

B.Sc.,
BIOTECHNOLOGY

SYLLABUS

FROM THE ACADEMIC YEAR
2023 - 2024

Periyar University, Salem-636011

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:	<p>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</p> <p>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.</p> <p>PO3: Critical thinking: Capability to apply analytic thought to a body of knowledge; analyze 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.</p> <p>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.</p> <p>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</p>

viewpoints.

PO6: Research-related skills: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesizing and articulating; Ability to recognize cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyze, 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 analyze, 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 to embrace

	<p>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 demonstrating the ability to identify ethical issues related to ones work, avoid unethical behavior 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.</p> <p>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.</p> <p>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.</p>
<p>Programme Specific Outcomes:</p>	<p>On successful completion of Bachelor of Biotechnology programme, the student should be able to:</p> <p>PSO1: Disciplinary Knowledge: Understand the fundamental principles, concepts, and theories related to biotechnology. Also, exhibit proficiency in performing experiments in the laboratory.</p> <p>PSO2: Critical Thinking: Analyze complex problems, evaluate information, synthesize information, apply theoretical concepts to practical situations, identify assumptions and biases, make informed decisions and communicate effectively.</p> <p>PSO3: Problem Solving: Employ theoretical concepts and critical reasoning</p>

	<p>ability with physical, mathematical and technical skills to solve problems, acquire data, analyze their physical significance and explore new design possibilities.</p> <p>PSO4: Analytical & Scientific Reasoning: Apply scientific methods, collect and analyze data, test hypotheses, evaluate evidence, apply statistical techniques and use computational models.</p> <p>PSO5: Research related skills: Formulate research questions, conduct literature reviews, design and execute research studies, communicate research findings and collaborate in research projects.</p> <p>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.</p>
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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.	<ul style="list-style-type: none"> • Instil confidence among students • Create interest for the subject
I, II, III, IV	Skill Enhancement papers (Discipline centric / Generic / Entrepreneurial)	<ul style="list-style-type: none"> • Industry ready graduates • Skilled human resource • Students are equipped with essential skills to make them employable
		<ul style="list-style-type: none"> • Training on Computing / Computational skills enable the students gain knowledge and exposure on latest computational aspects
		<ul style="list-style-type: none"> • Data analytical skills will enable students gain internships, apprenticeships, field work involving data collection, compilation, analysis etc.
		<ul style="list-style-type: none"> • Entrepreneurial skill training will provide an opportunity for independent livelihood • Generates self – employment

		<ul style="list-style-type: none"> • Create small scale entrepreneurs • Training to girls leads to women empowerment
		<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Exposure to industry moulds students into solution providers • Generates Industry ready graduates • Employment opportunities enhanced
II year Vacation activity	Internship / Industrial Training	<ul style="list-style-type: none"> • Practical training at the Industry/ Banking Sector / Private/ Public sector organizations / Educational institutions, enable the students gain professional experience and also become responsible citizens.
V Semester	Project with Viva – voce	<ul style="list-style-type: none"> • Self-learning is enhanced • Application of the concept to real situation is conceived resulting in tangible outcome

VI Semester	Introduction of Professional Competency component	<ul style="list-style-type: none"> • 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		<ul style="list-style-type: none"> • 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
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CREDIT DISTRIBUTION FOR UG PROGRAMME

3 – Year UG Programme			
Credits Distribution			
		No. of Papers	Credits
Part I	Tamil(3 Credits)	4	12
Part II	English(3 Credits)	4	12
Part III	Core Courses (4 Credits)	15	68
	Elective Courses :Generic Discipline Specific (3 Credits)	8	24
Total			116
Part IV	NME (2 Credits)	2	4
	Skill Enhancement Courses	5	9
	Skill Enhancement Courses	1	2
	Professional Competency Skill Enhancement Course	1	2
	EVS (2 Credits)	1	2
	Value Education (2 Credits)	1	2
Total			21
Summer internship			2
Part V	Extension Activity (NSS / NCC / Physical Education)		1
Total Credits for the UG Programme			140

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	3	6	4	2	23
Part V	-	-	-	-	-	1	1
Total	23	23	22	25	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	Paper code	Name of the Course	Title of the paper	Ins Hrs	Credits	Int. Marks	Ext. Marks	Total
Part – I		Language	Tamil I	6	3	25	75	100
Part - II		Language	English I	6	3	25	75	100
Part III	23UBTCT01	Core Paper I	Core Paper I -Cell and Developmental Biology	4	4	25	75	100
	23UBTCT02	Core paper II	Core paper II Molecular biology	3	3	25	75	100
	23UBTDE01	Elective I	Elective I Biological chemistry	3	3	25	75	100
	23UBTCP01	Core Practical I	Core practical I-Cell and Molecular Developmental Biology and biological chemistry	4	3	40	60	100
Part IV	23UBTNE01	*Skill Enhancement Course SEC-I (NME)	Food nutrition	2	2	25	75	100
	23UBTNE02		Public Health and Hygiene					
	23UBTFC01	Skill Enhancement (Foundation Course)	Mushroom cultivation technology	2	2	25	75	100
Total				30	23	215	585	800

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

SECOND SEMESTER

Course Content	Paper code	Name of the Course	Title of the paper	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part – I		Language	Tamil II	6	3	25	75	100
Part - II		Language	English II	4	3	25	75	100
Part-II		NMSDC	Language Proficiency for employability- Overview of English Communication	2	2	25	75	100
Part - III	23UBTCT03	Core paper III	Core Paper III - Genetics	5	5	25	75	100
	23UBTCT04	Core paper IV	Core paper IV Human Physiology	2	2	25	75	100
	23UBTDE02	Elective II	Elective II Fundamentals of Microbiology	3	3	25	75	100
	23UBTCP02	Core practical II	Core Practical II – Genetics and Microbiology	4	3	40	60	100
	23UBTNE03	*Skill Enhancement Course SEC-2(NME)	1.Organic farming and health management	2	2	25	75	100
	23UBTNE04		2.Biotechnology for society					
	23UBTSE01	Skill Enhancement Course SEC-3	Vermicompost technology	2	2	25	75	100
Total				30	25	215	585	800

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

THIRD SEMESTER

Course Content	Paper code	Name of the Course	Title of the paper	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part – I		Language	Tamil III	6	3	25	75	100
Part - II		Language	English III	6	3	25	75	100
Part - III	23UBTCT05	Core Paper V	Core Paper V- Immune system and Immunotechnology	5	5	25	75	100
	23UBTCT06	Core paper VI	Core Paper VI-Clinical biotechnology	2	2	25	75	100
	23UBTDE03	Elective III	ELECTIVE III bioinformatics and biostatistics	3	3	25	75	100
	23UBTCP03	Core Practical III	Core Practical III – Immunotechnology, bioinformatics and biostatistics	4	3	40	60	100
PART IV	23UBTSE02	Skill Enhancement Course (SEC-4)	Quality control in industries	1	1	25	75	100
		NMSDC	Digital Skills for Employability-Digital Skills	2	2	25	75	100
	23UES01	*	* Environmental Studies	1	-	-	-	-
Total				30	22	215	585	800

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

FOURTH SEMESTER

Course Content	Paper code	Name of the Course	Title of the paper	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part – I		Language	Tamil IV	6	3	25	75	100
Part - II		Language	English IV	6	3	25	75	100
Part - III	23UBTCT07	Core paper VII	Core paper VII Genetic Engineering	6	6	25	75	100
	23UBTDE04	Elective IV	ELECTIVE IV Bioinstrumentation	3	3	25	75	100
	23UBTCP04	Core Practical IV	Core Practical IV Lab in Genetic Engineering and Bioinstrumentation	4	4	40	60	100
Part-IV	23UBTSE04	Skill Enhancement Course (SEC-6)	Fundamentals in Research Methodology	2	2	25	75	100
	23UBTSE05	Skill Enhancement Course(SEC-7)	Cryogenics and cryobiology	2	2	25	75	100
			Environmental Studies	1	2	25	75	100
Total				30	25	215	585	800

FIFTH SEMESTER

Course Content	Paper code	Name of the Course	Title of the paper	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part - III	23UBTCT08	Core Paper VIII	Core Paper VIII Plant Biotechnology	5	4	25	75	100
	23UBTCT09	Core Paper IX	Core Paper IX Animal Biotechnology	5	4	25	75	100
	23UBTDE05	Elective paper V	*Nano Biotechnology	4	3	25	75	100
	23UBTDE06		*Enzymology and Enzyme technology					
	23UBTDE07		*Pharmaceutical Biotechnology					
	23UBTDE08	Elective paper VI	Biofarming	4	3	25	75	100
	23UBTDE09		*Bioethics, Biosafety and IPR					
	23UBTDE10		*Dairy science and technology					
	23UBTCP05	Core Practical V	Core Practical V – Plant Biotechnology	4	3	40	60	100
		Core Practical VI	Core Practical VI – Animal Biotechnology	4	3	40	60	100
	23UBTPR01	■	Project	2	2	25	75	100
Part- IV	23UBTIO01	■	■ Internship	-	2	-	-	-
Part- V			Value Education	2	2	25	75	100
Total				30	26	230	570	800

* Choose any one Elective

- Students undergo summer vacation after IV Semester for 2 weeks.

SIXTH SEMESTER

Course Content	Paper code	Name of the Course	Title of the paper	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part-III	23UBTCT11	Core paper X	Core Paper X– Entrepreneurship development in Biotechnology	5	3	25	75	100
	23UBTCT12	Core paper XI	Core paper XI Environmental and Industrial Biotechnology	5	3	25	75	100
		Core paper XII	Core paper XII Stem cell technology and Tissue engineering	4	3			
	23UBTCP06	Core practical VII	Core Practical VII – Environmental and Industrial Biotechnology	4	3	40	60	100
	23UBTDE11	Elective paper VII	*Marine science and technology	5	3	25	75	100
	23UBTDE12		*Food science and technology					
	23UBTDE13		*Cancer Biology					
	23UBTDE14	Elective paper VIII	*Medical Biotechnology	5	3	25	75	100
	23UBTDE15		*Forensic science and technology					
	23UBTDE16		*Good Laboratory Practices					
Part IV		Professional competency skill enhancement	Skill Based Paper For Competitive Examination	2	2	25	75	100
Part V	23UEX01		Extension Activities		1	25	75	100
Total				30	21	215	585	800

Remarks: English Soft Skill Two Hours Will be handled by English Teachers

(4+2 = 6 hours for English).

CORE PAPER

S.NO	SEM	SUB CODE	CORE PAPER	SUBJECT CODE	CREDITS
1	I	23UBTCT01	Core Paper I	Cell and Developmental Biology	4
2		23UBTCT02	Core paper II	Molecular Biology	3
3		23UBTCP01	Core Practical I	Lab in Cell and Molecular Developmental Biology and Biological chemistry	3
4	II	23UBTCT03	Core Paper III	Genetics	5
5		23UBTCT04	Core Paper IV	Human Physiology	2
6		23UBTCP02	Core Practical II	Lab in Genetics and Microbiology	3
7	III	23UBTCT05	Core Paper V	Immune system and immunotechnology	5
8		23UBTCT06	Core Paper VI	Clinical biotechnology	2
9		23UBTCP03	Core Practical III	Lab in Immunotechnology, bioinformatics and biostatistics	3
10	IV	23UBTCT07	Core paper VII	Genetic Engineering	6
11		23UBTCP04	Core practical IV	Lab in Genetic Engineering and Bioinstrumentation	4
12		23UBTCT08	Core Paper VIII	Plant Biotechnology	4
13	V	23UBTCT09	Core Paper IX	Animal Biotechnology	4
14		23UBTCP05	Core Practical V	Lab in Plant Biotechnology	3
15		23UBTCP06	Core Practical VI	Lab in Animal Biotechnology	3
16	V	23UBTPR01	Project	Project	2
17	VI	23UBTCT10	Core Paper X	Entrepreneurship development in Biotechnology	3
18		23UBTCT11	Core paper XI	Environmental and Industrial Biotechnology	3
		23UBTCT12	Core paper XII	Stem cell technology and Tissue engineering	3

19		23UBTCP07	Core Practical VII	Lab in Environmental and Industrial Biotechnology	3
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ELECTIVE PAPER

SEM	PART	SUBJECT CODE	ELECTIVE	SUBJECT	CREDITS
I	III	23UBTDE01	ELECTIVE I	Biological chemistry	3
II	III	23UBTDE02	ELECTIVE II	Fundamentals of microbiology	3
III	III	23UBTDE03	ELECTIVE III	bioinformatics and biostatistics	3
IV	III	23UBTDE04	ELECTIVE IV	Bioinstrumentation	3
V	III	23UBTDE05	ELECTIVE V	Nano Biotechnology	3
		23UBTDE06		Enzymology and enzyme technology	
		23UBTDE07		Pharmaceutical Biotechnology	
		23UBTDE08	ELECTIVE VI	Biofarming	3
		23UBTDE09		Bioethics, Biosafety and IPR	
		23UBTDE010		Dairy science and technology	
VI	III	23UBTDE11	ELECTIVE VII	Marine science and technology	3
		23UBTDE12		Food science and technology	
		23UBTDE13		Cancer Biology	
		23UBTDE14	ELECTIVE VII	Medical Biotechnology	3
		23UBTDE15		Forensic science and technology	
		23UBTDE16		Good Laboratory Practices	

SKILL ENHANCEMENT COURSE SEC-I (NME)

SEM	PART	SEC	SUBJECT CODE	SUBJECT	CREDITS
I	IV	SEC 1	23UBTNE01	Food Nutrition	2
			23UBTNE02	Public Health and Hygiene	
II	IV	SEC 2	23UBTNE03	Organic farming and Health Management	2
			23UBTNE04	Biotechnology For Society	

SKILL ENHANCEMENT COURSE

SEM	PART	SEC	SUBJECT CODE	SUBJECT	CREDITS
II	IV	SEC -3	23UBTSE01	Vermicompost technology	2
III	IV	SEC-4	23UBTSE02	Quality control in industries	1
		SEC-5	23UBTSE03	Medicinal herb	2
		SEC-6	23UBTSE04	Fundamentals of research methodology	2
IV	IV	SEC-7	23UBTSE05	Cryogenics and cryobiology	2

SKILL ENHANCEMENT (FOUNDATION COURSE)

SEM	PART	SUBJECT CODE	SUBJECT	CREDITS
I	IV	23UBTFC01	MUSHROOM CULTIVATION TECHNOLOGY	2

MANDATORY SUBJECTS

- 1) Cell and Developmental Biology
- 2) Molecular Biology
- 3) Biological Chemistry
- 4) Genetics
- 5) Human Physiology
- 6) Fundamentals of Microbiology
- 7) Immune system and immunotechnology
- 8) Clinical Biotechnology
- 9) Bioinformatics and Biostatistics
- 10) Genetic Engineering
- 11) Bioinstrumentation
- 12) Plant Biotechnology
- 13) Animal Biotechnology
- 14) Environmental and Industrial Biotechnology
- 15) Nano Biotechnology
- 16) Enzymology and enzyme technology
- 17) Bioethics, Biosafety and IPR
- 18) Cancer Biology
- 19) Entrepreneurship development in Biotechnology
- 20) Pharmaceutical Biotechnology
- 21) Marine science and technology
- 22) Food science and technology
- 23) Forensic science and technology
- 24) Good Laboratory Practices

25) Medical Biotechnology

26) Stem cell technology

FIRST YEAR - SEMESTER – I

CORE PAPER- I: CELL AND DEVELOPMENTAL BIOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCT01	3	1			4	4	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.

COURSE OUTCOME

Upon successful completion, students will have the knowledge and skills to:		
CO1	Understanding the prokaryotic and Eukaryotic cell.	
CO2	Discussing in detail the cell membrane and function.	
CO3	Overview of the central dogma of life and various molecular events Learning molecular events in the DNA replication and role of different enzymes-Molecular Events Translation leading to protein synthesis and Post translational modification.	
CO4	Compare and contrast the events of cell cycle and its regulation Gaining knowledge for cell to cell signaling.	
CO5	understands the students about sequential changes from single cell organization to organ level in the development of multicellular organisms.	
UNIT	Contents	No. of Hours
I	Discovery and diversity of cells - Cell theory - Structure of prokaryotic (bacteria) and eukaryotic cells (plant and animal cells).	10
II	Structure and Functions of Cell Organelles: Cell wall - Cell membrane - Cytoplasm - Nucleus - chromosomes -Endoplasmic reticulum - Ribosomes - Golgi bodies - Vacuoles - Lysosomes - Mitochondria - Microbodies - Flagella - Cilia - Centrosome and Centrioles - Cytoskeleton.	20
III	Cell cycle - Cell cycle checkpoints - Cell division - Mitosis and Meiosis - Cellular differentiation - Cell junctions - Cell Adhesion - Extracellular Matrix - Cell to cell communications - Signal transduction - G - Protein Coupled Receptors Signal transduction pathways.	15
IV	Specialised cells -Motile cells(Amoeboid, Ciliary, Flagellar Movements, Nerve cells and Nerve impulse conduction, Muscle cells and Muscle contraction, Plant cells (Parenchyma cells,Xylem and Phloem Cells)	15

V	Gametogenesis - Spermatogenesis and Oogenesis in mammals. Fertilization- Types of cleavage, blastula formation, gastrulation and formation of germ layers in animals- Organogenesis.	15
Total		75
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, 11 th edition. Sinauer Associates Inc. Publishers, MA. USA.	
4	Bruce Alberts, 6 th 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.	
6	Pijushroy .,2010,Plant Anatomy,New Central Book Agency,Put Lit.,New Delhi	
7	P.S.Verma &V.K.Agarwal. ,(2016-Reprint)-Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S.Chand Publishing Company Pvt Ltd,New Delhi.	
Reference Books		
1	Karp's Cell and Molecular Biology: Concepts and Experiments. 8 th Edition (2015). Wiley Publications.	
2	James D. Watson, 7 th Edition (2014), Molecular Biology of the Gene, Pearson Publications.	
3	Geoffrey M. Cooper, 7 th Edition (2015). The Cell: A Molecular Approach, Sinauer Associates, Qxford University Press.	

4	Lodish Harwey, 6 th Edition (2016), Molecular Cell Biology, W. H. Freeman Publications.
5	Wolpert L, Tickle C, 2015. Principles of Development, 5 th 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

CORE PAPER II -MOLECULAR BIOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total

23UBTCT02	2	1	-	3	3	25	75	100
Learning Objective								
LO1	Know about basics structure of DNA and RNA, and Organization of genes in prokaryotes & Eukaryotes. Gain knowledge about replication in Prokaryotes & Eukaryotes and role of enzymes in replication							
LO2	Understand the gene expression by Translation and Transcription process and regulation of gene expression.							
LO3	Know about the Mutation, their types and repair mechanism							
LO4	Understand the Genetics exchanges in microbes							
LO5	Know about basics structure of DNA and RNA, and Organization of genes in prokaryotes & Eukaryotes. Gain knowledge about replication in Prokaryotes & Eukaryotes and role of enzymes in replication							
Course objectives								
CO1	Gain knowledge on the structure and characters of Genetic materials.							
CO2	Understand replication of DNA.							
CO3	Learn transcription and translation process in prokaryotes and Eukaryotes.							
CO4	Perceive Genetic alterations and their repair mechanisms.							
CO5	Understand the methods of genetic exchange.							
UNIT	Contents							No. of Hours
1	DNA and RNA as genetic material, Characters of a genetic material, Chemistry & Molecular structure of DNA, Topology of DNA, Structure and types of RNA. Bacterial chromosome, Organization of genes in prokaryotes .							12
II	Replication of DNA – Replication in prokaryotes– Mechanism & enzymology of replication – Theta replication & Rolling circle replication.							12
III	Transcription in prokaryotes , Post transcriptional modifications. – Genetic code – Translation of proteins , Post translational modifications. Regulation of gene expression in prokaryotes – Operon concept – lac & trp Operon							12

IV	Mutation - spontaneous and induced Mutagen & Mutagenesis – DNA repair mechanism.	12
V	Genetic exchange – Transduction (specialized & generalized), Transformation, Conjugation - Hfr mapping, genetic recombination.	12
Total		60
Text Books		
1	Gardner, E. J, Simmons, M J& D P Snustard ,1991 , Principles of Genetics, 8th edition. John Wiley & Sons.NY	
2	David Freifelder .S, 1987 Microbial Genetics, Jones & Bartlett, Boston.	
3	Robert H .Tamarin. Principles of Genetics, 5th edition, WmC Brown Publishers.	
Reference Books		
1	Lewin.B, 1990. Genes, 6th edition, Oxford University Press.	
2	Klug .W.S. & Cummings, MR, 1996, Essentials of Genetics, Mentics Hail. NewJersey.	
Web Resources		
1	https://www.youtube.com/watch?v=0lZRAShqft0	
2	https://www.youtube.com/watch?v=JQByjprj_mA	
3	https://www.zmescience.com/medicine/genetic/dna-replication-steps-43264/# https://www.youtube.com/watch?v=NGLuO-NYRug	
4	https://www.youtube.com/watch?v=a48GfC0ygpq	
5	https://www.youtube.com/watch?v=0lZRAShqft0	

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	3	3	3	2
CO2	2	2	3	3	3	3	3	3	2
CO3	2	2	3	3	3	3	3	3	2
CO4	3	3	3	3	3	3	2	3	3
CO5	3	3	3	3	3	3	3	3	3
Total	14	13	15	14	15	15	14	15	12
Average	2.8	2.6	3	2.8	3	3	2.8	3	2.4

23UBTDE01 - BIOLOGICAL CHEMISTRY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCT02	3	1			3	4	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 and preparation of buffer solutions
LO3	Recall the Structure, Classification, Chemistry and Properties of Carbohydrates and Explain Various Biochemical Cycles involved in Carbohydrate Metabolism.
LO4	Recall the Structure, Classification, Chemistry and Properties of Lipids, Nucleic acid and Explain Various Biochemical Cycles involved in Fatty acid and Nucleic acid Metabolism.
LO5	Understand the Structure, Classification, Chemistry and Properties of proteins amino acids and Identify and explain nutrients in foods and the specific functions in maintaining health.

COURSE OUTCOME

CO1	To make students have a strong foundation in chemical biology.
CO2	To introduce them to metabolic pathways of the major biomolecules and relevance to clinical conditions
CO3	To correlate Biochemical process with biotechnology applications
CO4	To discuss the significance of various metabolic processes occurring in biological system

CO5	To evaluate of both Hormones and Enzymology and also its medical importance in the human life.	
UNIT	Contents	No. of Hours
I	Atomic theory, formation of molecules, electronic configuration of atoms- s & p shapes of atomic orbitals. Periodic table, periodic classification, valency. Types of chemical bonds. Classification of organic compounds -. Hybridization in methane, ethane, acetylene, and benzene.	12
II	Acids & Bases properties and differences, Concepts of acids and bases- Arrhenius, Lowry-Bronsted and Lewis. Concentration of solution, ways of expressing concentrations of solutions – per cent by weight, normality, molarity, molality, mole fraction. pH of solution, pH scale, measurement of pH. Buffer solutions, properties of buffers, Henderson-Hasselbalch equation, mechanism of buffering action of acidic buffer and basic buffer.	15
III	Classification of carbohydrates. Properties of carbohydrates. Metabolism of Carbohydrates – Glycogenesis, Glycogenolysis, Glycolysis, Gluconeogenesis TCA cycle, bioenergetics of carbohydrate metabolism.	15
IV	Classification of Lipids. Characteristics, Properties and Biological importance of lipids. Metabolism of Fatty acids, phospholipids, cholesterol. B-oxidation of fatty acids.	15
V	Classification and structure of amino acids. Structural conformation of proteins. Classification of proteins. Properties and biological importance of amino acids and proteins. Degradation of Amino acids and Urea Cycle. Vitamins (Biological functions, daily requirements, deficiency symptoms and diseases-Structure not required) and Hormones.	15
Total		75

Text Books	
1	P.L. Soni , A Text-book of Inorganic Chemistry, 11 th Edition, S. Chand & Sons publications
2	Abhilasha Shourie, Shilpa S, Chapadgoankar & Anamika Singh (2020) Textbook of Biochemistry 1 st Edition
3	J.L. Jain, 2016, Fundamentals of Biochemistry, S. Chand publication, 7th edition.
4	A.C. Deb, 2016, Fundamentals of Biochemistry, New central book agencies, 7th edition.
5	Satyanarayana .U, 2016, Biochemistry, MJ publishers 3 rd edition (2006).
Reference Books	
1	Lehninger (2013) Principles of Biochemistry 4 th edition WH Freeman and Company NY
2	Murray <i>et al.</i> , (2003) Harper's biochemistry 26 th edition Appleton and Lange Publishers Florida USA
3	Geoffrey L. Zubay, William W. Parson, Dennis E. Vance, 1995, Principles of Biochemistry, W.C. Brown Publishers, 1995, 3rd edition.
4	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, 22 nd 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://www.sciencedirect.com › topics › agricultural-and-biological-sciences

5	https://biochemistry.org › education › careers › becoming-a-bioscientist
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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 PRACTICAL - I CELL AND DEVELOPMENTAL BIOLOGY AND BIOLOGICAL CHEMISTRY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCP01			4		3	4	40	60	100
Learning Objective									
LO1	Demonstrate the operation of Light Microscope Identify blood cells and its components								
LO2	Isolate and identify plant, and animal cells. Summarizes the concept of gametes								

	Develop skill to perform cell fractionations.	
LO3	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	
LO4	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. Understand the methods of acidimetry, alkalimetry and permanganometry.	
LO5	Quantify Ascorbic acid in lemon by Dichlorophenol indo phenol dye method, Glycine by sorensens formal titration method. Estimate Glucose,Cholesterol and Proteins.	
COURSE OUTCOME		
CO1	Find out the various stages of Cell division Sex chromatin determination by performing a Barr body experiment	
CO2	To know the different stages of chick embryo	
CO3	To analyse the organic compounds present in the cell	
CO4	To know the components in unknown sample	
CO5	to calculate the unknown concentration of a solution	
UNIT	Contents	No. of Hours
I	CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY 1. Components of a Compound / Light Microscope. 2. Blood smear preparation and Identification of Blood cells 3. Buccal smear preparation and Identification of squamous epithelial cells.	9

II	4.Isolation and Identification of plant cells and animal cells 5.Observation of sperm & Egg 6. Mounting of chick Embryo - 24 hrs, 48 hrs, 72 hrs, 96 hrs. 7.Cell fractionation and Identification of cell organelles (Demo)	9
III	BIOLOGICAL CHEMISTRY Systematic analysis of Organic compounds 8.Functional group tests (Carboxylic acid (Benzoic acid, phthalic acid), Phenol, Urea, Benzaldehyde, Aniline (Aniline not to be given for exam) Detection of elements (N, Halogens)	9
IV	Qualitative Analysis 9. Qualitative analysis of carbohydrates - Glucose, Fructose, Lactose, maltose, sucrose, starch. 10. Qualitative analysis of amino acids - Tyrosine, Tryptophan, Arginine, Proline and Cysteine.Histidine.	9
V	Colorimetric Analysis 11. Estimation of glucose- Ortho touluidine method 12. Estimation of Cholesterol- Zak's method 13.Estimation of proteins – Lowry's method	9
Total		45
Text Books		
1	K.V. Chaitanya, (2013), <i>Cell and molecular biology: Lab manual</i> , PHI publishers,. ISBN 978-81-203-800-4	
2	J. Jayaraman, <i>Laboratory Manual in Biochemistry</i> , New Age International Pvt Ltd Publishers, 2011.	
3	S. K. Sawhney Randhir, Singh, <i>Introductory Practical Biochemistry</i> , Alpha Science International Ltd, 2 nd edition, 2005.	

4	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	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

***SKILL ENHANCEMENT COURSE SEC-I (NME)**

NON MAJOR ELECTIVE 1 (Offered to other dept)

FOOD AND NUTRITION

Subject	T	P	S	Instructional	Marks
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Code	L				Credits	Hours	CIA	External	Total
23UBTNE01	1	1			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								
COURSE OUTCOME									
CO1	Learn about nutrition and their importance								
CO2	To know about the classification of nutrients and its deficiency								
CO3	To analyse the BMR								
CO4	To know about the basic food groups and adulteration								
CO5	To learn the knowledge of principles and objectives of meal planning								
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.								6
II	Carbohydrate, Protein, Fat, Vitamin and Minerals (Calcium, Phosphorous, Sodium, Potassium, Iron, Iodine, Fluorine) -Sources, Classification, Function and Deficiencies of these nutrients. Function of water and dietary fiber.								6
III	BMR: Definition, factors affecting BMR and total energy requirements								6

	(Calculation of energy of individuals)	
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, Safety measures in food handling, Food adulteration, food Preservatives and food Packaging.	6
V	Principles and Objectives of meal planning. Diet planning for different age groups (infant, school children, adults and old age)	6
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), <i>Food Biotechnology- Principles and practices</i> , I.K.International Publishing House Pvt. Ltd., New Delhi, .	
2	Ravishankar Rai, V,(2015), <i>Advances in Food Biotechnology</i> , (First edition), John Wiley & Sons, Inc, ISBN 9781118864555	
3	Foster, G.N., (2020), <i>Food Biotechnology</i> , (First edition), CBS Publishers & Distributors Pvt Ltd, ISBN 9789389396348	
4	Anthony Pometto, Kalidas Shetty, Gopinadhan Paliyath, Robert E. Levin (2005), <i>Food Biotechnology</i> , (2 nd edition), <i>CRC Press</i> , ISBN 9780824753290	
5	Perry Johnson-Green (2018), <i>Introduction to Food Biotechnology</i> , Special Indian	

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 SEC-I (NME) (offered to other department)**

NME-PUBLIC HEALTH AND HYGIENE

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTNE02	1	1			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	
COURSE OUTCOME		
CO1	Learn about public health and hygiene	
CO2	Gain knowledge and understanding of the wider determinants of health and ill-health	
CO3	To know awareness of the debates and dilemmas that may arise from the promotion of public health.	
CO4	To learn some knowledge and understanding of the roles of people and agencies who undertake work in the promotion of public health	
CO5	Gain knowledge on health problems to develop solutions	
UNIT	Contents	No.of Hours
I	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.	6
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 treatment).	6
III	Communicable viral diseases- measles, poliomyelitis, swine flu, dengue, chickungunya, rabies, leprosy and hepatitis, COVID. 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.	6
IV	Non-communicable diseases such as hypertension, stroke, coronary heart disease, myocardial infarction. Osteoporosis and rheumatoid arthritis-cause, symptom, precautions. Diabetes- types and their effect on human health. Gastrointestinal disorders- acidity,(Gastro intestinal reflex disorder-GIRD), peptic ulcer, constipation,. (cause, symptoms, precaution and treatment) Obesity (Definition and consequences). Mental illness (depression and anxiety). Oral cancer and their	6

	preventive measures.	
V	Health Services Organizations: World Health Organization (WHO), United Nations International Children's Emergency Fund (UNICEF) and Indian Red Cross (IRC).	6
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. <i>Public Health Management Principles And Practice</i> , 2nd Edition, CBS Publishers and Distributors Pvt Ltd, ISBN: 978-93-87742-93-2.	
2	Mary-Jane Schneider (2016), <i>Introduction to Public Health</i> ,(5th Edition), Jones & Bartlett Learning,. ISBN-13: 978-1284197594	
3	Carolyn D. Berdanier, Johanna T. Dwyer, David Heber (2013), <i>Handbook of Nutrition and Food</i> , (3rd Edition), CRC Press,. ISBN 9781466505711	
4	Sue Reed, Dino Pisaniello, GezaBenke, Kerrie Burton. (2013), <i>Principles of Occupational Health and Hygiene: An Introduction</i> , (2nd Revised ed. Edition), Allen &Unwin,	
5	V. Kumaresan, R. Sorna Raj, (2012) <i>Public Health and Hygiene</i> ,(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 (FOUNDATION COURSE)
MUSHROOM CULTIVATION TECHNOLOGY**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTFC01	1			1	2	2	25	75	100

Learning Objective

LO1	Students can start small scale industry of Mushroom cultivation- Students study the morphology and types of Mushrooms. They are aware of the identification of edible and poisonous Mushrooms
LO2	Learned the prospects and scope of mushroom cultivation in small scale industry.
LO3	Learned the life cycle of the <i>Agaricus species</i>
LO4	Students will be able produce spawn on their own.
LO5	Studied the technique of Mushroom cultivation. Understood the Diseases. Post harvesting techniques of Mushrooms.

Course objectives

CO1	To know the nutrient value of mushroom- To study the morphology and types of Mushrooms. To aware the identification of edible and poisonous Mushrooms
CO2	To learn the prospects and scope of mushroom cultivation in small scale industry.
CO3	To learn the life cycle of <i>Agaricus species</i>
CO4	To know the spawn production technique.
CO5	To understand the Diseases. Post harvesting techniques of Mushrooms.

UNIT	Contents	No. of Hours
I	Introduction: Morphology, Types of Mushroom, identification of edible and poisonous mushroom, Nutritive values, life cycle of common edible mushrooms.	6
II	Mushroom cultivation, prospects and scope of Mushroom cultivation in small scale Industry.	6
III	Life cycle of <i>Pleurotus spp</i> and <i>Agaricus spp</i> .	6
IV	Spawn production, growth media, spawn running and harvesting of mushrooms and marketing.	6
V	Diseases and post harvest technology, Insect pests, nematodes, mites, viruses, fungal competitors and other important diseases.	6
Total		30

Text Books

1	Handbook of Mushroom Cultivation. 1999. TNAU publication.
2	Marimuthu, T., Krishnamoorthy, A.S., Sivaprakasam, K. and Jayarajan. R. (1991). Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
3	Swaminathan, M. 1990. Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
4	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.
5	Bahl, N. (1984-1988). Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

Reference Books

1	Suman. 2005. Mushroom Cultivation Processing and Uses, M/s. IBD Publishers and Distributors, New Delhi.
2	Sing. 2005. Modern Mushroom Cultivation, International Book Distributors, Dehradun.
3	Handbook of Edible Mushroom Today and Tomorrows printers and publishers.
4	Sharma V.P. 2006. Diseases and Pests of Mushrooms, M/s. IBD Publishers and Distributors, New Delhi.
5	Tewari, P and Kapoor, S.C.1988. Mushroom cultivation, Mittal Publications New Delhi.

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	2	2	3	3	3
CO3	3	2	2	3	2	3	3	3	3
CO4	3	3	2	2	2	3	3	3	2
CO5	3	2	3	3	3	3	3	2	3
Total	15	13	13	14	12	14	15	13	14
Average	3	2.6	2.6	2.8	2.4	2.8	3	2.6	2.8

SEMESTER – II

CORE PAPER III GENETICS

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCT03	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 in depth Knowledge on population Genetics.								
Course outcome									
CO1	Obtain acquaintance on historical overview of microbial genetics and genetic Materials								

CO2	Comprehend the concept of replication of genetic materials	
CO3	Understand about regulation of gene expression and mutation	
CO4	Grasp the Basic of genetics and their role	
CO5	Gain knowledge on mutation	
UNIT	Contents	No. of Hours
1	Mendel's experiments, Monohybrid cross, Dihybrid cross, Backcross or Testcross, Mendel's laws. Dominance (complete and incomplete). Interaction of Genes- Epistasis and lethal genes. Multiple alleles in Drosophila and Blood group inheritance in man.	15
II	Linkage - linkage in Drosophila- Morgan's experiments, factors affecting linkage. Crossing over- types, mechanism, significance of crossing over. Mapping of Chromosomes, interference and coincidence. Cytoplasmic inheritance –Linked Inheritance and Sex-Determination in Man.	15
III	Fine structure of the gene and gene concept, Operon Concept. Identification of the DNA as the genetic material- Griffith experiments, Avery, McLeod, McCarty and Hershey Chase experiment.	15
IV	Mutation – types of mutation, mutagens, DNA damage and Repair Mechanism. Chromosomal aberrations- Numerical and Structural, Pedigree Analysis-Mendelian inheritance in human. (Cystic Fibrosis, Muscular Dystrophy).	15
V	Population Genetics– Hardy Weinberg principle, gene frequency, genotype frequency and factors affecting gene frequency. Eugenics and	15

	Euthenics.	
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.knrnpublishings.com, ISBN-978-81-907011-2-9	
3	Verma, P.S. and Agarwal, V.K., 1995. Genetics, 8 th edition, S.Chand & Co., New Delhi – 10055.	
4	Verma, P.S., and Agarwal, V.K., 1995. Cell and Molecular Biology, 8 th 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. 4 th 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

CORE PAPER IV : HUMAN PHYSIOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCT04	1	1			2	2	25	75	100

Learning Objective

LO1	Illustrate about digestive secretions and absorptive mechanisms
LO2	Comprehend the process of gaseous exchange in tissues and lungs
LO3	Obtain an insight about muscle physiology and cardiovascular system
LO4	Understand urine formation and physiology of reproductive system
LO5	Get an idea about neuron structure and sensory physiology

Course objectives		
CO1	To build an in depth knowledge about basic physiological principles of various organs in the human body.	
CO2	To understand physiology of various systems and its functions.	
CO3	To get adequate knowledge on cardiovascular system and skeletal system	
CO4	To understand physiology of excretory system	
CO5	To get adequate knowledge on sensory organs.	
UNIT	Contents	No. of Hours
I	Digestive System: Overview of the digestive system, secretions of digestive tract, digestive hormones, process of digestion, absorption, assimilation of carbohydrates, proteins, fats, nucleic acids. Absorption of vitamins, minerals and water	12
II	Respiratory System: Overview of the respiratory system, pulmonary ventilation, Alveolar ventilation, composition and partial pressure of inspired air, alveolar air and expired air, exchange and transport of respiratory gases.	12
III	Muscle physiology and Cardiovascular System: overview of muscle tissue, contraction and relaxation of skeletal muscle, cardiac muscle tissue and cardiac conduction system, cardiac cycle, cardiac output, blood pressure and human skeletal system, skeletal divisions and functions of skeleton.	12
IV	Excretory System: Overview of renal system, Renal physiology: - glomerular filtration, tubular reabsorption and secretion, production of dilute and concentrated urine. Reproductive System: Overview of male and female reproductive system, menstrual cycle, physiology of pregnancy,(fetal development), fertilization process, parturition and lactation	12
V	Nervous System: Overview of nervous system, classification of nervous system, signal transmission at synapse, neurotransmitters. Special Senses: Physiology of Olfaction, Gustation, Vision, Hearing and equilibrium	12
Total		60

Text Books	
1	Essentials of Medical Physiology, K. Sembulingam and Prema Sembulingam, 6 th Edition, 2012
2	Principles of Anatomy and Physiology, Tortora and Grabowski, 2003, John Wiley & Sons, Inc.
3	Human Physiology, Chatterjee. C. 11th edition Medical agency allied, Calcutta.
Reference Books	
1	Textbook of medical physiology, A.C. Guyton 10th edition.
2	Human body, Atlas, Publication Garden cheers.
3	A Text Book of Human physiology, Sarada Subrahmanyam et al., 2010, S Chand & Company
Web Resources	
1	https://mymedicallibrary.files.wordpress.com/2016/08/jaypee-essentials-of-medical-physiology-6thedition.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	2	3	3	2
CO2	3	2	3	3	3	3	3	3	3
CO3	3	2	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3	2
Total	15	13	15	14	15	14	15	15	13
Average	3	2.6	3	2.8	3	2.8	3	3	2.6

ELECTIVE II-FUNDAMENTALS OF MICROBIOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total

23UBTDE02	2	1			3	3	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.								
Course outcome									
CO1	Remember and recall the historical events which paved the development of different types of microscopes.								
CO2	Understand and differentiate the different types of microbes								
CO3	Analyze the media composition and grow the desired microbe								
CO4	Apply the knowledge to enumerate the microorganisms from natural environment.								
CO5	Evaluate the success of understanding the microbial diseases								
UNIT	Contents								No. of Hours
I	History of Microbiology (Biogenesis and abiogenesis, spontaneous generation), Classification of bacteria, fungi, virus, protozoa and algae – classical and molecular approaches. Scope and applications								15

	of microbiology –Contributions of scientists in the field of microbiology.	
II	Structure of bacteria (Gram positive and Gram negative) - Bacterial growth and measurement of growth, Media and its types Staining methods (Gram's, capsule, spore, LCB mount). Methods of preservation of microorganisms. <i>In vitro</i> cultivation of, virus and algae.	15
III	Sterilization methods - physical and chemical methods. Definition and classification of antibiotics. Mode of action of different groups of antibiotics.– Antimicrobial resistance and its mechanism. MRSA, ESBL	15
IV	Bioinsecticides - <i>Bacillus thuringiensis</i> , Baculoviruses- Biofertilizers - <i>Azospirillum</i> and blue green algae - single cell protein – prebiotics and probiotics - Dairy products (Cheese and Yoghurt). Types of microscopy – Definitions, light, dark field, phase contrast, fluorescence, and electron microscopes.	15
V	Microbial Disease- host -pathogen interaction, clinical features, lab diagnosis and treatment of Airborne disease (Pneumonia, Chicken pox), food borne disease (Typhoid, Aspergillosis), Water borne disease (Cholera, Amoebiasis), Sexually transmitted disease (AIDS, Trichomoniasis), Vector borne disease (Dengue, Malaria).	15
Total		75
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, 10 th 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, 14 th edition, 2017.
2	Gillespie, Bamford, Medical Microbiology and Infection at a Glance, 4 th edition, 2012.
3	Boyd, R.F. (1998). General Microbiology, 2 nd Edition., Times Mirror, Mosby College Publishing, St Louis.
4	Tortora, G.J., Funke, B.R., Case, C.L. (2013). Microbiology. An Introduction 11 th Edition., A La Carte Pearson.
5	Salle. A.J (1992). Fundamental Principles of Bacteriology. 7 th Edition., McGraw Hill Inc. New York.

Web Resources

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

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 PRACTICAL II – GENETICS AND MICROBIOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCP02			4		3	4	25	75	100
Learning Objective									
LO1	Demonstrate the basic principles of important techniques in Molecular biology and Genetics. Analyze the Polytene chromosome of the organisms. Identify Barr bodies from Buccal smear								
LO2	Demonstrate the Preparations and maintenance of culture medium Demonstrate Human karyotyping								
LO3	Describe the general Laboratory safety & Sterilization Techniques Develop Skills in Media Preparation, Isolation & Serial Dilution Techniques and Pure Culture Techniques								
LO4	Microscopically analyze the morphological features of Bacteria and fungi and define various Staining Techniques. Perform the Motility of organisms								
LO5	Able to characterize and identify bacteria using Biochemical tests.								
Course outcome									
CO1	Examine and evaluate the stages of Mitosis								
CO2	Analyze the sex chromatin present in different cells								

CO3	Be aware of the laboratory rules and regulations	
CO4	Learns to visualize the cells by employing different types of microscopes	
CO5	Bring in the concepts of microbial culturing techniques	
UNIT	Contents	No. of Hours
1	1.Mitotic stages of onion (<i>Allium cepa</i>) root tip 2.Meiotic stages of cockroach testes/ Flower bud 3.Giant chromosomes from Chironomus larvae/ Drosophila salivary glands 4.Identification of Barr bodies from Buccal smear	9
II	5.Preparations of culture medium and culture of Drosophila – methods of maintenance 6.Identifications of mutants of Drosophila Human karyotyping (Demo)	9
III	7.Sterilization techniques – Preparation of Media 8.Inoculation techniques- Pour plate, spread plate and streak plate (simple, continuous, „T“ streak and quadrant streak methods) 9. Isolation of bacteria from air, soil and water. Serial dilution method.	9
IV	10.Staining techniques: Simple, Gram’s, Capsule Spores, 11.Preparation of temporary mounts- Lacto phenol cotton blue staining 12. Motility test: Hanging drop technique.	9
V	13. Biochemical characterization - catalase, oxidase, IMVIC test and TSI. 14. Antibiotic sensitivity test by Kirby-Bauer method (demonstration).	9
Total		45
Text Books		
1	Practical Manual on "Fundamentals of Genetics" (PBG-121). 2019, Edition: First Publisher: Odisha University of Agriculture & Technology. Editor: Kaushik Kumar Panigrahi	

2	Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications.
3	James G Cappucino and N. Sherman MB(1996). A lab manual Benjamin Cummins, New York 1996.
4	Sundararaj T (2005). Microbiology Lab Manual (1 st edition) publications.
5	Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ld., Publishers, New Delhi.
6	R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishing.
Reference Books	
1	Atlas.R (1997). Principles of Microbiology, 2 nd Edition, Wm.C.Brown publishers.
2	Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1 st Edition). Elsevier India.
3	Talib VH (2019). Handbook Medical Laboratory Technology. (2 nd Edition). CBS.
4	Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication.
5	Lim D. (1998). Microbiology, 2 nd 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	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 SEC-2(NME)

ORGANIC FARMING AND HEALTH MANAGEMENT

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTNE03	1	1			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								
Course Objectives									
CO1	To understand advanced concepts of crop growth and productivity in relation to climate change								

CO2	Students will have knowledge on the conservation of biodiversity	
CO3	Understand the principles of agribusiness management.	
CO4	Discuss and learn public health care system in India	
CO5	Analyze the health conditions of the family members	
UNIT	Contents	No. of Hours
I	Ecology and Environment – Principles of ecology – Ecosystem - Biotic and abiotic components and interaction – Energy flow –Nutrient cycle – Biodiversity – Endemic – Exotic - Interrelationships.	6
II	Composting – Microbial Compost – Vermicompost – Setup for vermicompost unit - Nutrition garden – Ring garden – Double digging – Cultivating vegetables – Common medicinal herbs – Identification and Cultivation.	6
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.	6
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.	6
V	Exercise and Health related fitness: Health related fitness, health promotion and physical activity for health benefits. Sports related fitness: Role of nutrition in sports, nutrition to athletic performance.	6
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	Adrienne E. Hardman, 2009. Physical Activity and Health – The evidence explained, Second	

edition, Taylor and Francis Group.

Reference Books

1	Farmers of Forty Centuries: Permanent Organic Farming in China, Korea, and Japan Hardcover – 10 June 2011 by <u>F. H. King</u> (Author)
2	Organic Farming: Components And Management Edition: 1 Author/s:Gehlot D , Publisher: M/s AGROBIOS (INDIA) ISBN: 9788177544008

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 SEC-2(NME)

BIOTECHNOLOGY FOR SOCIETY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CI A	External	Total
23UBTNE04	1	1			2	2	25	75	100
Learning Objective									

LO1	Will understand the role of Biotechnology in Sericulture, Apiculture and Mushroom Cultivation	
LO2	Will gain knowledge about the production of Bio fertilizer and advantages of Biopesticides	
LO3	Will understand the significance of microorganisms in Biodegradation	
LO4	Will get know about History of Antibiotics	
LO5	Will able to comprehend about Transgenic Plants	
UNIT	Contents	No. of Hours
I	Introduction to Biotechnology- Role of Biotechnology in sericulture- Rearing of silkworms- Importance and applications- Role of Biotechnology in apiculture- Bee hive hierarchy- Bee keeping process- Products obtained- Mushroom farming stages- Cultivation of paddy straw mushroom- importance of mushroom cultivation.	6
II	Biofertilizer- Definition- Mass production of <i>Rhizobium</i> -Advantages and disadvantages- Biopesticides- Definition- Microbial biopesticides- <i>Bacillus thuringiensis</i> - Single cell protein- Introduction- history- production of <i>Spirulina</i> SCP- Applications- Advantages & disadvantages.	6
III	Biodegradation- Definition- Process-role of microorganisms in biodegradation - biodegradable plastics-advantages- Bio weapons- introduction- history- potential agents- delivery methods- harmful effects.	6
IV	Antibiotics- Definition- Introduction and history of antibiotics- sources- classification- spectrum- production of penicillin- definition of antibiotic resistance.	6
V	Transgenic plants – Definition of transgene and transgenesis - BT Cotton, Flavr-Savr tomato and Golden rice- history – importance, applications, advantages and disadvantages.	6
Total		30
Text Books		

1	Sathyanarayana, U., Chakrapani, U., (2008). <i>Biotechnology</i> , First edition, Books and allied (P) Ltd, Kolkata.
2	A.K. Chatterji, (2011). <i>Introduction to Environmental Biotechnology</i> , Third edition, PHI Learning Pvt Ltd. New Delhi. ISBN-978-81-203-4298-9
3	R.C. Dubey, (2014). <i>A text book of Biotechnology</i> , S.Chand & Company, New Delhi. ISBN 9788121926089
4	H. Patel, (2011). <i>Industrial Microbiology</i> , (2 nd edition), MacMillan Publishers
5	Thakur, I.S., (2019). <i>Environmental Biotechnology- Basic principles and applications-</i> (2 nd edition)- Dreamtech Press, ISBN 978-93-89307-55-9
3	
1	Basics of Biotechnology Paperback – 1 January 2004 by A.J. Nair (Author) Publisher Laxmi Publications
	Basic Biotechnology Paperback – 2 February 2008 by Ratledge Colin (Author) Publisher Cambridge University Press

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	2	3	3
CLO3	3	2	3	3	3	3	3	2	3
CLO4	3	3	3	3	3	3	3	3	3
CLO5	3	3	3	3	2	3	2	3	3
TOTAL	15	14	15	15	14	15	13	14	15

Average	3	2.8	3	3	2.8	3	2.6	2.8	5
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SKILL ENHANCEMENT COURSE SEC-3

VERMICOMPOST TECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTSE01	1	-	-	1	2	2	25	75	100
Learning Objective									
LO1	Vermicomposting technology broadly followed at the global level and some Indigenous methods, role of microbes in increasing the soil fertility by the action of earthworms, their advantages and limitations dealt								
LO2	understand the environmental conservation process and its importance, pollution control, biodiversity and protection of earthworms through vermiculture								
LO3	To learn vermicomposting techniques								
LO4	Contribute their knowledge to develop organic fertilizer with rural and urban biodegradable wastes using the Earthworms.								
LO5	To understand various applications of earthworms in organic solid waste management, soil fertility, and bioremediation.								
Course objectives									
CO1	Find out Vermicomposting is an eco-friendly, economically and socially acceptable technology								

CO2	Illustrate that Vermitechnology is useful for stabilization and recycling of both industrial and domestic organic waste.	
CO3	Utilize Vermitechnology to improve the soil texture, soil aeration, improve the water retention capacity in the soil	
CO4	Improve Vermitechnology to manufacture the vermicompost in small scale industry by which the economy of the farmer is improved. It provides the employment opportunity in rural and urban areas.	
CO5	Justify and prove that the Earthworms are having the capacity to observe heavy metals into their body tissues and converting the soil without heavy metals.	
UNIT	Contents	No. of Hours
I	Types, Collection and Preservation of earthworms - Types and basic characteristics of species suitable for vermicomposting; Role of earth worms in soil fertility, Biology of <i>Lampito maruitti</i> ; Collection and Preservation of Earthworms; Flow sheet for vermi technology.	6
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.	6
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.	6
IV	Large scale techniques of Vermicomposting Outdoor dual bin; Raised cage; Dual pit; Commercial model; Trickling filter vermicomposting; Keep it simple and save plan.	6

V	Vermiwash and Economics - Chemical composition of vermiwash; Techniques of vermiwash production: Advantages of Vermicomposting; Prospects of vermi-culture as self employment venture.	6
Total		30
Text Books		
1	The Earthworm book, Ismail, S.A., other India Press, Goa	
2	Somani, L.L. 2008. Vermicomposting and vermiwash. Agrotech Publishing Academy, Udaipur.	
3	Talashilkar and Dosani, 2005. Earthworm in Agriculture. Agrobios (India), Jodhpur.	
4	Ranganathan, L.S. 2006. Vermibiotechnology from soil health to human health – Agrobios, India.	

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	2	3	3	3	3
CO4	3	3	3	3	2	3	3	3	3
CO5	3	2	3	2	3	3	3	2	3
Total	15	14	15	14	13	15	15	14	15
Average	3	2.8	3	2.8	2.6	3	3	2.8	3

SEMESTER – III

CORE PAPER V- IMMUNE SYSTEM AND IMMUNOTECHNOLOGY

Subject	L	T	P	S	Credits	Instructional	Marks
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Code					Hours	CIA	External	Total
23UBTCT05	4	1			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.							
Course outcome								
CO1	Design a model of Immunoglobulin/Antibodies							
CO2	Describe which cell types and organs present in the immune response							
CO3	Illustrate various mechanisms that regulate immune responses and maintain Tolerance							
CO4	Exemplify the adverse effect of immune system including Allergy,							
CO5	Gain knowledge on hypersensitivity and autoimmunity							
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. Antigen processing and presentation (MHC molecules – structure, types and functions).	15
III	Antigen – Antibody interactions- Agglutination and precipitation reactions, Immunodiffusion and Immuno electrophoresis. Principle and application of ELISA and RIA and Fluorescent antibody technique and Western Blotting. Purification of antibodies.	15
IV	The complement system and activation and regulation. Types – Classical, alternative and Lectin pathway. Biological function of complement proteins. Cytokines- Structure, types and biological functions. Vaccines – Types, Production and application.	15
V	Hypersensitivity Reactions and Types. Major Histocompatibility Complex – MHC genes, MHC in immune responsiveness, Structure and function of Class I and Class II MHC molecules. HLA tissue typing. Auto immunity and autoimmune disorders. Transplantation immunology, Graft vs Host reaction mechanism of graft rejection.	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. 3 rd Edition.
3	William R Clark. (1991). The Experimental Foundations of Modern Immunology. 3 rd Edition. John Wiley and Sons Inc. New York.
4	Frank C. Hay, Olwyn M. R. Westwood. (2002). Practical Immunology, 4 th Edition., Wiley-Blackwell.
5	Noel R. Rose, Herman Friedman, John L. Fahey. (1986). Manual of Clinical Laboratory Immunology. ASM.3 rd 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

CORE PAPER VI : CLINICAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCT06	1	1	-		2	2	25	75	100
Learning Objective									
LO1	The major objective of the paper is to envisage thorough knowledge in genetic diseases								
LO2	Offers knowledge regarding Chromosomal aberrations								
LO3	Provides knowledge on genetic diseases								
LO4	Provides knowledge regarding various aspects of Human genetics								
LO5	Provide knowledge regarding clinical management and clinical enzymes								
Course outcome									
CO1	The students will gain knowledge about the inheritance pattern of the genes and								

	genetic diseases	
CO2	gain knowledge on numerical and structural changes of chromosomal	
CO3	The students will learn the modern molecular techniques for genetic disease diagnosis	
CO4	The students learn about the inheritance pattern of genes which cause genetic diseases in humans	
CO5	Gain knowledge on clinical management and clinical enzymes	
UNIT	Contents	No. of hrs.
I	Classification of genetic diseases. Chromosomal disorders-numerical disorders e.g. trisomers and monosomes, structural disorders e.g. deletions, duplications, translocations and inversions, chromosomal instability syndromes.	12
II	Gene controlled diseases-autosomal and X-linked disorder, mitochondrial disorders, Fragile X syndrome, myotonic dystrophy. Mitochondrial diseases. Microarray technology application in diseases.	12
III	Huntington's disease- sickle cell diseases, AAT (alpha-1 antitrypsin deficiency), Alzhemiers disease, cystic fibrosis, infection of nervous system.	12
IV	Clinical management & metabolic manipulation – PKU, Familial hyper cholesterolemia, Rickets, ADA, Congenital hypothyroidism.	12
V	Clinical Enzymes: Enzymes as thrombolytic agents, anti inflammatory agents, Streptokinase & Asparaginase. Catalytic antibodies.	12
Total		60
Reference book		
1	Betty Forbes, Danial SAHM Alics Weinfield, Bailey 2007. Scott's diagnostic microbiology, 12 th edition Mosby.	

2	Gerald collee, J, Andrew G. Fraser, Barri P Marmion, Mackie and Mc Cartney's Pratical medical microbiology, elesiver 2006.
3	Elmer W Koneman <i>et al.</i> , Koneman's 2005. Color Atlas and Textbook of diagnostic microbiology, 6 th edition. Lippincott Williams and Wilkins 35

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	3	3	2	3
CO2	3	2	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3
Total	15	12	15	15	15	15	15	13	15
Average	3	2.4	3	3	3	3	3	2.6	3

ELECTIVE III BIOINFORMATICS AND BIostatITICS

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTDE03	3	1			3	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.	
Course outcome		
CO1	A student will develop a fundamental knowledge of DNA databank , protein data bank and sequence alignment tool	
CO2	Acquire knowledge on handling biological databases	
CO3	Understand the practical skills in Statistics	
CO4	Understand test of significance	
CO5	Understand measures of central tendency like mean median-mode	
Unit	Contents	No. of Hours
1	Introduction to Bioinformatics – Genome, Transcriptome and Proteome, Gene prediction rules and software. Nucleic acid Databases – Primary and Secondary Databases – Structure Database – CATH, SCOP – Data base Searching – BLAST and FASTA, BLOSSUM.	15
II	Sequence analysis (Proteins and Nucleic acids), Protein Database: Comparison of Protein sequences and Database searching – methods for protein structure prediction - Homology modeling of proteins, visualization tools (RASMOL).	15
III	Multiple Sequences alignment – method of multiple sequences alignment- Evolutionary analysis, clustering methods Phylogenic trees - Methods to generate phylogenetic tree- Tools for multiple sequences alignment and phylogenetic analysis - History of Drug Discovery, Steps in Drug design - Chemical libraries – Role of molecular docking in drug design.	15

IV	Statistics – collection, classification, tabulations of Statistical Data – Diagrammatic representation – Graphs – Sampling method and standard error. Measures of central tendency – measures of dispersion.	15
V	Correlations and regression. Probability distribution-Binomial, Negative binomial, multinomial distribution, Poisson distribution. Tests of significance – t tests – F tests – Chi square test. Analysis of variance – Statistical Soft wares.	15
Total		75
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 Biostatistics" MJP Publishers	
5	Verbala Rastogi .(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 PRACTICAL III – IMMUNOTECHNOLOGY, BIOINFORMATICS AND BIOSTATISTICS

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCP03			4		3	4	25	75	100

Learning Objective

LO1	Perform blood grouping and determine blood type. Able to count WBC and RBC.
LO2	Conduct serological diagnostic tests such as ASO, CRP, RA and Widal test.
LO3	Acquire technical skills required for immunodiffusion and know the principle behind the

	techniques. Able to Demonstrate ELISA, Handling of Laboratory animals.	
LO4	Analyse the Biological databases, Able to perform BLAST and FASTA	
LO5	Represent data in to graphical form, Test the level of significance of biological data and interpret the results. Determine averages of the biological data	
COURSE OUTCOME		
CO1	Understand the practical skills in Immunology	
CO2	Examining and analyzing the results involved in immune techniques	
CO3	Acquire skills in instrument handling	
CO4	To know about the biological databases	
CO5	Learn about MS excel, Data Analysis and Interpretation	
UNIT	Contents	No. of Hours
I	IMMUNOTECHNOLOGY 1. Separation of Serum and Plasma. 2. Blood grouping and Rh typing. 3.WBC counting 4.RBC counting 5.Differential blood count	9
II	6.WIDAL Slide test 7.ASO test 8.Immunoelectrophoresis 9.Double Immunodiffusion 10.Single Radial Immunodifusion	9
III	11.ELISA – Demonstration 12.Western blotting(demo)	9

	13.Dot blot (demo) 14.Handling of Laboratory animals - Demonstration 15.Skin test – Demonstration	
IV	16.Biological databases (NCBI, SWISSPROT and PDB) 17.Sequence retrieval and alignment 18.BLAST FASTA 19.Protein visualization tools (Rasmol) 20.Identification of functional domains in nucleotide binding proteins using a domain analysis server like SMART	9
V	21. Preparation of bar diagram, line diagram and pie diagram using MS EXCEL. 22.Measurement of Central tendency- mean, geometric mean, median using MS EXCEL 23. Calculation of dispersion – Mean deviation, quartile deviation and standard deviation using MS EXCEL. 24.Calculation of student's t test using MS EXCEL 25.Analysis of variance (ANOVA)	9
Total		45
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. 3 rd Edition.
5	Peter J. Delves, Seamus Martin, Dennis R. Burton, Ivan M. Roitt. (2006). Roitt's Essential Immunology, 11 th Edition., Wiley-Blackwell.
6	Sharda University Abstract Laboratory Manual for Bio-instrumentation, Biochemistry, Microbiology, Cell Biology and Enzyme Technology.2018
7	Bhomwik (2011), <i>Analytical techniques in Biotechnology – A complete laboratory manual</i> , MGH Publisher, ISBN-13 : 978-0070700130

Reference book

1	P. Palanivelu (2017), <i>Analytical Biochemistry and Separation techniques – A laboratory manual</i> , (5 th Edition), Twentyfirst century publishers, ISBN: 978-81-908489-0-9
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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

Skill Enhancement Course (SEC-4)

QUALITY CONTROL IN INDUSTRIES

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTSE02	1	-	-		1	1	25	75	100
Learning Objective									
LO1	To impart basic knowledge about quality control in pharmaceutical industry, quality control audits in industries.								
LO2	Train the students on the basics of food safety and food quality.								
LO3	To teach the microbial quality control in hospitals aim to impart knowledge on manufacturing operation in industries								
LO4	Acquire skills to Manufacturing operations and controls								
LO5	Demonstrate handling of waste and scrap disposal.								
Course outcome									
CO1	To acquire the knowledge quality control in pharmaceutical industry								

CO2	To learn the quality control audits in industries.	
CO3	To understand the basics of food safety and food quality.	
CO4	Skilled on manufacturing operation in industries	
CO5	To understand the manufacturing skills and controls	
UNIT	Contents	No. of hrs
I	Industrial quality control-Process of quality control- sterile and non-sterile preparations – raw materials, purity check, quality check of finished products - Pharmaceutical products and their quality control-drugs and vaccines. Environmental Monitoring – Pharmaceutical industry.	5
II	Food safety and Food Quality-Microbiological criteria of food, food products, Monitoring of factory hygiene and sanitation, Food Safety and Standards. Food contaminants and diseases.	5
III	Microbial quality control in Hospitals-Control of Healthcare associated infections - Monitoring water quality in hospitals, healthcare infrastructures.	5
IV	Manufacturing operations and controls-Sanitation of manufacturing premises, cross contamination, processing of bulk products, packaging operations, release of finished product.	5
V	Manufacturing operations and controls- Expiry date calculation, calculation of yields, production record review, and handling of waste and scrap disposal.	5
Total		25
Text Books		
1	Nally, J. D. (Ed.) (2007). Good Manufacturing Practices for Pharmaceuticals, Sixth	

	Edition, Informa Healthcare USA, Inc., ISBN 10: 0-8593-3972-3 & ISBN 13: 978-0-8493-3972-1, New York.
2	The training manual for Food Safety Regulators. (2011) Food Safety regulations and food safety management. Food Safety and Standards Authority of India, New Delhi (http://www.fssai.gov.in/trainingmanual.aspx)
Reference book	
1	U.S. Environmental Protection Agency (EPA). Washington, DC (2014). 21-Food and drugs, chapter I--Food and Drug Administration.
2	WHOTRS823. (1992). WHO expert committee on specifications for pharmaceutical preparations: thirty-second report. WHO Technical Report Series: 823, ISBN 92 4140823 6, ISSN 0512-3054, Geneva
Web contents	
1	https://foodlicensing.fssai.gov.in/index.aspx
2	https://www.fda.gov/drugs/pharmaceutical-quality-resources/guidances-and-manuals-pharmaceutical-quality

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	2	3	3	2
CO2	3	3	2	2	2	2	3	3	2
CO3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3
CO5	3	3	2	3	3	3	3	3	3
Total	15	15	12	14	14	13	15	15	13
Average	3	3	2.4	2.6	2.6	2.8	3	3	2.8

**Skill Enhancement Course (SEC-5)
MEDICINAL HERBS**

Subject	L	T	P	S	Credits	Instructional	Marks
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Code					Hours	CIA	External	Total
23UBTSE03	1	1			2	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							
Course outcome								
CO1	demonstrate the ability to acquire basic knowledge on ethanobotany							
CO2	To understand the role of herbal medicine							
CO3	To know the diagnosis and treatment of diseases by tribal medicine							
CO4	To understand the knowledge and utility of some medicinal plants							
CO5	To understand the role of traditional medicine							
UNIT	Contents							No. of Hours
I	Ethnomedicine – definition, history and its scope – Inter disciplinary approaches in ethnobotany – Collection of ethnic information.							6
II	Importance of medicinal plants – role in human health care – health and balanced diet (Role of proteins, carbohydrates, lipids and vitamins).							6
III	Tribal medicine – methods of disease diagnosis and treatment – Plants in folk religion – <i>Aegle marmelos</i> , <i>Ficus benghalensis</i> , <i>Curcuma domestica</i> ,							6

	<i>Cynodon dactylon</i> and <i>Sesamum indicum</i> .	
IV	Traditional knowledge and utility of some medicinal plants in Tamil Nadu <i>Solanum trilobatum</i> , <i>Cardiospermum halicacabum</i> , <i>Vitex negundo</i> , <i>Adathoda vasica</i> , <i>Azadirachta indica</i> , <i>Gloriosa superba</i> , <i>Eclipta alba</i> , <i>Aristolochia indica</i> and <i>Phyllanthus fraternus</i> .	6
V	Plants in day today life – <i>Ocimum sanctum</i> , <i>Centella asiatica</i> , <i>Cassia auriculata</i> , <i>Aloevera</i> . Nutritive and medicinal value of some fruits (Guava, Sapota, Orange, Mango, Banana, Lemon, Pomegranate) and Vegetables - Greens (Moringa, <i>Solanum nigrum</i> Cabbage).	6
Total		30
Text Books		
1	R.K.Sinha & Shweta Sinha (2001), Ethnobiology. Surabhe Publications – Jaipur.	
2	D.C. Pal & S.K. Jain Naya Prakash, (1998), Tribal medicine, Bidhan Sarani, Calcutta ,	
3	S.K. Jain (2001) Contribution to Indian Ethnobotany – S.K. Jain, 3rd edition, scientific publishers, 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 Medicine Making Guide	
2	M.C. Joshi (2007) Handbook of Indian Medicinal Plants Hardcover.	
3	Neelesh Malviya and Sapna Malviya (2019). <i>Herbal Drug Technology</i> , (1st Edition), CBS Publishers and Distributors, ISBN: 9789387964334.	
4	Rageeb Md. Usman, Vaibhav M. Darvhekar, Vijay Kumar D, and Akhila S.A, (2019). <i>Practical Book of Herbal Drug Technology</i> , (1st Edition), Nirali Prakashan Publishers, ISBN: 9789388108002.	
5	Pragi and Varun Arora (2019). <i>Herbal Drug Technology</i> , (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

SEMESTER –IV

CORE PAPER VII- GENETIC ENGINEERING

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCT07	4	2			6	6	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.								

Course outcome		
CO1	Acquaint with the vocabulary involved in molecular cloning strategies and techniques used to probe DNA for specific genes of interest	
CO2	Apprehend with the tools and techniques in rDNA technology and types of Vectors	
CO3	Relate the role of restriction and modifying enzymes in recombinant DNA Technology	
CO4	Explore the techniques involved in construction of genomic DNA library and cDNA library	
CO5	Design the protocols for analyzing gene transfer methods and to explore knowledge on hybridization based markers	
UNIT	Contents	No. of Hours
I	Genetic Engineering – Introduction. Tools in recombinant DNA technology –recombinant DNA – cloning strategies- Enzymes-Restriction enzymes, modifying enzymes, ligation. Vectors-Cloning vectors: plasmid - definition, properties and types. pUC19 & pBR322- phage vectors (λ & M13), Expression vectors; YAC (<i>S.cerevisiae</i> as a model) & BAC (<i>E.coli</i>) 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), <i>Molecular Biology techniques</i> ,(3 rd edition).	
2	<u>Anton Byron</u> (2019), <i>Introduction to Gene Cloning</i> , Publisher: Oxford Book Company	
3	Monika Jain (2012), <i>Recombinant DNA technology</i> , (I edition), Alpha Science International. ISBN-13 : 978-1842656679.	
4	Primrose.S.B (2014), <i>Principles of gene manipulation</i> , (7th edition), Blackwell Scientific limited, Germany. ISBN: 978-1-405-13544-3	

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

COURSE PAPER IV - BIOINSTRUMENTATION

Subject	L	T	P	S	Credits	Instructional	Marks
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Code						Hours	CIA	External	Total
23UBTDE04	2	1			3	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.								
COURSE OUTCOME									
CO1	Demonstrate the basics of instrumentation by analysis								
CO2	Exemplify the structure of atoms and molecules by using the principles of Spectroscopy								
CO3	Evaluate by Separating and Purifying the components								
CO4	understand the need and applications of imaging techniques								
CO5	categorize the working principle and applications of fluorescence and radiation based techniques								
UNIT	Contents								No.of Hours

I	pH – Definition – pH meter. Measurement of pH and calibration of pH meter - Buffers – Preparation of Buffers. Microscopy: Principle and applications of Compound, Bright field, Phase contrast and Fluorescence Microscope.	10
II	Spectra – Absorption and Emission Spectra – Beer Lambert’s law – Colorimeter, UV-Visible Spectrophotometer. Fourier transform Infra red spectroscopy (FTIR), Mass spectroscopy - Atomic absorption spectrometer (AAS) - Nuclear magnetic resonance spectrometer (NMR). Raman spectroscopy.	10
III	Chromatography - Principles – Paper Chromatography, TLC, Ion-Exchange, Affinity Chromatography Gas Liquid Chromatography and HPLC. Electrophoresis: Principle, Paper Electrophoresis – Cellulose Acetate Electrophoresis - Agarose Gel Electrophoresis – SDS- PAGE and Iso-electric focusing.	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.	10
Total		50
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, New York.
3	Khandpur R S, 2014. Handbook of Biomedical Instrumentation, 3rd edition, McGraw Hill Education (India).
4	L.A Geddes and L.E. Baker (2008) “Principles of Applied Biomedical Instrumentation” Wiley India Third Edition.
5	Sharma B K, 2005. Instrumental Methods of Chemical Analysis, 24th Edition, GOEL Publishing House.

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	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 PRACTICAL IV- LAB IN GENETIC ENGINEERING AND BIOINSTRUMENTATION

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCP04			4		4	4	25	75	100
Learning Objective									
LO1	Isolate the Plasmid DNA and Genomic DNA. and predict the molecular weight of DNA by Agarose gel electrophoresis. Demonstrate working principles of PCR, RFLP and other important Genetic Engineering techniques.								
LO2	Prepare the competent cells and perform bacterial transformation.								
LO3	Determine the restriction digestion of DNA Determine the restriction fragment length polymorphism								
LO4	Practice, experiment with and apply the basic instruments in the laboratory such as weighing balance, pH meter, shaker, incubator etc. in various research processes. Predict the functionality of Beer – Lambert’s law in identifying and quantifying biomolecules.								
LO5	Employ the separation techniques for separating biomolecules based on paper chromatography.								

	Employ the separation techniques for separating biomolecules based on Thin layer chromatography. Employ the separation techniques for separating biomolecules based on centrifugal force by centrifugation.	
Course outcome		
CO1	Gain knowledge on isolation techniques	
CO2	Learn about gene transfer mechanism	
CO3	Acquire skills in instrument handling	
CO4	Developing and applying the recent technology involved in diagnostic techniques of immunology with instrument	
CO5	Acquires skills in separation techniques	
Unit	Contents	No.of hours
1	1.Isolation of genomic DNA 2.Isolation of plasmid DNA 3.Isolation of RNA	9
II	4.Production of competent cells for transformation 5.Bacterial transformation	9
III	6.Restriction Digestion of DNA 7.Ligation of digested DNA fragments 7.Restriction Fragment Length Polymorphism(DEMO) 8.PCR(Demonstration)	9
IV	BIOINSTRUMENTATION 9.Preparation of Buffer (Phosphate Buffer) 10.Determination of pH of biological samples using pH meter 11. Estimation of DNA and proteins by UV spectrophotometer.	9

V	<p>12. Chromatographic analysis of sugar, amino acids, lipids by paper chromatography.</p> <p>13. Chromatographic analysis of sugar, amino acids, lipids by Thin layer chromatography.</p> <p>14. Separation of chlorophyll pigments by column chromatography technique.</p> <p>15. Separation of DNA by Agarose Gel Electrophoresis (AGE)</p> <p>16. Separation of protein by SDS PAGE</p>	9
Total		45
Text Books		
1	Laboratory Manual for GENETIC ENGINEERING 1st Edition, Kindle Edition by S. JOHN VENNISON (Author) 2009.	
2	Pennington, S.R. and Punn, M.J. 2002. Proteomics: from protein sequence to function. Viva books Pri. Ltd.	
3	Maleolm and Goosfship. J. 2001. Genotype to phenotype, 2nd edition. Bios Scientific Publishers Ltd	
4	Misener, S. and Krawetz. S.A. 2000. Bioinformatics: Methods and Protocols. Humana press.	
5	Attwood, T.K. and Parry-Smith, D.J. 1999. Introduction to Bioinformatics. Pearson Education Asia.	
6	Primrose, S.B. 1998. Principle of genome analysis. 2nd edition. 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	2.8	2.8	2.8	3	2.8	2.8

Skill Enhancement Course (SEC-6)

FUNDAMENTALS OF RESEARCH METHODOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTSE04	1	1			2	2	25	75	100
Learning Objective									

LO1	To familiar with Introduction, types and methods of research	
LO2	Students should be able to identify the overall process of designing a research study from its inception to its report	
LO3	Students should understand a general definition of research design	
LO4	Students should know the primary characteristics of quantitative research and qualitative research	
LO5	Students should be able to identify a research problem stated in a study	
Course outcome		
CO1	This course aims to inculcate a clear idea of research among students, understand the existing social issues in research, frame hypothesis, design the wet lab procedures and interpret the results.	
CO2	Learn about Introduction, types and methods of research	
CO3	Acquiring the skills of scientific reading, writing and presentations of research	
CO4	Analyze the mechanism of separation and imaging techniques	
CO5	Learn the statistical analysis of biological data	
UNIT	Contents	No.of hrs
I	Objectives, Motivation to perform research. Types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Literature- review and its consolidation; Library research; field research; laboratory research.	6
II	Basic concepts of Statistical sampling methods, Sample Size, Sampling Frame, Sampling Error, Characteristics of a good sample, Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie	6

	charts, percentages)	
III	Research Question & Investigation Question, Hypothesis, Qualities of a good Hypothesis, Features of a good research design, Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.	6
IV	Layout of a Research Paper, Journals in Life Science, Impact factor of Journals, Ethical issues related to publishing: Plagiarism and Self-Plagiarism. Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.	6
V	Methods to search required information effectively, Reference Software such as Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Softwares for detection of Plagiarism.	6
Total		30
Text Books		
1	Research Methods for the Biosciences. Holmes, Moody & Dine. Oxford University Press.	
2	Experimental Design for the Life Sciences. Ruxton & Colegrave. Oxford University Press.	
3	Robert A. Day (1998), How to Write & Publish a Scientific Paper. Oryx Press; 5 editions	
4	Frank D. Bell (1995), Basic Biostatistics: Concepts for the Health Sciences. William C. Brown	
Reference book		
1	1. Judith Bell. Doing your research, A guide for first-time researchers in education, health, and social science. 4 th edition. Open University press. McGraw Hill education (2005).	
Web contents		
1	https://explorable.com/quantitative-research-design	

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	2	3
CO5	3	2	3	3	3	3	3	2	3
Total	15	13	15	15	15	15	15	13	15
Average	3	2.6	3	3	3	3	3	2.6	3

**Skill Enhancement Course (SEC-7)
CRYOGENICS AND CRYOBIOLOGY**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTSE05	1	1			2	2	25	75	100
Learning Objective									
LO1	Introduction to cryobiology and history of cryopreservation progress								
LO2	to understand the factors that influence the cryopreservation outcome								
LO3	The aims of the course are to introduce to students to basic concepts in ice physics and cryobiology								

LO4	to understand Application of Cryobiology	
LO5	apply the fundamental principles of cryobiology to improve current cryopreservation procedures	
Course outcome		
CO1	The course will help the student gain the knowledge about the latest cold preservation techniques. To learn and understand the detailed concept of cryopreservation, Nature's adaptation to cold conditions and the application of Cryobiology.	
CO2	The students will be familiar with the cryobiology fundamental, will have the knowledge to plan cryopreservation procedures involving freezing of biological materials.	
CO3	Will understand methods of investigation of ice binding proteins, their structure – function relations and their use in cryobiological applications.	
CO4	In addition students will learn debating in organize debate on issues such as genetically modified food and will participate in a demo development of a biotech cryobiology startup.	
CO5	summarize current cryopreservation practices in ART	
UNIT	Contents	No of hrs
I	Introduction to Cryobiology, cryopreservation - natural cryopreservation, temperature, risks, slow, permeable freezing, vitrification, uses freezable tissues, equipment, limitations.	6
II	Liquid nitrogen – uses, safety, production; glass transition- introduction, transition temperature T _g , kauzmann's paradox, the glass transition, specific materials, silica, polymers, mechanism of vitrification, electronic structures; ex-situ conservation; cryoprotectants; cryostasis;	6

	neuropreservation.	
III	Cryopreservation in nature – antifreeze protein, antifreeze, psychrophile, insect winter ecology, cryogenic treatment, cryogenic seal, cryogenic fuel, energy storage, crystal, cryotank, absolute zero, target temperature management.	6
IV	Hibernation, heterothermy, hibernaculum, hypothermia, chilblains, frost bite, trench feet, thermoregulation.	6
V	Application of Cryobiology - cloning, molecular cloning, organ transplantation, sperm bank, semen extender, in-vitro fertilization, embryo transfer, cryosurgery, cryoablation.	6
Total		30
Reference book		
1	Colby Gunn, A comprehensive introduction to Cryobiology, 2017 library press publishing, New York.	
2	http://ndl.iitkgp.ac.in/document	

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CLO1	3	1	1	1	1	1	1	1	1
CLO2	1	3	1	1	1	1	2	1	1
CLO3	1	1	3	1	2	1	1	1	1

CLO4	1	1	1	3	1	2	1	1	1
CLO5	1	1	1	1	3	2	2	3	1
TOTAL	7	7	7	7	8	7	7	7	5
AVERAGE	1.4	1.4	1.4	1.4	1.6	1.4	1.4	1.4	1

SEMESTER –V

CORE PAPER-VIII PLANT BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCT08	3	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.								
Course outcome									
CO1	Acquire the knowledge about the techniques of Plant Tissue Culture, Lab. organization & measures adopted for aseptic manipulation								
CO2	Acquire the knowledge about the nutritional requirements of cultured tissues.								

CO3	Learn the large scale clonal propagation of plants through various micropropagation techniques, Production of secondary metabolites under in vitro conditions	
CO4	A good understanding of r-DNA technology, methods of gene transfer, molecular markers and marker assisted selection	
CO5	Develop transgenics resistant to biotic & abiotic stresses & quality characteristics and their role in crop improvement	
Unit	Contents	No.of Hours
I	History of plant biotechnology, Conservation of Plant using Biotechnology. Plant genome organization: structural features of a representative plant gene, gene families in plants. Organization of chloroplast genome and mitochondrial genome.	15
II	Auxins, cytokinins and gibberlins – molecular basis of action – phytochrome – role in photomorphogenesis – abscisic acid – and stress – induced promoter switches in the control of gene expression – Ethylene and fruit ripening.	15
III	Media composition (MS media) - Micropropagation techniques - direct and indirect organogenesis - somoclonal variation - somatic embryogenesis - haploid and triploid - Protoplast isolation, fusion and culture - hybrid and cybrid production, Synthetic seed production. Secondary metabolite production.	15
IV	Agrobacterium and crown gall tumors – Mechanism of T-DNA transfer to plants, Ti and Ri Plasmid vectors and their utility – Plant viral vectors. Symbiotic nitrogen fixation in Rhizobia, nif gene.	15
V	Crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors. Transgenic plants- plant vaccines, genetically modified food - future perspectives & ecological impact of transgenic plants.	15

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 PAPER IX- ANIMAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCT09	3	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.	
COURSE OUTCOME		
CO1	To develop an understanding on basic pattern of animal cell culture and controlling characters	
CO2	To gain knowledge on the infrastructure requirements for animal cell culture like laboratory layout & design, equipments, substrates and media requirements for animal cell culture, properties of animal cell culture medium and maintenance of aseptic condition.	
CO3	Understand the gene transfer technology and gene expression	
CO4	Understand the transgenic animal and stem cell technology	
CO5	Highlight the applications of animal biotechnology in various fields	
UNIT	Contents	No.of Hours
I	Animal cell culture – History and development, Pluripotency, Media, balanced salt solutions, Physical, chemical and metabolic functions of constituents of culture media, Role of carbon dioxide, Serum, growth factors and amino acids in media. Serum containing and serum free media. Constitution of a media for cell line. Essential equipments required for animal cell culture.	15
II	Types of cell culture- Primary, Secondary, Organ culture and cell lines. Role of feeder layers in cell culture, Cell separation techniques, cell synchronization, Cell counting methods, cryopreservation, Cell banking procedures. Biology of cultured cells- Apoptosis and cell death.	15

III	Transfection of cells in culture- Animal viral vectors for transfection, Physical methods of transfection, HAT selection, selectable markers. Micro manipulation of cells, Gene targeting, gene silencing and Gene knockout and their applications.	15
IV	Protein production by genetically engineered mammalian cell lines, Stem cells and their applications-; Cell culture as a source of valuable products - Transgenic Animals.	15
V	Collection and preservation of embryos, Semen banking, AI, IVF and ICSI. Case Study-any two relevant studies.	15
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 <i>et al.</i> , 2009, Animal Biotechnology, Oxford & IBH Publishing Co. Pvt. Ltd.	
4	B.C. Currell <i>et al.</i> , 1994, In vitro Cultivation of Animal Cells (Biotol), Butterworth-Heinemann Ltd.	
5	Jenkins, N. (ed). 1999 Animal cell Biotechnology: Methods and protocols. Humana press, New Jersey.	
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 Pasternak. 2002. Molecular Biotechnology: Principle and applications of recombinant DNA.	

3	Kreuzer, H. and Massey, A. 2001. Recombinant DNA and Biotechnology: A guide for teachers, 2nd edition. ASM Press Washington.
4	Traven. 2001. Biotechnology. Tata McGraw – Hill.
5	Walker, J.M. and Gingold, E.B. 1999. Molecular biology and Biotechnology, 3 rd 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

ELECTIVE V- NANO BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTDE05	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.								
Course outcome									
CO1	The student will develop a fundamental knowledge of nanobiotechnology								
CO2	Understand the various types of nanoparticle characterization techniques.								
CO3	The student will develop a fundamental knowledge of nanomaterials								
CO4	The detail understanding of the importance of nanoparticles and its application in Nano biotechnology								
CO5	The detail understanding of nano biosensors and their applications								
UNIT	Contents								No. of Hours
1	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								12

	Institutes in the field of nanobiotechnology.	
II	Metals: Silver nanoparticle synthesis and its analyses by UV-spectroscopy and FTIR. Self-Assembly nanomaterial: Cell membrane and its analyses by SEM	12
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.	12
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.	12
V	Nano biosensors (Firefly-luciferase) and its applications, Introduction to Biomimetics (Gecko foot effect, Lotus leaf effect: Paint and fabrics, Box fish based Car).	12
Total		60
Text Books		
1	Vasantha Pattabhi and N. Gautham (2009), Biophysics, Narosa Publishing House, New Delhi.	
2	Narayanan.P (2010), Essentials of Biophysics, New Age International (P) Ltd. Publishers, New Delhi.	
3	Rai, Mahendra, and Clemens Posten (2013). <i>Green biosynthesis of nanoparticles: Mechanisms and applications</i> , CABI, ISBN: 9781780642246.	
4	Shanmugam.S, "Nanotechnology", MJP publishers, 2010.	

5	Pradeep T (2012). <i>Textbook of Nanoscience and Nanotechnology</i> , McGraw Hill publications, ISBN: 9781259007323.
Reference Books	
1	D.Voet & J.G.Voet (2010), <i>Biochemistry</i> , John Wiley & Sons, New York.
2	<i>Biochemistry</i> by Lubert Stryer, 4 th Ed., WH.Freeman, 1995.
3	David S. Goodsell, “ <i>Bionanotechnology</i> ”, John Wiley & Sons Inc., publications, 2004.
4	Guozhong Cao (2004). <i>Nanostructures and Nanomaterials, synthesis, properties and applications</i> , Imperial College Press, ISBN: 978-1860944802.
5	C.M.Niemeyer, C.A. Mirkin (2007). <i>Nanobiotechnology</i> , WILEY-VCH Verlag GmbH & Co. KG, Weinheim, ISBN: 9783527306589.
Web Resources	
1	http://vvm.org.in/study_material/ENG%20-20Indian%20Contributions%20to%20Science .
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 AND ENZYME TECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTDE06	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.								
Course Outcome									
CO1	Distinguish the fundamentals of enzyme properties, nomenclatures, characteristics and mechanisms								
CO2	Understand the characteristic features of enzymes								
CO3	Get an overall understanding the enzyme kinetics								
CO4	To know the biochemical techniques for enzyme isolation								

CO5	Understand the process of Immobilization of enzymes , Enzyme engineering and Designer enzymes in various Industrial purposes.	
UNIT	Contents	No. of Hours
I	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).	12
II	Active site (definition, characteristic features), Enzyme specificity. Bisubstrate and multisubstrate reactions. ES complex formation, lock and key model and induced fit model. Enzyme units - IU & Katal. Turnover number. Isoenzymes (LDH & CPK), Definition – Ribozymes & Abzymes.	12
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, feedback inhibition.	12
IV	Membrane bound proteins – Fluid mosaic model. Extraction of enzymes – Chemical agents and Physical methods of extraction, ultrasonication. Nature of the extraction medium. Technique for enzyme isolation, purification of enzymes- dialysis, chromatography, electrophoresis. Intracellular localization of enzymes and marker enzymes.	12
V	Immobilization of enzymes- Chemical and Physical methods. Clinical and industrial applications of immobilized enzymes. Enzyme engineering and Designer enzymes. Pharmaceutical, Clinical and Industrial uses of enzymes.	12

Total		75
Text Books		
1	Satyanarayana. U. 2013. Biochemistry.4 th edition, Elsevier India.	
2	Jain J L, 2014, Fundamentals of Biochemistry, 7 th edition, S.Chand publishing.	
3	Rodwell, V.W, Bender D.A, Botham K.M. 2015, Harper's Illustrated Biochemistry, 30 th 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 Lubert Stryer,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. 6 th edition.W.H. Freeman & Company.	
5	Jeremy M Berg, Stryer, L. 2015. Biochemistry, 8 th 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	

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- PHARMACEUTICAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTDE07	3	1			3	4	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								
Course outcome									
CO1	Compare and contrast the specific pharmacology of the major classes of drugs,								

	important distinctions among members of each class	
CO2	Getting the knowledge for the biotech protein products	
CO3	Getting the knowledge for the biological products	
CO4	Understand the medicinal and pharmaceutical importance of drug compounds Analyze the fundamental principles of pharmacokinetics and pharmacodynamics.	
CO5	To know the Scope and career opportunities in pharmaceutical sectors.	
UNIT	Contents	No.of Hours
I	Objectives of Pharmaceutical Biotechnology - Generic and Biogeneric drugs. Stages in the drug development process -Drug discovery - Drug designing - Drug production - Preclinical trials - Clinical trials - Pharmacokinetics and Pharmacodynamics - Patenting & Drug Approval - Drug Marketing - Post clinical trials.	12
II	Production of recombinant proteins - Development of Nucleic acid based therapies - Biopharmaceutical considerations - Pharmaceutical regulations - Formulation of Biotechnology products - Drug delivery - Pharmacognosy .	12
III	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).	12
IV	Drug toxicity analysis - Common side effects of drugs and managements - Drugs of abuse - Life changing complications - Prevention and management	12
V	National and International Drug approval agencies - Top National and International pharmaceutical industries - Scope and career opportunities in pharmaceutical sectors.	12
Total		60

Text Books	
1	Chandrakant Kokate and Pramod H.J 1 st Edition (2011), Text Book of Pharmaceutical Biotechnology, Elsevier
2	Crommelin, Dean J. A., Sindelar, Robert, Meobohm, Bernd (Eds.) (2019), Pharmaceutical Biotechnology: Fundamentals and Applications, Springer.
3	Ashish Dixit, Pawan Tiwari and Vivekanand Kishan Chatap (2015), Textbook of Pharmaceutical Biotechnology, Studium Press (India) Pvt. Ltd.
4	John F. Corpenter, Mark C. Manning (2012). <i>Rational Design of stable formulation Theory and Practice</i> , (1st edition), US: Springer Science, ISBN: 9781461351313.
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, 2 nd Edition (2005), Drugs of abuse, Pharmaceutical Press
4	Hiten J. Gutka, Harry Yang, Shefali Kakar (2018). <i>Biosimilars: Regulatory, Clinical, and Biopharmaceutical Development</i> , (1st ed), USA: Springer, ISBN: 978-3-319-99679-0.
5	Yui-Wing F. L. and Stuart S. (2019). <i>Pharmacogenomics: Challenges and Opportunities in Therapeutic Implementation</i> , (2nd Ed), TX, USA: Academic Press, ISBN: 9780128126264.
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

ELECTIVE VI - BIOFARMING

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTDE08	3	1			3	4	25	75	100

Learning Objective	
LO1	To provide knowledge on the basics of conventional cropping systems and natural farming.
LO2	To learn the types of farming
LO3	To learn the role of pest management
LO4	To provide the knowledge on organic farming.

LO5	To learn the concepts of organic agricultural policy and GMOs	
Course outcome		
CO1	Understand the principles of conventional cropping systems and natural farming	
CO2	Understand the knowledge about green revolution in India	
CO3	Manipulate integrated pest management for the development of pesticide free plant products	
CO4	Develop the concepts of organic farming	
CO5	Understand the concepts of organic agricultural policy and GMOs	
UNIT	Contents	No. of Hours
I	Agro-ecological zones and geographical distribution of crop plants in Tamil Nadu. Cropping systems - different types and their importance in food production- Package and practices followed for major crops and cropping systems in Tamil Nadu	15
II	Green revolution in India - After effects - Definitions of Natural Farming, Traditional farming - Their concepts and scope - Natural Farming -Institutions- their activities and role.	15
III	Pest - Definition - categories of pests-pest control - natural, artificial-pest management IPM. Store grain pest management. Pesticides consumption and hazards. Role of biopesticides and biofertilizers in IPM.	15

IV	Organic farming - concept and relevance in the agriculture - problems and remedies - Encouragement and dissemination for effective practicing of organic farming. Production and marketing of Organic products.	15
V	Organic agriculture policy, Genetically Modified Organisms as organic regulation	15
Total		75
Text Books		
1	Basu, D.N. and Guha, G.S. (1996). Agroclimatic regional planning in India, ARPU, Ahmedabad	
2	Krishna, K. R., (2010). Agroecosystems of south India, Brownwalker press, Florida	
3	John H. Perkins, Geopolitics and the Green Revolution: Wheat, Genes, and the Cold War, Oxford University Press, 1997.	
	Lester R. Brown, Seeds of Change: The Green Revolution and Development in the 1970's, 1970, Praeger Publishers, New York.	
Reference Books		
1	Kogan, M 1998. Integrated Pest Management: Historical Perspectives and Contemporary Developments, Annual Review of Entomology Vol. 43: 243-270 (Volume publication date January 1998).	
2	Dharam P. Abrol (Editor), Uma Shankar 2013. Integrated Pest Management: Principles and Practice Amazon text book store	

	NPCS Board of Consultants & Engineers, (2008). The complete book on organic farming and production of organic compost, Asia Pacific Business Press Inc.
	Shalini Suri, APH, (2012). Organic farming Vedams books from India.

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	2	3	3	3	3	2	2
CO2	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3
Total	15	13	14	15	15	15	15	14	14
Average	3	2.6	2.8	3	3	3	3	2.8	2.8

ELECTIVE VI – BIOETHICS, BIOSAFETY & IPR

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTDE09	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.								

Course Objectives		
CO1	Interpret basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life	
CO2	To understand the impact of Gene cloning in societal problems	
CO3	Understand ethical aspects related to biological, biomedical, health care and biotechnology research.	
CO4	To get knowledge about Patents Rights	
CO5	To understand 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.	12
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).	12
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.	12
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.	12

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.	12
Total		60
Text Books		
1	Ignacimuthu, S (2009), <i>Bioethics</i> , Narosa Publication house, ISBN: 978-81-7319-966-0	
2	V. Sree Krishna . V (2007), <i>Bioethics and Biosafety in Biotechnology</i> , (1st ed.), New Age International Private Limited.	
3	Rhona Smith. (2003), <i>International Human rights</i> , Blackstone Press.	
4	Manual of patent practice and procedure. IPR India, 2005.	
5	Ministry of commerce and industry, New Delhi, pp.163.	
Reference Books		
1	Trayer, P.C, Fredrick.R., and Koch, M. (2002), <i>Biosafety</i> . Michigan State University	
2	Biosafety, Traylor, Fredric & Koch, 2002. Michigan state University pub., USA.	
3	Contemporary issues in Bioethics, Beauchamp & Leroy, 1999. Wardsworth Pub. Co. Belmont, California.	
4	Biotechnology and safety assessment, John.A.Thomas, 2004. pp.333	
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
CO1	3	2	3	3	3	2	3	2	3
CO2	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	3	2
CO4	3	3	3	3	3	3	3	3	3
CO5	3	3	2	3	3	3	3	3	2
Total	15	14	13	15	15	14	15	14	13
Average	3	2.8	2.6	3	3	2.8	3	2.8	2.6

ELECTIVE VI – DAIRY SCIENCE AND TECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTDE10	3	1			3	4	25	75	100

Learning Objective	
LO1	Gain information about spoilage of milk and its products and its antimicrobial properties
LO2	Learn about the various fermented product and its various stage spoilage
LO3	Learn about functional dairy food products

LO4	Impart current knowledge of probiotics,	
LO5	Impart current knowledge of prebiotics and functional dairy foods for the health benefits	
Course Objectives		
CO1	To gain information about microflora of milk	
CO2	To study about the production of fermented dairy products	
CO3	To study the functional dairy foods for the health benefits	
CO4	To impart current knowledge of probiotics, prebiotics	
CO5	To create a sustainable environmentally and technologically advanced dairy farm	
UNIT	Contents	No. of Hours
I	Microflora of raw milk - sources of contamination. Spoilage and preservation of milk and milk products. -antimicrobial systems in raw milk. Importance of biofilms, their role in transmission of pathogens in dairy products and preventive strategies.	12
II	Food fermentations: Indian Pickles Bread, vinegar, fermented vegetables (sauerkraut), fermented dairy products (yoghurt, cheese, Acidophilus Milk, Kefir, Koumiss).	12

III	Oriental fermented foods-Miso –Tempeh Ontjom . Natto, Idli Spoilage and defects of fermented dairy products -. Functional fermented foods and nutraceuticals, bioactive proteins and bioactive peptides, genetically modified foods.	12
IV	Probiotic microorganisms, concept, definition safety of probiotic microorganisms, legal status of probiotics Characteristics of Probiotics for selection: stability maintenance of probiotic microorganisms. Role of probiotics in health and disease: Mechanism of probiotics. Application of bacteriocins in foods.Biopreservation.	12
V	Prebiotics: concept, definition, criteria, types and sources of prebiotics, prebiotics and gut microflora - Prebiotics and health benefits: mineral absorption, immune response, cancer prevention, elderly health and infant health, prebiotics in foods.	12
Total		60
Text Books		
1	Banwart GJ. (1989). Basic food microbiology, Chapman & Hall, New York.	
2	Sugumar D. (1997). Outlines of dairy technology, Oxford University press. 1997.	
3	Frazier WC and West off DC. (2017). Food microbiology. 5 th Edition TATA McGraw Hill Publishing Company Ltd. New Delhi.	
Reference Books		
1	Robinson, R. K.(2002). Dairy Microbiology Handbook - The Microbiology of Milk and Milk Products (Third Edition), A John Wiley & Sons, Inc., New York.	

2	Yuankunlee, Sepposalminen. (2008). Handbook of probiotics and prebiotics Second Edition. A John Wiley & Sons publication Inc.
3	Dharumaurai Dhansekaran, Alwarappan Sankaranarayanan. (2021). Advances in Probiotics Microorganisms in Food and Health 1 st Edition. eBook ISBN:9780128230916.
Web Resources	
1	https://www.researchgate.net/publication/228662659_Fermented_Dairy_Products_Starter_Cultures_and_Potential_Nutritional_Benefits/link/000084160cf23f86393d5764/download
2	https://www.fda.gov/food

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	3	3	2	3
CO2	3	3	2	3	3	3	3	3	2
CO3	3	3	2	3	3	3	3	3	2
CO4	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3
Total	15	14	13	15	15	15	15	14	13
Average	3	2.8	2.6	3	3	3	3	2.8	2.6

CORE PRACTICAL V- PLANT BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCP05	-	-	4		3	4	25	75	100
Learning Objectives									

LO1	Explain plant tissue culture and Illustrate Callus development.	
LO2	To examine the culture techniques of the plant tissue in-vitro and its applications	
LO3	Develop technical skills in isolation of DNA and RNA from plants and microorganisms.	
LO4	Develop technical skills in Protoplast isolation	
LO5	To point out the genomic isolation technique	
Course Outcome		
CO1	To gain knowledge on the media preparation and techniques	
CO2	Learning different pathways of plant regeneration under in vitro conditions -	
CO3	To learn haploid production	
CO4	Learn plant regeneration from protoplast isolation	
CO5	To isolate the DNA from plant	
UNIT	Contents	No. of Hours
I	1. Plant tissue culture media preparation & sterilization techniques. 2.Explant Preparation	9
II	3.Seed germination 4 Establishment and maintenance of callus culture 5.Shoot tip initiation	9
III	6.Root initiation using MS media 7.Anther culture 8.Pollen Culture 9.Embryo culture	9
IV	10. Isolation of plant protoplast & viability test 11. Synthetic seeds (Entrapment method).	9
V	12. Isolation of plant DNA 13. Isolation of Agrobacterium plasmid DNA (Demo)	9
Total		45
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), <i>Environmental Biotechnology Theory and Lab Practices</i> , (2nd edition), Hardcover – Global Vision Publishing House, ISBN: 9788182205840
Reference Books	
1	S. Lal, Vikas. (2018), <i>Public Health Management Principles And Practice</i> , (2nd Edition), CBS Publishers and Distributors Pvt Ltd, ISBN 13: 9789387742932
2	S. Harisha. (2012), <i>Biotechnology procedures and experiments handbook</i> , 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

CORE PRACTICAL VI- ANIMAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCP06	-	-	4		3	4	25	75	100
Learning Objectives									
LO1	Make use of the techniques used in preparing tissue culture medium and membrane filtration in culturing animal cells								
LO2	Prepare single cell suspension and evaluate cell counting and viability.								
LO3	To probe into the animal cell culture techniques								
LO4	Examine the importance of trypsinization in monolayer and subculture and cryopreservation.								
LO5	To point out the genomic isolation technique								
Course Outcome									
CO1	Learn about the culture media used in animal cell culture.								
CO2	Gain the knowledge on Preparation of media for animal cell culture.								

CO3	Primary culture of chick embryo fibroblasts. Primary culture of chick organ - spleen and kidney cells	
CO4	Gain the knowledge on proliferative assay	
CO5	To point out the genomic isolation technique	
UNIT	Contents	No. of Hours
I	1.Preparation of Animal Tissue culture media AND membrane filtration 2.Preparation of Single Cell Suspension from spleen 3.Preparation of single cell suspension from thymus	9
II	4.Cell counting Cell viability Test	9
III	5.Culture of chick embryo fibroblast (monolayer). 6.Trypsinization of monolayer and subculturing (Demo)	9
IV	7.Measurement of phagocytic activity (Demo) 8.MTT Assay (Demo) 9.Cryopreservation and thawing (Demo)	9
V	10.Isolation of genetic DNA from animal tissue.	9
Total		45
Web Resources		
1	https://www.mooc-list.com/course/cell-culture-basics-canvasnet https://nptel.ac.in/courses/102/104/102104059/	
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 Paper X - ENTREPRENEURSHIP DEVELOPMENT IN BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCT10	4	1			3	5	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 the process of biogas production								
LO4	Will aspire to set up biofertilizer production								
LO5	Will learn the technique of Single cell protein Cultivation								
Course Outcome									
CO1	To be familiar with the different schemes offered by Government institutions to support entrepreneurs and also provides the basic knowledge on project proposal preparation,								

	feasibility analysis, execution and management.	
CO2	To have a fundamental idea about the principles of management, learn to make a business proposal, arrange for financial resources and maintenance of business establishment by accounting practices and other essential concepts required for executing a business plan.	
CO3	Understand the process of biogas production and its application	
CO4	Able to understand the techniques of biofertilizers	
CO5	To know 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)	15
II	Business plan preparation; business feasibility analysis by SWOT, business plan proposal for virtual startup company; statutory and legal requirements for starting a company/venture; basics in accounting practices. Market Conditions, Identifying the need of the customers.	15
III	Biogas as an alternative energy source. Biogas utilization. Biogas burners. Design of biogas burners. Stove models. Lighting mantles. Biogas using stationary power plants. Mobile power plants. Pollution control through anaerobic digestion.	15
IV	Biofertilizer production: Nutritional value and composition of Azolla species. Growth requirements and mass cultivations of azolla, Media	15

	composition Azolla growth, Azolla production in small and large scale, harvesting and marketing.	
V	Single Cell Protein Production: Source: Algae, Bacteria, Yeast – Cultivation of Single Cell protein: SPIRULINA Cultivation – Production site, Microorganism, Experimental design; harvesting and Drying.	15
Total		75
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 Paper XI - ENVIRONMENTAL & INDUSTRIAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCT11	4	1			3	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.	
Course Objective		
CO1	Studying the impact of environmental pollution and its remediation measures.	
CO2	Getting sound knowledge for waste water treatment	
CO3	To understand the bioprocess engineering, basic techniques, methods and functions.	
CO4	To understand the selective methods to purify the fraction to develop as commercial purpose	
CO5	To understand the various techniques for isolation, recovery and purification of a protein and evaluate the outcome.	
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, Chromatography, 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. Microbial Polysaccharide production: Xanthan, Dextran.	15
V	Ore leaching (methods and examples), MEOR, Production of antibiotics – Penicillin - streptomycin. Alcoholic beverages: Wine, Beer – Biofertilizers- Rhizobium & Azotobacter. Biopesticides – <i>Bacillus thuringiensis</i> and microbial toxin production and their applications - Biosurfactants, Vitamins- Folic acid & Vitamin B12, Organic acids.	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 (07102, 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

Core Paper XII – STEM CELL TECHNOLOGY AND TISSUE ENGINEERING

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCT11	3	1			3	4	25	75	100
Learning Objective									
LO1	To provide students with knowledge of wide ranging topics related to stem cells, regenerative medicine and tissue engineering.								
LO2	To offer the student state of the art education of pluripotent and multipotent cells								
LO3	To offer the students to know how the pluripotent and multipotent cells can be used to treat the neurodegenerative disorders, cardiovascular disorders and diabetes.								
LO4	To review the current scenario of tissue engineering applications in bioartificial organs development and transplantation.								
LO5	To learn application of tissue engineering								
Course Objective									
CO1	Gain fundamental knowledge in stem cell biology and tissue engineering								
CO2	Describe sources, selection, potential manipulations and challenges of using stem cells for tissue engineering								
CO3	Explain significance, current status and future potential of tissue engineering.								
CO4	Identify key challenges in tissue engineering of different human tissues.								
CO5	Describe design, fabrication and biomaterials selection criteria for tissue engineering scaffolds								

UNIT	Contents	No. of Hours
1	<p>Introduction to Stem cells and Basics of Stem cell culture -Introduction to Stem Cells – Definition, Classification, characteristics; Stem cell Vs Somatic cells; Differentiation, dedifferentiation and transdifferentiation. Basics of animal cells/stem cells culture; Isolation, expansion, genetic manipulation, genetic reprogramming, and cloning of Stem cells. Cells cryopreservation.</p>	15
II	<p>Types of Stem Cells-Different kinds of stem cells – Embryonic stem cells, Embryonic Germ cells; Stem cell Niche. Adult Stem Cells: hematopoietic stem cells, neural stem cells, muscle and cardiac stem cells, umbilical cord blood stem cells, cancer stem cells, mesenchymal stem cells, induced pluripotent Stem cells</p>	15
III	<p>Stem Cell Therapy: Therapeutic applications: stem cells and neurodegenerative disorders, stem cells and diabetes, stem cells and cardiac disorders, Stem cell therapy for kidney failure, liver failure, infertility and cancer. Stem cell banking. Current status of Stem cell research. National and International Guidelines/Regulations for stem cell research. Ethical considerations in stem cells research.</p>	15
IV	<p>Introduction to Tissue Engineering, Biomaterials and Scaffolds: Principles of Tissue Engineering – History, importance and scope, Basics/fundamentals of Tissue Engineering, Tissue dynamics/homeostasis. Tissue Engineering triangle, Role of growth factors, Biomaterials and Scaffolds in Tissue Engineering. Requirement of biomaterials as tissue engineering scaffold. Properties and types of scaffolds, tissue specific scaffolds; Methods of scaffold design/preparation.</p>	15
V	<p>Tissue Engineering Applications-Tissue and organ transplantation. Bio-artificial organs: Skin Tissue engineering, Liver tissue engineering, Bladder reconstruction, Kidney tissue engineering, Muscle tissue engineering, Neural tissue engineering, Bone and cartilage tissue engineering, Cardiovascular tissue engineering. Commercial products from tissue engineering. Ethical issues in tissue engineering.</p>	15
Total		75

Text Books	
1	Ed.RobertLanzaetal.;Principles of Tissue Engineering – 5 th Edition (2020);AcademicPress
2	2 LanzaR.,AtalaA.;EssentialsofStemCellBiology 3rd Edition (2013);AcademicPress
Reference Books	
1	BoerJDetal.;TissueEngineering – 2 nd Edition (2014);AcademicPress
2	PalluaN,SuschekCV;TissueEngineering:fromLabtoClinic (2011);Springer
3	BarnesSJ,HarrisLP;TissueEngineering:Roles,MaterialsandApplications – 1 st Edition (2008); Nova Science PublishersInc
4	MinuthWW.StrehlR.SchumacherK;TissueEngineering:fromCellBiology to Artificial Organs (2017); WileyVCH
5	Knoepfler;StemCells:AnInsider’sGuide (2013);WorldScientificPublishingCompany
Web Resources	
1	https://nptel.ac.in/courses/102/106/102106036/
2	https://www.classcentral.com/course/stem-cells-10745
3	https://research.pasteur.fr/en/course/mooc-advances-in-stem-cell-biology/
4	http://ecoursesonline.iasri.res.in/course/view.php?id=73

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CLO1	2	2	3	2	2	2	3	3	3
CLO2	2	3	3	2	3	3	3	3	3
CLO3	2	3	3	3	3	2	3	3	3
CLO4	2	2	2	2	2	2	3	3	3

CLO5	2	3	3	2	3	3	3	3	3
TOTAL	10	13	14	11	13	12	15	15	15
Average	2	2.6	2.8	2.2	2.6	2.4	3	3	3

CORE PRACTICAL VII - ENVIRONMENTAL AND INDUSTRIAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTCP06	-	-	4	-	3	4	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	1. Isolation of Air borne Pathogens 2. Study of Growth Curve and Generation time of Bacteria/ Yeast using turbidometry.								9

II	3. Water analysis – MPN and BOD. 4. Immobilization of whole yeast cells/ enzyme by Alginate beads. 5. Production of wine and estimation of alcohol 6. Production of Biogas – <i>In vitro</i> & Compost Making.	9
III	7. Biofertilizer production/Spirulina production - field visit. (Report should be included in the record) 8. Isolation and identification of starter organisms from Idli batter/ curd	9
IV	9. Grading of raw milk (Dye reduction test, MBRT test). 10. Determination of efficiency of Pasteurization by quantitative phosphatase test.	9
V	11. Preparation and Efficiency testing of Biofertilizer/ Biopesticide. (Demo) 12. Production of microbial Polysaccharide. (Demo) 13. Lignin degradation by using microorganism and assays (Demo) 14. Textile dye degradation by using microbes (demo)	9
Total		45
Text Books		
1	Aneja K R, <i>Laboratory Manual of Microbiology and Biotechnology</i> , MEDTECH, 2014. ISBN-13 : 978-9381714553	
2	Vijaya Ramesh, (2007), <i>Food Microbiology</i> , MJP Publishers, Chennai, ISBN-13 : 978-8180940194	
Reference Books		
1	Raghuramulu, N., Madhavan Nair, K., and Kalyanasundaram, S. Ed., (1983), <i>A Manual of Laboratory Techniques</i> , 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 SCIENCE AND TECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTDE11	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								
Course objectives									
CO1	Explain important features of microbial diversity with reference to different niches in Oceans.								
CO2	To know about the microbial habitats								
CO3	To understand the medicinal compounds from flora and fauna								
CO4	Explain fundamental principles of aquaculture								
CO5	Know about important marine sources for valuable products.								
UNIT	Contents								No. of

		Hours
I	Marine Ecosystems & Its functioning, Ocean currents, Physical & chemical properties of seawater, Ecological divisions of the Sea- Euphotic-Mesopelagic-Bathopelagic- Benthos-Intertidal, Estuarine- Salt Marsh- Mangrove- Coral Reef.	15
II	Marine microbial habitats- Screening for Secondary metabolites from marine microbes (Bacteria, Fungi, Actinomycetes and marine microalgae). Biofouling, Biofilm, Antifouling, Anticorrosion. Probiotic bacteria and their importance in aquaculture.	15
III	Definitions- Medicinal compounds from flora (Seaweeds, Seagrass and Mangrove) and fauna (Sponges, Sea anemone and Corals)- marine toxins- antiviral and antimicrobial agents.	15
IV	Culture aspect-Seaweed (<i>Kappaphycus alvarezii</i>), Fish chromosome manipulation in aquaculture- Hybridization- Gynogenesis- Androgenesis- Polyploidy, Artificial Insemination, Eyestalk ablation- Transgenesis and Cryopreservation.	15
V	Agar- Agarose - Alginate- Carrageenan- Chitin- Chitosan- Heparin.	15
Total		75
Text Books		
1	Italy, E (Eds). 1998, New Developments in Marine Biotechnology, Plenum Pub. Corp.	
2	Milton Fingerma and Rachakonda Nagabhusanam, 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), <i>Environmental Biotechnology and cleaner Bioprocess</i> , (1 st edition), CRC Press, ISBN 9780367455552
5	Kirchman, D.L.Gasol, J.M. (2018), <i>Microbial ecology of the oceans</i> , (3 rd edition), 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 SCIENCE AND TECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTDE12	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								
Course Outcomes									
CO1	to understand the basic concepts of the food industry								
CO2	Understand basic composition & structure of food grain								
CO3	Developments and current status of fruits and vegetables storage and processing								
CO4	Understand the compositional and technological aspects of meat, milk, and fish								
CO5	To understand the type od adulterants								
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, types of browning- Maillard & caramelization. Structure and composition of pulses, toxic constituents in pulses, processing of pulses soaking, germination, decortications, cooking and fermentation. Fats and Oils. Refining of oils, types- steam refining, alkali refining, bleaching. Rancidity –Types- hydrolytic and oxidative rancidity and its prevention.	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 – Climacteric rise, horticultural maturity, physiological maturity, physiological changes, 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. Composition and nutritive value of egg, characteristics of fresh 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 additives, 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), <i>Food Biotechnology- Principles and practices</i> , I.K.International Publishing House Pvt. Ltd., New Delhi,.	
4	RavishankarRai, V,(2015), <i>Advances in Food Biotechnology</i> , (First edition), John Wiley & Sons, Inc, ISBN 9781118864555.	
5	Perry Johnson-Green.(2018), <i>Introduction to Food Biotechnology</i> , Special Indian Edition, <i>CRC Press</i> , 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), <i>Food Biotechnology</i> , (First edition), CBS Publishers & Distributors Pvt Ltd, ISBN 9789389396348.
4	Anthony Pometto, Kalidas Shetty, Gopinadhan Paliyath, Robert E. Levin(2005), <i>Food Biotechnology</i> , (2 nd edition), <i>CRC Press</i> ,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
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Elective VII - CANCER BIOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTDE13	4	1			3	5	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.								
Course Objectives									
CO1	Understand basic aspects of cancer								
CO2	The role gene mutations play in the development of cancer								
CO3	To know the types of cancer								
CO4	To learn the technologies and methods used to detect and treatment of cancer								
CO5	To understand the preventive measures								
UNIT	Contents								No.of Hours
I	Cancer: Introduction; Origin of Cancer- Mutations that cause changes in signal molecules, effects on receptor, signal switches, Development and causes of cancer Difference between Normal and Cancer cells; Signs and symptoms.								15
II	Principles of cancer metastasis: Clinical significances of invasion,								15

	heterogeneity of metastatic phenotype, three step theory of invasion, Proteinases and tumor cell invasion.	
III	Types of Cancer: - Blood & Lymph – Leukemia, Malignant lymphoma, Bone-Soft tissue Sarcoma, Thorax- Breast cancer, Male genitalia- Prostate cancer, Female genitalia- Cervical cancer; Tumor suppressor genes; Classification of Tumor suppressor genes.	15
IV	New molecules for cancer therapy: Different forms of therapy, Chemotherapy, Radiation Therapy, Detection of Cancers, Prediction of aggressiveness of Cancer, Advances in Cancer detection. Detection and Treatment:- Early detection, Molecular detection of Carcinomas, Markers in blood urine;	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		75
Text Books		
1	A. Sarkar, 2011, Biology of Cancer, Discovery Publishing House, New Delhi.	
2	Ranjit 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	Ranjit 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

ELECTIVE VIII - MEDICAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CI A	External	Total
23UBTDE14	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								
Course Objectives									
CO1	Understand broad theoretical knowledge and critical understanding of advanced principles in antibodies and vaccines								
CO2	Gain the practical knowledge required to support a career in biomedical research environment								
CO3	Gain the knowledge about the diagnostics of infectious diseases								

CO4	Have a sound platform for setting up basic therapeutical production	
CO5	Gain the knowledge about clinical trials and applications	
UNIT	Contents	No. of Hours
I	Antibodies and vaccines - Therapeutic production of antibodies, antibody mediated drug delivery of vaccines, different kind of vaccines and applications of recombinant vaccines. Diagnosis - Biochemical diagnostics, inborn errors of metabolism, haemoglobinopathies.	15
II	Molecular basis of disease, Recombinant DNA Technology in medicine, gene probes as molecular diagnostic reagents. Polymerase Chain Reaction in clinical diagnostics, DNA sequencing of representative clones to detect mutations.	15
III	Diagnosis of infectious diseases, Viral diseases – HIV, influenza; bacterial diseases - enteric diseases, mycobacterium diseases; immune arrays. FACs immune histo chemical staining, ELISA, FISH techniques.	15
IV	Immunoblot analysis of antigens and allergens. Production of therapeutic agents – Productions and application of therapeutic agents, Production of cytokines and interferons.	15
V	Principles of project management in Clinical trials and its application. Principles of research ethics; Ethical issues in clinical trials; Animal rights and use of animals in the advancement of medical technology. Use of humans in Scientific Experiments; Introduction to ethical codes and conduct.	15
Total		75
Text Books		
1	Roli, M. (2017). <i>National Ethical Guidelines for Biomedical and Health Research Involving Human Participants</i> , ISBN: 978-81-910091-94	
2	Lela, B. and Maribeth, L. F. (2011). <i>Molecular Diagnostics: Fundamentals, Methods and Clinical Applications</i> , (1st Edition) . Philadelphia, USA. F A Davis Company. ISBN-13: 978-0803626775	
3	<i>Clinical Applications</i> , (1st Edition) . Philadelphia, USA. F A Davis Company. ISBN-13: 978-0803626775	
Reference Books		

1	Bernard, R. G. Terry, L.D. and Cheryl, L.P. (2014). <i>Medical Biotechnology</i> , (2 nd edition).
2	Patrick, R.M. Kenneth, S.R. and Michael, A.P. (2016). <i>Medical Microbiology</i> , (8 th edition). USA. Elsevier Publishers, eBook ISBN: 9780323388504
3	Pamela, G. Michelle, M, (2009). <i>Molecular Therapeutics: 21st century medicine</i> , (1st Edition). Hoboken, New Jersey. Wiley Publishers.
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 AND TECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total

23UBTDE15	4	1		3	5	25	75	100
Learning Objective								
LO1	Students will gain insight into Forensic Biotechnology.							
LO2	Will know about various investigations protocol							
LO3	Will know about blood related issues							
LO4	Will know the use of molecular approaches to investigation							
LO5	Will understand DNA fingerprinting							
Course Objectives								
CO1	The student will be able to describe the fundamental principles and functions of forensic science and its significance to human society.							
CO2	The student will be able to demonstrate the art of collecting, packaging and preserving different types of physical and trace evidence at crime scenes, The legal importance of chain of custody.							
CO3	to justify the importance of biological fluids – blood, urine, semen, saliva, sweat and milk – in crime investigations							
CO4	The student will be able to explain the basic principle of DNA analysis and forensic significance of DNA typing							
CO5	The student will be able to describe the importance of restriction fragment length polymorphism in DNA technique							
UNIT	Contents							No.of Hours
1	Definition and scope of Forensic Biotechnology, History and development, Forensic genetics, Forensic agriculture.							15
II	Crime scene investigation; collection, preservation, packing and forwarding of physical and trace evidence. Biological Evidence: Nature, collection, identification, evaluation of hair and fibres. Questioned documents – identification of handwriting, signature and detection of forgery. Forensic Art Illustration: Introduction, Finding and identifying human face image. Post mortem drawing, methods of superimposition.							15

III	Definition and Classification of fingerprints (Henry system). Taking fingerprints from living and dead persons. Automatic fingerprint identification system (AFIS). 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	Fatality Forensics: Introduction, cause, manner and characteristics of death, Road traffic fatality (RTF) investigation. General classification of RTFs.	15
V	DNA Fingerprinting (DFP) technology: An overview, Applications of DFP in forensic investigations, paternity disputes. DNA Profiling practice in India with reference to criminal cases.	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, (2 nd edition), Select Publishers, New Delhi, ISBN: 9788190113526.	
4	Barbara H. Stuart (2013). Forensic Analytical Techniques (Analytical Techniques in the Sciences (AnTs), (1 st edition), UK, Wiley, ISBN: 978-0-470-68727-7.	
5	C. Champod, C. Lennard, C. Margot, P. and Stoilovic (2015). Fingerprints and other Ridge Skin Impressions, (7 th 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). <i>Huber and Headrick's Handwriting Identification: Facts and Fundamentals</i> , (2nd Edition), Boca Raton, CRC Press, ISBN: 9781498751308.	
4	Ghosal S. and Avasthi A.S. (2018). <i>Fundamentals of Bioanalytical Techniques and</i>	

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
CO1	3	3	2	2	2	3	3	3	2
CO2	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	2	3	3	3
CO5	3	2	3	3	3	3	3	3	3
Total	15	14	14	14	14	14	15	15	14
Average	3	2.8	2.8	2.8	2.8	2.8	3	3	2.8

Elective VIII -GOOD LABORATORY PRACTICES (GLP)

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
23UBTDE16	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	
Course Outcome		
CO1	To learn about the types of lab associated with biotechnology	
CO2	To learn the basics of instrumentation	
CO3	To know the calculations	
CO4	To learn the operating guidelines	
CO5	To know the disposal of biological and chemical wastes	
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,	15

	Internal audit basics, ISO, BIS and HACCP standards.	
V	Definition of waste, types of waste: Biological and chemical 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, 2 nd Edition.	
Reference book		
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

PROFESSIONAL COMPETENCY SKILL ENHANCEMENT

SKILL BASED PAPER FOR COMPETITIVE EXAMINATION

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	1	1			1	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.								6

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	6
III	VERBAL ABILITY- Reading Comprehension. Cloze Test. Sentence Rearrangement. Antonyms and Synonyms. Error Detection. Idioms and Phrases, One-word substitution, Word analogy, Resume writing	6
IV	ARITHMETICAL 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.	6
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	6
Total		30
Text Books		
1	A Modern Approach 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	
	Upkars Current Genral knowledge current affairs and who is who?	
	General English for all competitive exams by S.C.Guptha	
2	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