9788182205840
Reference Books	
1	S. Lal, Vikas. (2018), *Public Health Management Principles And Practice*, (2nd Edition), CBS Publishers and Distributors Pvt Ltd,ISBN 13: 9789387742932
2	S. Harisha. (2012), *Biotechnology procedures and experiments handbook*,ISBN13 9781934015117
Web Resources	
1	https://www.plantcelltechnology.com/pct-blog/different-types-of-tissue-culture-processes/
2	https://www.thermofisher.com/in/en/home/references/gibco-cell-culture-basics.html

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

SEMESTER- VI

CORE COURSE XIII - BIOENTREPRENEURSHIP

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	5	1			4	6	25	75	100

Learning Objective	
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

UNIT	Contents	No.of Hours
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)	**20**
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	**15**
III	Vermicomposting–Earthworms-Ecologicaltypes-Vermiculture-Compostpit-Vermibed-applications. Sericulture-Mulberrycultivation-SilkwormRearing-Economicsofsilkworm Production-Chawki Rearing-Sericulture in India, Budget plan to establish sericulture farm	**15**
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, Budget plan to establish mushroom cultivation	**25**
V	Single Cell Protein Production: Source: Algae, Bacteria, Yeast – Cultivation of Single Cell protein: SPIRULINA Cultivation – Production site, Microorganism, Experimental design; harvesting and Drying and Budget	**15**
Total		**90**

Text Books	
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
Reference Books	
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 Rusell
5	Neutraceutical spirulina: Commercial cultivation using rural technology in india by Pushpa Srivastava
Web Resources	
1	https://archive.india.gov.in › citizen › agriculture
2	http://www.recirculatingfarms.org/resources/
3	https://academy.vertical-farming.net/intro-to-mushroom-growing/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

CORE COURSE XIV - PHARMACEUTICAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	5	1			4	6	25	75	100

Learning Objective	
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

UNIT	Contents	No.of Hours
1	Objectives of Pharmaceutical Biotechnology - Generic and Biogeneric drugs. Stages in the drug development process -Drug discovery - Drug designing - Drug production - Preclinical trials - Clinical trials, Patenting & Drug Approval - Drug Marketing - Post clinical trials.	20
II	Production of recombinant proteins - Development of Nucleic acid based therapies - Biopharmaceutical considerations - Pharmaceutical regulations - Formulation of Biotechnology products - Drug delivery - Pharmacognosy .	20
III	Pharma products-Human Insulin (Humulin), Growth hormones (Humatrope) - Blood coagulating factor (factor VIII - Kogenate) - Erythropoietin - (Epogen) Granulocyte colony stimulating factors (Neulasta) - Interferons (Avonex) - Antimicrobial peptides (β - defensin 2) - Vaccines (Pentavac), Biologics (Humira - Adalimumab), - Cancer based biologics (rituximab).	20
IV	Drug toxicity analysis - Common side effects of drugs and managements - Drugs of abuse - Life changing complications - Prevention and management	15
V	National and International Drug approval agencies - Top National and International pharmaceutical industries - Scope and career opportunities in pharmaceutical sectors.	15
Total		90

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

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CLO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CLO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
TOTAL	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

CORE COURSE XV- ENVIRONMENTAL AND INDUSTRIAL BIOTECHNOLOGY PRACTICAL

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

Learning Objective	
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.

UNIT	**Contents**	**No.of Hours**
1	Enumeration of air borne bacteria Study of Growth Curve and Generation time of Bacteria	20
II	Water analysis –BOD. Immobilization of whole yeast cells/ enzyme by Alginate beads. Production of wine Compost Making	20
III	Biofertilizer production/Spirulina production - field visit. (Report should be included in the record) Isolation and identification of starter organisms from Idli batter/ curd	20
IV	Grading of raw milk (Dye reduction test).	15
V	Preparation and Efficiency testing of Biofertilizer/ Biopesticide. (Demo)	15
Total		**90**

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

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CLO1	**3**	**2**	**3**	**2**	**2**	**2**	**3**	**3**	**3**
CLO2	**3**	**2**	**3**	**2**	**2**	**2**	**3**	**3**	**3**
CLO3	**3**	**2**	**3**	**2**	**2**	**2**	**3**	**3**	**3**
CLO4	**3**	**2**	**3**	**1**	**2**	**2**	**3**	**3**	**3**
CLO5	**3**	**2**	**3**	**1**	**2**	**2**	**3**	**3**	**3**
TOTAL	**15**	**10**	**15**	**8**	**10**	**10**	**15**	**15**	**15**
Average	**3**	**2**	**3**	**1,6**	**2**	**2**	**3**	**3**	**3**

ELECTIVE VII -MARINE BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			3	5	25	75	100

Learning Objective		
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	
UNIT	**Contents**	**No. of Hours**
1	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	Medicinal compounds from flora (Seaweeds, Seagrass and Mangrove) and fauna (Sponges, Ascidians and Corals)-marine toxins- antiviral and antimicrobial agents.	15
IV	Culture aspect-Seaweed (*Kappaphycus alvarezii*), Fish chromosome manipulation in aquaculture- Hybridization-Gynogenesis- Androgenesis- Polyploidy, Artificial Insemination, Eyestalk ablation- Trangenesis and Cryopreservation.	15
V	Marine Bioproducts-Agar-Agarose-Alginate-Carrageenan-Chitin-Chitosan- Heparin, Omega-3-Fatty acids	15
Total		**75**

Text Books	
1	Italy, E (Eds). 1998, New Developments in Marine Biotechnology, Plenum Pub. Corp.
2	Milton Fingerman and Rachakonda Nagabhushanam, 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. Biotechnology in the Marine Sciences (Advances in Marine Science & Biotechnology) Wiley Interscience
Reference Books	
1	Scheupr, P.J. (Ed.), 1984. Chemistry of Marine Natural Products, ,Chemical and Biological Perspectives. Vol. I III, Academic Press, New York
2	Marine Biology- Lalli C.M. and T.R. Parsons., 1997. Biological Oceanography - An Introduction, Elsevier, 314 pp
3	Marine Pollution- Clark, R. B. 2001. Marine pollution, Fifth edition. Oxford University press, New York Inc., 231pp
4	Gloria Sanchez, Elizabeth Hernandez,(2019*), Environmental Biotechnology and cleaner Bioprocess,* (1st edition), CRC Press, ISBN 9780367455552
5	Kirchman, D.L.Gasol, J.M. (2018), Microbial ecology of the oceans, (3rdedition), Wiley –Blackwell.
Web Resources	
1	http://coe.genomics.org.cn/
2	http://www.bcb.iastate.edu/
3	http://www.nwfsc.noaa.gov/protocols/bioinformatics.html
4	http://www.ebi.ac.uk/ ExPASy.org/
5	http://www.expasy.org/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

ELECTIVE VII- FOOD TECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			3	5	25	75	100

Learning Objective	
LO1	Students will be able to understand the basic concepts of the food industry
LO2	Will learn about classification of food
LO3	Will learn about fruits, vegetables and horticulture
LO4	Will learn about Non vegetarian food
LO5	Will learn about food adulteration and biosensors to detect them

UNIT	Contents	No.of Hours
1	Biotechnology relating to the food industry – Role of bioprocess engineering in biotechnology industry- Regulatory and social aspects of biotechnology in foods- Application of biotechnology in waste treatment of food industries. Historical evolution of food processing technology.	15
II	Cereals and Millets. Wheat- composition, types (hard, soft/ strong, weak). Malting, gelatinization of starch. Rice- and composition, parboiling of rice- advantages and disadvantages. Composition of pulses, toxic constituents in pulses, processing of pulses soaking, germination, decortications, cooking and fermentation. Fats and Oils. Refining of oils, Rancidity.	15
III	Classification of fruits and vegetables, general composition, enzymatic browning, names and sources of pigments, Dietary fibre. Post-harvest changes in fruits and vegetables –physical changes, chemical changes, pathological changes during the storage of fruits and vegetables.	15
IV	Concept of red meat and white meat, composition of meat, marbling, post-mortem changes in meat- rigor mortis, tenderization of meat, ageing of meat. Aquaculture, composition of fish, characteristics of fresh fish, spoilage of fish - microbiological, physiological and biochemical. Composition and nutritive value of egg, deterioration of egg quality. Milk and Milk Products. Chemical composition of milk, its constituents, processing of milk, pasteurization, homogenization.	15

V	Types of food adulterants – test to detect adulterants in foods – metal contaminants - contaminants of processed foods- Food products as analytical samples, general aspects of biosensors- biosensors for food contaminant analysis, commercially available biosensors for food analysis. Food additivies, FSSAI regulations, Methods of fortifying and enriching foods.	**15**
Total		**75**
Text Books		
1	Bawa. A.S, O.P Chauhan et al. Food Science. New India Publishing agency, 2013.	
2	B. Srilakshmi, Food science, New Age Publishers,2002	
3	Joshi, V.K. and Singh, R.S., A. (2013), *Food Biotechnology- Principles and practices,* I.K.International Publishing House Pvt. Ltd., New Delhi,.	
4	RavishankarRai, V,(2015), *Advances in Food Biotechnology*, (First edition), John Wiley & Sons, Inc, ISBN 9781118864555.	
5	Perry Johnson-Green.(2018), *Introduction to Food Biotechnology*, Special Indian Edition, *CRC Press*, ISBN 9781315275703.	
Reference Books		
1	Roday,S. Food Science, Oxford publication, 2011.	
2	Meyer, Food Chemistry, New Age,2004 5. De Sukumar., Outlines of Dairy Technology, Oxford University Press, 2007	
3	Foster, G.N., (2020), *Food Biotechnology*, (First edition), CBS Publishers & Distributors Pvt Ltd, ISBN 9789389396348.	
4	Anthony Pometto, Kalidas Shetty, Gopinadhan Paliyath, Robert E. Levin(2005), *Food Biotechnology*, (2nd edition), *CRC Press,*ISBN 9780824753290.	
5	Roday,S. Food Science, Oxford publication, 2011.	
Web Resources		
1	https://ifst.onlinelibrary.wiley.com/journal/13652621	
2	https://app.knovel.com/web/browse-a-subject-area.v/catid:216/cat_slug:food-science/subcatid:27	
3	https://www.springer.com/journal/13197	
4	https://www.sciencedirect.com/referencework/9780081005965/food-science	
5	https://www.ift.org/news-and-publications/food-technology-magazine	

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CLO1	**3**	**2**	**1**	**1**	**2**	**2**	**3**	**3**	**3**
CLO2	**3**	**2**	**1**	**1**	**2**	**2**	**3**	**3**	**3**
CLO3	**3**	**2**	**1**	**1**	**2**	**2**	**3**	**3**	**3**
CLO4	**3**	**2**	**1**	**1**	**2**	**2**	**3**	**3**	**3**
CLO5	**3**	**2**	**1**	**1**	**2**	**2**	**3**	**3**	**3**
TOTAL	**15**	**10**	**5**	**5**	**10**	**10**	**15**	**15**	**15**
Average	**3**	**2**	**1**	**1**	**2**	**2**	**3**	**3**	**3**

ELECTIVE VIII -MEDICAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			3	5	25	75	100

Learning Objective		
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**
1	Antibodies and vaccines - Therapeutic production of antibodies, antibody mediated drug delivery of vaccines, different kind of vaccines and applications of recombinant vaccines.	**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 Clinical trials and its application. 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**
Total		**75**

Text Books	
1	Roli, M. (2017). *National Ethical Guidelines for Biomedical and Health Research Involving Human Participants,*ISBN: 978-81-910091-94
2	Lela, B. and Maribeth, L. F. (2011). *Molecular Diagnostics: Fundamentals, Methods and Clinical Applications*, (1st Edition) . Philadelphia, USA. F A Davis Company. ISBN-13: 978-0803626775
3	*Clinical Applications*, (1st Edition) . Philadelphia, USA. F A Davis Company. ISBN-13: 978-0803626775
Reference Books	
1	Bernard, R. G. Terry, L.D. and Cherryl, L.P. (2014). *Medical Biotechnology*, (2nd edition).
2	Patrick, R.M. Kenneth, S.R. and Michael, A.P. (2016). *Medical Microbiology*, (8th edition). USA. Elsevier Publishers, eBook ISBN: 9780323388504
3	Pamela, G. Michelle, M, (2009). *Molecular Therapeutics: 21st century medicine,* (1st Edition). Hoboken, New Jersey. Wiley Publishers.
Web Resources	
1	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2881260/
2	https://www.nature.com/articles/s41577-021-00542-x
3	https://www.ncbi.nlm.nih.gov/books/NBK26837/
4	https://www.sciencedirect.com/topics/medicine-and-dentistry/dna-sequencing
5	http://aquafind.com/articles/Elisa.php

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

ELECTIVE VIII - FORENSIC SCIENCE

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			3	5	25	75	100

Learning Objective		
LO1	Students will gain insight into Forensic science .	
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**
1	Definition and scope of Forensic Biotechnology, History and development, Forensic genetics.	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
Total		**75**

Text Books	
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, (2nd edition), Select Publishers, New Delhi, ISBN: 9788190113526.
4	Barbara H. Stuart (2013). Forensic Analytical Techniques (Analytical Techniques in the Sciences (AnTs), (1st edition), UK, Wiley, ISBN: 978-0-470-68727-7.
5	C. Champod, C. Lennard, C. Margot, P. and Stoilovic (2015). Fingerprints and otherRidge Skin Impressions, (7th edition), Boca Raton, CRC Press, ISBN: 9781498728959.
Reference Books	
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). *Huber and Headrick's Handwriting Identification: Facts and Fundamentals,* (2nd Edition), Boca Raton, CRC Press, ISBN: 9781498751308.
4	Ghosal S. and Avasthi A.S. (2018). *Fundamentals of Bioanalytical Techniques and Instrumentation,* (2nd Edition), Delhi, PHI, ISBN: 9789387472396.
Web Resources	
1	http://www.forensicsciencesimplified.org
2	www.nfstc.org
3	https://archive.org/details/FBI_Handbook_of_ForensicScience
4	https://www.soinc.org/forensics-notes

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

ELECTIVE VIII -GOOD LABORATORY PRACTICES (GLP)

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			3	5	25	75	100

Learning Objective		
LO1	The student will know the types of labs associated with Biotechnology	
LO2	Will know to use and maintain lab Instruments	
LO3	Will know the calculations needed in a laboratory	
LO4	Will know about good lab Guidelines	
LO5	Will know how to safely dispose bio waste	
UNIT	**Contents**	**No. of Hours**
1	Types of labs associated with Biotechnology (General lab, microbial culture lab, plant tissue culture lab, Fermentation lab, computational stimulation lab), Types of Chemical (Analytical grade, molecular grade) and its various arrangement (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, Health hazards (how to use UV-illuminator), Fumigation technique.	15
II	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
III	Principles, use and maintenance of laboratory instruments like Autoclave, hot air oven, Incubators, Water bath, Refrigerator, Centrifuge, Calorimeter, pH meter, Haemocytometer, Microtomes, Electronic balances, Biosafety cabinets. SOP preparation for instrumentation.	15
IV	Good Laboratory guidelines, Elements of GLP, Standard Operating Procedures and its importance, Quality Assurance & Quality control, Internal audit basics, ISO, BIS and HACCP standards.	15

V	Definition of waste, types of waste: Biological andchemical waste, methods of Safe Disposal of biological and chemical waste: treatment methods of Ethidium Bromide solutions, Electrophoresis Gels, Contaminated Gloves, debris, Wastes containing sodium azide, Silver staining solutions, Perchloric acid, Nanoparticle wastes, Spill management, Awareness and training for personnel.	15
Total		**75**
Text Books		
1	WHO training manual on Good Laboratory Practices, 2nd Edition.	
3		
1	Milton A. Anderson GLP Essentials: A Concise Guide to Good Laboratory Practice, Second Edition 2nd Edition, Published by CRC press.	
Web Resources		
1	https://www.who.int/tdr/publications/documents/glp-trainer.pdf"tdr	
2	https://www.who.int/tdr/publications/documents/glp-trainer.pdf"›publications › documents	
3	https://www.who.int/tdr/publications/documents/glp-trainer.pdf"glp	
4	https://www.who.int/tdr/publications/documents/glp-trainer.pdf"-trainer	
5	www.who.int/tdr/publications/documents/glp-handbook.pdf	

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CLO1	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**
CLO2	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**
CLO3	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**
CLO4	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**
CLO5	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**
TOTAL	**15**	**15**	**15**	**10**	**10**	**15**	**15**	**15**	**15**
AVERAGE	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**

PREPARATION FOR COMPETITIVE EXAM

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	2				2	2	**25**	**75**	**100**

Learning Objective	
LO1	Ability to use numbers at an appropriate level of accuracy
LO2	Develops skills of analysis and critical evaluation
LO3	Identifies the Sentence Rearrangement, Antonyms and Synonyms. Error Detection. Idioms and Phrases
LO4	Ability to learn the patterns and techniques to solve the questions
LO5	Develops knowledge in various issues of country

UNIT	Contents	No. of Hours
1	**SERIES COMPLETION:** Number Series. Alphabet Series, Alpha Numeric Series, Continuous Pattern Series. ANALOGY: Completing the Analogous Pair, Direct Analogy, Double Analogy, Multiple word Analogy, Number Analogy and Alphabet analogy. CLASSIFICATION: Choosing the odd word, Choosing the odd Pair of words, Choosing the odd Numeral word, Choosing the odd Numeral Pair of words, Choosing the odd Letter Group.	**10**
II	**Coding and Decoding**- Letter Coding, Direct Letter Coding, Number /Symbol Coding, Matrix Coding, Substitution, Deciphering Message Word Codes, Deciphering Number and Symbol Codes for Messages and Jumbled Coding. Blood Relations: deciphering jumbled up Descriptions, Relation Puzzle, Coded Relations. Family based Puzzles and Jumbled Problems.	**5**
III	**Verbal Ability**- Reading Comprehension. Cloze Test. Sentence Rearrangement. Antonyms and Synonyms. Error Detection. Idioms and Phrases, One-word substitution, Word analogy, Resume writing	**5**

IV	**ARITHEMATICAL REASONING**-Calculation based Problems, Data Based Questions, Problems On Ages, Venn Diagram based Questions. Inserting Missing Character, Data Sufficiency, Assertion and Reason, Situation Reaction Test and Verification of Truth of the Statement.	**5**
V	UNIT V: **General Awareness and Current Affairs.** Indian Polity and Governance, Economic and Social Development, General issues on Environmental Ecology, Biodiversity, and Climate Change, General Science, Current events of national and international importance, History of India and the Indian National Movement, Indian and World Geography	**5**

TEXT BOOKS

1	A Modern Apporoach to VERBAL REASONING – Dr, R.S AGGARWAL. S CHAND and Company Limited (AN ISO 9001:2008 COMPANY) Ram Nagar, NEW DELHI-110055,ISBN:978-93-5283-217-0
2	Upkars Current Genral knowledge current affairs and who is who?
3	General English for all competitive exams by S.C.Guptha
4	How to Crack Test Of Reasoning -Verbal,analytical and non-verbal reasoning-Jai Kishan,Premkishan

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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