

B.Sc., BIOTECHONOLOGY

SYLLABUS

**FROM THE ACADEMIC YEAR
2024-2025**

**TAMILNADU STATE COUNCIL FOR
HIGHER EDUCATION, CHENNAI - 600 005**

CHOICE BASED CREDIT SYSTEM AND LEARNING OUTCOMES-BASED CURRICULUMFRAMEWORK-B.Sc.Biotechnology	
Programme:	B.Sc.Biotechnology
Programme Code:	
Duration:	3Years(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; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development.</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 viewpoints.</p> <p>PO6: Research-related skills: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation</p> <p>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</p> <p>PO8: Scientific reasoning: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences</p>

	<p>from an open-minded and reasoned perspective.</p> <p>PO9: Reflective thinking: Critical sensibility to lived experiences, with self awareness and reflexivity of both self and society.</p> <p>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.</p> <p>PO11 Self-directed learning: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.</p> <p>PO12 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.</p> <p>PO 13: Moral and ethical awareness/reasoning: Ability to embrace 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 one's work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work.</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>PO15: 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 Physics with Computer Applications programme, the student should be able to:</p> <p>PSO1: Disciplinary Knowledge: Understand the fundamental principles, concepts, and theories related to physics and computer science. Also, exhibit proficiency in performing experiments in the laboratory.</p> <p>PSO2: Critical Thinking: Analyse complex problems, evaluate information, synthesize information, apply theoretical concepts to practical situations, identify assumptions and biases, make informed decisions and communicate effectively</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 analyse 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 • Data analytical skills will enable students gain internships, apprenticeships, fieldwork involving data collection, compilation, analysis etc. • Entrepreneurial skill training will provide an opportunity for independent livelihood • Generate self-employment • Create small scale entrepreneurs • Training to girls lead to women empowerment • Discipline centric skill will improve the Technical knowhow of solving real life problems using ICT tools
III, IV, V & VI	Elective papers- An open choice of topics categorized under Generic and Discipline Centric	<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
		<ul style="list-style-type: none"> • 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
V Semester	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.
VI 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

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	<ul style="list-style-type: none"> • Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

MSSU

Credit Distribution for UG Programmes

SemI	Credit	H	SemII	Credit	H	SemIII	Credit	H	SemIV	Credit	H	SemV	Credit	H	SemVI	Credit	H
1.1. Part I Language–Tamil	3	6	2.1. Part I Language–Tamil	3	6	3.1. Part. I Language–Tamil	3	6	4.1.Part1 Language–Tamil	3	6	5.1Core Course–CCIX	4	5	6.1Core Course–CCXIV	4	5
1.2. Part II English	3	6	2.2.Part II English	3	4	3.2 Part II English	3	6	4.2.Part II English	3	6	5.2Core Course–CC X	4	5	6.2Core Course–CCXV	4	5
1.3. Core Course–CCI	5	5	2.3 Core Course–CC III	5	5	3.3CoreCourse – CC V	4	4	4.3 Core Course–CC VII	4	4	5.3.Core Course CC -XI	4	5	6.6Core Course–CC XVI Project Viva Voce-	4	10
1.4 Core Course–CC II	4	5	2.4 Core Course–CC IV	4	5	3.4CoreCourse – CC VI	4	4	4.4Core Course–CC VIII	4	4	5. 4.Core Course – Practical-CC-XII	4	5	6.4Elective -VIGeneric/ Discipline Specific	3	4
1.5ElectiveI Generic/ Discipline Specific	4	4	2.5ElectiveII Generic/ Discipline Specific	4	4	3.5ElectiveIII Generic/ Discipline Specific	4	4	4.5Elective IV Generic/ Discipline Specific	4	4	5.5.Core Course – Practical-CC-XIII	3	4	6.5Elective VII Generic/ Discipline Specific	3	4
1.6 Skill Enhancement Course SEC-1	2	2	2.6 Skill Enhancement Course SEC-2	1	2	3.6 Skill Enhancement Course SEC-4	2	2	4.6Skill Enhancement Course SEC-5	2	2	5.6 Elective V Generic/ Discipline Specific	3	4	-	-	-
1.7 -Foundation Course	2	2	2.7 Skill Enhancement Course–SEC- 3	1	2	3.7 Naan Mudhalvan*	2	2	4.7Naan Mudhalvan*	2	2	5.7Naan Mudhalvan*	2	2	6.7 Naan Mudhalvan*	2	2
			2.8.Naan Mudhalvan*	2	2	3.8E.V.S.	2	2	4.8 Value Education	2	2	5.8 Internship /Industrial Training/Field Visit/Knowledge Updating Activity	1	-	6.8 Extension Activity	1	-
	23	30		23	30		24	30		24	30		25	30		21	30
Total– 140 Credits																	

**ChoiceBasedCreditSystem(CBCS),LearningOutcomesBasedCurriculum
Framework (LOCF) Guideline Based Credit and Hours Distribution System
forallUGcoursesincludingLabHours**

FirstYear–Semester-I

Part	List ofCourses	Credit	No.of Hours
Part-1	Language–Tamil	3	6
Part-2	English	3	6
Part-3	CoreCourses&AlliedCourses[inTotal]	13	14
Part-4	SkillEnhancementCourseSEC-1	2	2
	FoundationCourse	2	2
		23	30

Semester-II

Part	List ofCourses	Credit	No. of Hours
Part-1	Language–Tamil	3	6
Part-2	English	3	4
Part-3	CoreCourses&Allied Coursesincludinglaboratory[in Total]	13	14
Part-4	SkillEnhancementCourse-SEC-2	1	2
	SkillEnhancementCourse-SEC-3(Discipline/SubjectSpecific)	1	2
	Naan Mudhalavan	2	2
		23	30

SecondYear–Semester-III

Part	List ofCourses	Credit	No.of Hours
Part-1	Language-Tamil	3	6
Part-2	English	3	6
Part-3	CoreCourses&Allied Coursesincludinglaboratory[in Total]	12	12
Part-4	SkillEnhancementCourse-SEC-4(EntrepreneurialBased)	2	2
	E.V.S	2	2
	Naan Mudhalavan	2	2
		24	30

Semester-IV

Part	List ofCourses	Credit	No.of Hours
Part-1	Language-Tamil	3	6
Part-2	English	3	6
Part-3	CoreCourses&Allied Coursesincludinglaboratory[in Total]	12	12
Part-4	SkillEnhancementCourse-SEC-5(Discipline/SubjectSpecific)	2	2

	Value Education	2	2
	Naan Mudhalvan	2	2
		24	30

**Third Year
Semester-V**

Part	List of Courses	Credit	No. of Hours
Part-3	Core Courses including Practical/Elective Based	22	28
Part-4	Naan Mudhalvan	2	2
	Internship/Industrial Visit /Field Visit	1	-
		25	30

Semester-VI

Part	List of Courses	Credit	No. of Hours
Part-3	Core Courses including Project/Elective Based & LAB	18	28
Part-4	Naan Mudhalvan	2	2
	Extension Activity	1	-
		21	30

Consolidated Semester wise and Component wise Credit distribution

Parts	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Total Credits
Part I	3	3	3	3	-	-	12
Part II	3	3	3	3	-	-	12
Part III	13	13	12	12	22	18	90
Part IV	4	4	6	6	3	2	25
Part V	-	-	-	-	-	1	1
Total	23	23	22	25	26	21	140

Note: 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.

***Naan Mudhalvan**

- The Naan Mudhalvan substitute course for semesters II through VI should be given for one who absent or reappear, and they will only take external exams for 100 marks.

****Internship/Industrial Training/Field Visit/ Knowledge updating activity:**

- **Internal: 50 marks and External: 50 marks (Total: 100 marks)**

- A report should be submitted at the end of 5th semester and evaluated by external examiners.
- Internship students should submit certificate of attendance from the industry along with report.

***Extension Activity:

- NSS/NCC/YRC/RRC/Sports and Games/Youth Welfare Activity/ Outreach Programmes/Migration awareness in the Tamil Nadu Education System .
- Internal: 50 Marks and External: 50 Marks (Total: 100 Marks).
- External examination will be conducted in the 6th semester instead of 4th semester as per the existing pattern for extension activity.

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/C 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 YEAR- SEMESTER I

Course Content	Name of the Course	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part – I	Language Paper – I	6	3	25	75	100
Part - II	English Paper – I	6	3	25	75	100
Part III	Core I - Cell and Molecular Developmental Biology	5	5	25	75	100
	Core II- Practical I - Cell and Molecular Developmental Biology and Biological Chemistry	5	4	50	50	100
	ElectiveI (Generic/ Discipline Specific)- Biological Chemistry	4	4	25	75	100
Part IV	Skill Enhancement-SEC-1- Mushroom Cultivation	2	2	25	75	100
	Foundation Course- Basics of Biotechnology	2	2	25	75	100
		30	23			

SEMESTER-II

Course Content	Name of the Course	Ins.Hrs	Credits	Int. Marks	Ext. Marks	Total
Part – I	Language Paper – II	6	3	25	75	100
Part - II	English Paper – II	4	3	25	75	100
Part - III	Core III- Genetics	5	5	25	75	100
	Core IV-Practical II - Genetics and Fundamentals of Microbiology	5	4	50	50	100
	ElectiveII(Generic/ Discipline Specific)- Fundamentals of Microbiology	4	4	25	75	100
Part IV	Skill Enhancement-SEC-2- Vermitechnology	2	1	25	75	100
	Skill Enhancement-SEC-3- Essential Oil Preparations	2	1	25	75	100
	Naan Mudhalvan	2	2	-	-	100
		30	23			

SECOND YEAR – SEMESTER-III

Course Content	Name of the Course	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part – I	Language Paper – III	6	3	25	75	100
Part - II	English Paper – III	6	3	25	75	100
Part - III	Core V - Immunology and Immunotechnology	4	4	25	75	100
	Core VI- Practical III - Immunology and Immunotechnology and Bioinstrumentation	4	4	50	50	100
	ElectiveIII(Generic/ Discipline Specific)- Bioinstrumentation	4	4	25	75	100
PART IV	Skill Enhancement-SEC- 4- Aquaculture	2	2	25	75	100
	Naan Mudhalvan	2	2	-	-	100
	EVS	2	2	-	-	-
		30	24			

SEMESTER - IV

Course Content	Name of the Course	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part – I	Language Paper – IV	6	3	25	75	100
Part - II	English Paper – IV	6	3	25	75	100
Part - III	Core VII –Genetic Engineering and rDNA Technology	4	4	25	75	100
	Core VIII- Practical IV - Genetic Engineering and rDNA technology and Bioinformatics and Biostatistics	4	4	50	50	100
	ElectiveIV(Generic/ Discipline Specific)- Bioinformatics and Biostatistics	4	4	25	75	100
Part-IV	Skill Enhancement - SEC-5 – Herbal Medicine	2	2	25	75	100
	Naan Mudhalvan	2	2	-	-	100
	Value Education	2	2			
		30	24			

THIRD YEAR – SEMESTER-V

Course Content	Name of the Course	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part – III	Core Paper IX – Plant Biotechnology	5	4	25	75	100
	Core Paper X - Animal Biotechnology	5	4	25	75	100
	Core Paper XI – Environmental and Industrial Biotechnology	5	4	25	75	100
	Core XII-Practical V – Plant Biotechnology and Animal Biotechnology	4	4	50	50	100
	Core XIII-Practical VI – Environmental and Industrial Biotechnology	4	3	50	50	100
	Elective V - Nano Biotechnology / Enzymology / Cancer Biology/ Bioethics and Biosafety	5	3	25	75	100
Part- IV	Naan Mudhalvan	2	2	-	-	100
	Internship/Industrial Training / Field Visit / Knowledge Updating Activity	-	1	50	50	100
		30	25			

SEMESTER - VI

Course Content	Name of the Course	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part-III	Core Paper XIV – Bioentrepreneurship	5	4	25	75	100
	Core Paper XV –Pharmaceutical Biotechnology	5	4	25	75	100
	Core XVI-Project with Viva Voce	10	4	50	50	100
	Elective VI - Marine Biotechnology / Food Technology	4	3	25	75	100
	Elective VII - Medical Biotechnology / Forensic science / Good Laboratory Practices	4	3	25	75	100
Part IV	Naan Mudhalvan	2	2	-	-	100
Part V	Extension Activity- Industrial Visit	-	1	50	50	100
		30	21			

MSU

MANDATORY SUBJECTS

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

FIRST YEAR-SEMESTER-I**CORE PAPER-I: CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			5	5	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 function of Nucleic acid and discuss the molecular mechanism of Replication, Transcription and Translation and posttranslational modifications of proteins.								

LO4	Predict the response of cells to the intra and extracellular environment by studying about the intracellular signaling pathways.	
LO5	Understand the principles and molecular mechanisms involved in cellular differentiation, morphogenesis, growth and Potency of the cell.	
UNIT	Contents	No. of Hours
I	Discovery and diversity of cells-Cell theory-Structure of prokaryotic (bacteria) and eukaryotic cells (plant and animal cells).	10
II	Biomacromolecules and Biomicromolecules (Primary functions in the cell). Structure and Functions of Cell Organelles: Cell wall, Cell membrane, Cytoplasm, Nucleus, chromosomes, Endoplasmic reticulum, Ribosomes, Golgi bodies, Plastids, Vacuoles, Lysosomes, Mitochondria, Microbodies, Flagella, Cilia.	20
III	Structure and functions of DNA and RNA. Central Dogma of the cell - DNA Replication in prokaryotes and Eukaryotes, Transcription and Translation in Prokaryotes and Eukaryotes, Similarities and differences in prokaryotic and eukaryotic Translation, Post Translational Modifications, Genetic code.	15
IV	Cell cycle - Cell division - Mitosis and Meiosis, Cell adhesion, Cellular differentiation, Cell junctions, Extra Cellular Matrix, Cell to cell communications, G - Protein Coupled Receptors.	15
V	Gametogenesis-Spermatogenesis and Oogenesis in mammals. Fertilization- Types of cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals. Organogenesis.	15
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.	
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, Oxford University Press.
4	Lodish Harvey, 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

ELECTIVE I-BIOLOGICAL CHEMISTRY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			4	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.								
UNIT	Contents								No. of Hours
I	Atomic theory, formation of molecules, electronic configuration of atoms-s & p shapes of atomic orbitals. Types of chemical bonds. Classification of organic compounds. Hybridization in methane and ethane. Definition with examples- electrophiles, nucleophiles and free radicals. Types of reactions with an example: addition, substitution, elimination, condensation and polymerization. Electrophilic substitution reaction in benzene, nitration and sulphonation.								15
II	Acids & Bases- 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.								15

III	Importance to Biochemistry-the chemical foundation of life. Water: properties and characteristics of water. Carbohydrates: Properties and Classification- Ring structure of sugars and conformations of sugars. Metabolism of Carbohydrates – Glycogenesis, Glycogenolysis, Cori's cycle, Glycolysis, TCA cycle, bioenergetics of carbohydrate metabolism.	15
IV	Lipids: Classification, Characteristics, Properties and Biological importance. Metabolism of Fatty acids, triglycerides and phospholipids. Beta-oxidation of fatty acids. Nucleic acids: Classification-Purine and Pyrimidine bases. Classification of DNA & RNA. Metabolism of Nucleotides-Salvage pathway.	15
V	Amino acids: Classification and structure. Proteins: Structural conformation and Classification. Properties and biological importance of amino acids and proteins. Degradation of Amino acids and Urea Cycle. Vitamins: Types, Structure and function. ATP production. Electron transport chain and Oxidative phosphorylation. Photophosphorylation.	15
Total		75
TextBooks		
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, 7 th edition.	
4	A.C.Deb, 2016, Fundamentals of Biochemistry, New central book agencies, 7 th edition.	
5	Satyanarayana.U, 2016, Biochemistry, MJ publishers 3 rd edition (2006).	
ReferenceBooks		
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	

	FloridaUSA
3	GeoffreyL.Zubay,WilliamW.Parson,DennisE.Vance,1995,Principlesof Biochemistry,W.C.BrownPublishers,1995,3rdedition.
4	LubertStryer (2007) Biochemistry –Stanford University 5 th Edition-W H Freemann andcompany San Francisco
5	Bahl Arun, Bahl B. S. (2016), A Textbook of Organic Chemistry, 22 nd Edition, S. Chand& Sons publications
WebResources	
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/w

MAPPINGWITHPROGRAMMEOUTCOMESANDPROGRAMMESPECIFICOUTCOME

	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
AVERAG	3	2	2	2.8	2	1.8	3	2.8	3

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CORE II- PRACTICAL - I

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
			5		4	5	50	50	100

i. CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY

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

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

	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

ii. BIOLOGICAL CHEMISTRY

Learning Objective		
LO1	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.	
LO2	Understand the methods of acidimetry, alkalimetry and permanganometry.	
LO3	Quantify Ascorbic acid in lemon by Dichlorophenol indo phenol dye method, Glycine by Sorenson's formal titration method.	
LO5	Estimate Glucose, Cholesterol and Proteins.	
UNIT	Contents	No.of Hours
I	Qualitative Analysis Qualitative analysis of carbohydrates - Glucose, Fructose, Lactose, maltose, sucrose, starch & glycogen. Qualitative analysis of amino acids - Tyrosine, Tryptophan, Arginine, Proline and Cysteine.	14
II	Volumetric Analysis: 1. Estimation of Glycine- Formal Titration. 2. Determination of Ascorbic acid – DCPIP method. 3. Estimation of Ferrous sulphate using standard Mohr's salt	8
III	Colorimetric Analysis 1. Estimation of glucose 2. Estimation of Cholesterol- Zak's method 3. Estimation of proteins – Bradford's method	8
Total		30
Text Books		
1	J. Jayaraman, Laboratory Manual in Biochemistry, New Age International Pvt Ltd Publishers, 2011.	
2	S. K. Sawhney Randhir, Singh, Introductory Practical Biochemistry, Alpha Science International Ltd, 2 nd edition, 2005.	
3	Irwin H. Segel, Biochemical calculations, Liss, Newyork, 1991.	

Reference Books

1	Dr. O P Panday, D N Bajpai, Dr. S Giri, PRACTICAL CHEMISTRY, S Chand, Revised edition 2016.
2	Hands Thacher Clarke, A hand book of Oraganic:Qualitative and quantitative Analysis, 2007.
3	N.S. Gnanapragasam and G. Ramamurthy, Organic chemistry Lab manual, S.Viswanathan Co. Pvt. Ltd., 1998.

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

SKILL ENHANCEMENT COURSE (SEC-1)**MUSHROOM CULTIVATION**

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

LO1	To ease the transition of learning from higher secondary to higher education. Study about Morphology and Types of mushrooms	
LO2	Study about the cultivation of Mushrooms.	
LO3	Understand the lifecycle of Mushrooms.	
LO4	Understand the spawn production and marketing.	
LO5	Study the diseases and post harvest technology.	
UNIT	Contents	No. of
		Hours
I	Mushroom: Introduction, Morphology and Types, Identification of edible and poisonous mushroom, Nutritive values of Mushroom, life cycle of common edible mushrooms.	6
II	Mushroom cultivation: prospects and scope of Mushroom cultivation in small scale Industry	5
III	Lifecycle of <i>Pleurotus spp</i> and <i>Agaricus spp</i>	5
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	8
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	Sing. 2005. Modern Mushroom Cultivation, International Book Distributors, Dehradun	
4	Swaminathan, M. 1990. Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore – 560018	
5	Suman. 2005. Mushroom Cultivation Processing and Uses, M/s. IBD Publishers and Distributors, New Delhi	

**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

**FOUNDATION COURSE
BASICS OF BIOTECHNOLOGY**

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	2				2	2	25	75	100
Learning Objective									
LO1	To ease the transition of learning from higher secondary to higher education. 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	Study the structure and functions of Nucleic acid and discuss the molecular mechanism of Replication, Transcription and Translation and post translational modifications of proteins.								

LO3	Understand the classification of Microorganisms and structure of bacteria.	
LO4	Explain the role of immune cells and their mechanism in body defense mechanism & demonstrate the antigen – antibody reactions in various immune techniques.	
LO5	Demonstrate the basic principles of genetic engineering techniques and illustrate the specificity of vectors for cloning and advantages.	
UNIT	Contents	No. of
		Hours
I	Introduction to Biotechnology and Cell Biology: Diversity of cell size and shape. Cell theory, Isolation and growth of cells, Basic properties of cells, Different classes of cells – Prokaryotic and eukaryotic cells.	6
II	Molecular biology: Prokaryotic and Eukaryotic DNA replication, Prokaryotic & Eukaryotic Transcription & Translation.	5
III	Fundamentals of Microbiology: Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.	6
IV	Immunology: Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T lymphocytes & B lymphocytes	6
V	Recombinant DNA Technology: Molecular tools and applications- restriction enzymes, ligases, Cloning vectors (Natural Plasmid-F, R, Col, Degradative & Virulence, Artificial Plasmid), Microinjection and Electroporation	7
Total		30
Text Books		
1	T. Devasena (2012), Cell Biology, Oxford University Press.	
2	Bruce Alberts, 6 th Edition (2014). Molecular Biology of the cell, W. W. Norton & Company.	
3	Dubey R. C. and Maheswari, S. (2003). A text book of Microbiology, New Delhi: S. Chand & Co. Prescott, Harley, Klein, Microbiology, 10 th Edition, McGraw– Hill, 2016.	
4	Nandini Shetty, 1996, Immunology: introductory textbook – I. New Age International, New Delhi.	
5	Brown T. A, 2015. Gene Cloning and DNA Analysis: An Introduction, 7 th edition, Wiley -Blackwell.	

ReferenceBooks	
1	Karp's Cell and Molecular Biology: Concepts and Experiments. 8 th Edition (2015). Wiley Publications.
2	Lodish Harvey, 6 th Edition (2016), Molecular Cell Biology, W. H. Freeman Publications.
3	Boyd, R. F. (1998). General Microbiology, 2 nd Edition., Times Mirror, Mosby College Publishing, St Louis.
4	Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, 2011. Roitt's Essential Immunology, 12th edition, Wiley- Blackwell. USA.
5	Primrose. S. B (2014), <i>Principles of gene manipulation</i> , (7th edition), Blackwell Scientific limited, Germany. ISBN: 978-1-405-13544-3
WebResources	
1	http://www.cellbiol.com/education.php
2	https://dnalc.cshl.edu/websites/
3	https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology
4	https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/
5	https://www.britannica.com/recombinant-DNA-technology

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
AVERAG E	3	2	2	2.8	2	1.8	3	2.8	3

SEMESTER –II

CORE PAPER-III – GENETICS

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			5	5	25	75	100
Learning Objective									
LO1	Learn about the classical genetics and transmission of characters from one generation to the next.								
LO2	Obtain a strong foundation for the advanced genetics.								
LO3	Explain the properties of genetic materials and storage and processing of genetic information.								
LO4	Acquire knowledge about the Mutagens, Mutations, DNA Repairs and Genetic disorders in human.								
LO5	Categories Eugenics, Euphenics and Euthenics and in depth Knowledge on population Genetics.								

UNIT	Contents	No. of Hours
I	Mendel's experiments, Monohybrid cross, Dihybrid cross, Backcross or Testcross, Mendel's laws. Incomplete dominance. Interaction of Genes- Epistasis-lethal genes. Multiple alleles – In Drosophila, Rabbit and Blood group inheritance in man.	15
II	Linkage-linkage in Drosophila-Morgan's experiments, factors affecting linkage. Crossing over- types, mechanism and significance of crossing over. Mapping of Chromosomes, interference and coincidence. Cytoplasmic inheritance - Carbon dioxide sensitivity in Drosophila and milk factor in mice. Sex –Linked Inheritance and Sex- Determination in Man.	15

III	Fine structure of the gene and gene concept, Operon Concept. Identification of the DNA as the genetic material-Griffith experiments, Avery, McLeod, McCarty and Hershey Chase experiment. Microbial Genetics- Bacterial recombination - Conjugation, Transformation, Transduction and sexduction.	15
IV	Mutation – types of mutation, mutagens, DNA damage and Repair Mechanism. Chromosomal aberrations- Numerical and Structural, Pedigree Analysis-Mendelian inheritance in human.	15
V	Population Genetics– Hardy Weinberg principle, gene frequency, genotype frequency and factors affecting gene frequency. Eugenics, Euphenics and Euthenics.	15
Total		75
TextBooks		
1	Dr. Veer Bala Rastogi, 2020, Elements of Genetics, 11th Revised & Enlarged Edition, Kedar Nath Ram	
2	Nath Publications, Meerut, 250001. www.knrnpublishations.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.	
ReferenceBooks		
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	Goodenough U. 1985. Genetics. Hold Saunders international.	
WebResources		
1	https://nptel.ac.in/courses/102/106/102106025/	

2	http://www.ocw.mit.edu
3	http://enjoy.m.wikipedia.org
4	https://www.acpsd.net

MAPPING WITH PROGRAMME OUTCOME AND PROGRAMME SPECIFIC OUTCOME

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

ELECTIVE PAPER II- FUNDAMENTALS OF MICROBIOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			4	4	25	75	100
Learning Objective									
LO1	Understand the classification of Microorganisms and structure of bacteria								

LO2	Understand the various microbiological techniques, different types of media, and techniques involved in culturing microorganisms.	
LO3	Categorize the methods of sterilization and identify the significance of culture media in the growth of different microbes.	
LO4	Exhibit knowledge in analyzing the importance of Bioinsecticides, Bio fertilizers, prebiotics and probiotics.	
LO5	Distinguish between normal flora and pathogens and describe the role of microbes in food intoxications.	
UNIT	Contents	No. of Hours
I	History of Microbiology, Classification of bacteria, fungi, virus, protozoa and algae – classical and molecular approaches. Scope of microbiology, Role of microbes in biotechnology.	15
II	Structure of bacteria - Bacterial growth and measurement, Media – types and preparation- plating methods, staining methods (Gram's, capsule, spore, LCB mount), methods of preservation and storage of microbes. Culture of fungi, virus and algae.	15
III	Sterilization methods- physical and chemical methods- Mode of action. Antibiotic in clinical use, Resistance to antibacterial agents - MRSA, ESBL.	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).	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 text book of Microbiology, New Delhi: S. Chand & Co.	

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 IV- PRACTICAL II

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
			5		4	5	50	50	100

i. GENETICS

Learning Objective	
LO1	Demonstrate the basic principles of important techniques in Molecular biology and Genetics.
LO2	Analyze the Polytene chromosome of the organisms
LO3	Identify Barr bodies from Buccal smear
LO4	Demonstrate the Preparations and maintenance of culture medium
LO5	Demonstrate Human karyotyping
UNIT	Contents
	No. of Hours

I	Mitotic stages of onion (<i>Allium cepa</i>) root tip Meiotic stages of cockroach testes/ Flower bud/Grasshopper	9
II	Giant chromosomes from Chironomus larvae/ Drosophila salivary glands	9
III	Identification of Barr bodies from Buccal smear	9
IV	Preparations of culture medium and culture of Drosophila – methods of maintenance Identifications of mutants of Drosophila	9
V	Human karyotyping (Demo)	9
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	

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
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ii. FUNDAMENTALS OF MICROBIOLOGY

Learning Objective		
LO1	Describe the general Laboratory safety & Sterilization Techniques	
LO2	Develop Skills in Media Preparation, Isolation & Serial Dilution Techniques and Pure Culture Techniques	
LO3	Microscopically analyze the morphological features of Bacteria and fungi and define various Staining Techniques.	
LO4	Perform the Motility of organisms.	
LO5	Able to characterize and identify bacteria using Biochemical tests.	
UNIT	Contents	No. of Hours
I	Sterilization techniques – Preparation of Media	6
II	Inoculation techniques- Pour plate, spread plate Isolation of bacteria from various sources and dilution techniques.	6
III	Staining techniques: Simple, Gram's, Capsule (Negative), Spores, Preparation of temporary mounts- Lacto phenol cotton blue staining.	6
IV	Motility tests: Hanging drop technique.	6
V	Biochemical characterization - catalase, oxidase, IMVIC test and TSI. Antibiotic sensitivity test (demonstration).	6
Total		30
Text Books		
1	James G Cappucino and N. Sherman MB(1996). A lab manual Benjamin Cummins, New York 1996.	
2	Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications.	
3	Sundararaj T (2005). Microbiology Lab Manual (1 st edition) publications.	
4	Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ltd.,	

	Publishers, New Delhi.
5	R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishing.
Reference Books	
1	Atlas.R (1997). Principles of Microbiology, 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	2	2	2	1	2	3	3	3
CLO2	3	2	2	2	1	1	3	3	3
CLO3	3	2	1	1	-	1	3	3	3
CLO4	3	2	1	2	3	2	3	3	2

CLO5	3	3	2	3	3	2	3	2	3
TOTAL	15	11	8	10	8	8	15	14	14
AVERAGE	3	2.2	1.6	2	1.6	1.6	3	2.8	2.8

SKILL ENHANCEMENT COURSE (SEC-2)

VERMITECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	2				1	2	25	75	100
Learning Objective									
LO1	Understand the types, collection and preservation of earthworms. Study the vermitechology								
LO2	Study about the culturing techniques of earthworms and methods of vermicomposting.								
LO3	Learn the small scale techniques of vermicomposting and study the properties of vermicompost.								
LO4	Learn the large scale techniques of vermicomposting.								
LO5	Understand the Vermiwash, Economic and self-employment.								
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>Lampitomarutti</i> , Collection and Preservation of Earthworm, 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								7

IV	Large scale techniques of Vermicomposting Outdoor dual bin; Raised cage; Dual pit; Commercial model; Trickling filter vermicomposting; Keep it simple and save plan	5
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
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

MSU

SKILL ENHANCEMENT COURSE (SEC-3)

ESSENTIAL OIL PREPARATIONS

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	2				1	2	25	75	100
Learning Objective									
LO1	Understand the Preparation of essential oils -Source,distribution and applications								
LO2	Characterize-boilingpoint,volatilityandsolubility, physicochemicalpropertiesandConstituentsofessentialoils								
LO3	Understand the extraction methods of oil								
LO4	Identify the oil producing plants by different methods.								
LO5	Study the packing, storage and marketing of essential oil.								
UNIT	Contents								No. of
									Hours
1	Essential oils- Source,distributionandapplications.Factorsaffectingtheyieldandquality. Aromatherapy uses.								5
II	Characterization- boilingpoint,volatilityandsolubility,physicochemicalpropertiesandConstituents ofessentialoils.								5
III	Extractionmethods–Distillation- Steamdistillation,Hydrodistillation,Maceration,Solvent extraction,distillationapparatus,Advantages,LC-MS.								7
IV	Plantsyieldingessentialoil-Morphology,Methodofextraction,Medicinalusesof Clove, Sandal, Lemongrass, Eucalyptus and Peppermint.								7
V	Registration,Packing,Storageandutilisationofessentialoils.Quality&purity,Grade,Pricingand marketing, Economic benefits.								6
Total									30
Text Books									
1	AromaticandMedicinalplants,yieldingessentialoilforpharmaceuticalperfumeryand cosmetic industry and Trade by Shiva M.P (2002)								
2	AromaticandvitaloilplantsbyRajkumarJoshi.AgrotechpressNew Delhi.(2013).								

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

SECOND YEAR - SEMESTER – III

CORE PAPER-V- IMMUNOLOGY AND IMMUNOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			4	4	25	75	100
Learning Objective									
LO1	Explain the role of immune cells and their mechanism in body defense mechanism.								
LO2	Demonstrate the antigen –antibody reactions in various immune techniques.								
LO3	Gain new insights into Antigen -Antibody interactions and to demonstrate immunological techniques.								
LO4	Gain knowledge of production of vaccines.								

LO5	Apply the knowledge of immune associated disease, hypersensitivity reactions.	
UNIT	Contents	No.of Hours
I	Introduction to Immunology, Cells involved in immune response, Primary and Secondary lymphoid organs – Thymus, Bone marrow, Lymph nodes and Spleen. Hematopoiesis, Development of B and T lymphocytes. Types of immunity – Innate and acquired.	15
II	Antigen: Characteristics and types. Antibody – Structure, Types, Properties and their Biological Function. Production of antibodies- Hybridoma technology, Applications of Monoclonal antibodies in biomedical research.	15
III	Antigen – Antibody interactions: Immunodiffusion and Immuno electrophoresis. Principle and application of ELISA , RIA, Flourescent antibody technique and Western Blotting. Purification of antibodies.	15
IV	The complement system: activation and regulation, Types – Classical, alternative and Lectin pathway. Biological function of C' proteins. Cytokines- Structure and Function. Vaccines – Types, Production and application.	15
V	Hypersensitivity Reactions and Types. Major Histocompatibility Complex – MHC genes, MHC in immune responsiveness, Structure and function of Class I and Class II MHC molecules. HLA tissue typing.	15
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	
	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
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ELECTIVE PAPER III - BIOINSTRUMENTATION

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			4	4	25	75	100
Learning Objective									
LO1	Practice, experiment with and apply the basic instruments in the laboratory.								
LO2	Predict the functionality of Beer – Lambert’s law in identifying and quantifying a biomolecule.								
LO3	Employ the separation techniques for separating biomolecules based on chromatography and electrophoretic techniques.								
LO4	Understand the clinical important isotopes and detection of isotopes.								
LO5	Employ the separation techniques for separating biomolecules based on centrifugal force by centrifugation.								
UNIT	Contents								No.of Hours
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.								15
II	Spectra – Absorption and Emission Spectra, Beer Lambert’s law, Colorimeter, UV-Visible Spectrophotometer, Mass spectroscopy, Atomic absorption spectrometer (AAS), Nuclear magnetic resonance spectrometer (NMR).								15
III	Chromatography – Principle and Applications: Paper Chromatography, TLC, Gel filtration, Ion-Exchange, Affinity Chromatography, Gas Liquid Chromatography and HPLC. Electrophoresis- Principle and Applications: Paper Electrophoresis, Cellulose Acetate Electrophoresis , Agarose Gel Electrophoresis and SDS-PAGE.								15
IV	Radioactivity- Isotopes: Clinically important isotopes, Measurement of Radioactivity – GM Counters, Scintillation Counters and Autoradiography – Applications. SOPs for Radioactive materials.								15

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 VI-PRACTICAL III

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
			4		4	4	50	50	100

i. IMMUNOLOGY AND IMMUNOTECHNOLOGY

Learning Objective		
LO1	Perform blood grouping and determine blood type.	
LO2	Able to count WBC and RBC.	
LO3	Conduct serological diagnostic tests such as ASO, CRP, RA and Widal test.	
LO4	Acquire technical skills required for immunodiffusion and know the principle behind the techniques.	
LO5	Able to Demonstrate ELISA, Handling of Laboratory animals.	
UNIT	Contents	No.of Hours
1	Separation of Serum and Plasma. Blood grouping and Rh typing.	6

II	WBC counting RBC counting Differential blood count	6
III	WIDAL Slide test ASO test	6
IV	Double Immunodiffusion Single Radial Immunodifusion	6
V	ELISA – Demonstration Handling of Laboratory animals - Demonstration Skin test – Demonstration	6
Total		30
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.	
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

ii. BIOINSTRUMENTATION

Learning Objective	
LO1	Practice, experiment with and apply the basic instruments in the laboratory such as weighing balance, pH meter, shaker, incubator etc. in various research processes.
LO2	Predict the functionality of Beer – Lambert’s law in identifying and quantifying biomolecules.
LO3	Employ the separation techniques for separating biomolecules based on paper chromatography.
LO4	Employ the separation techniques for separating biomolecules based on Thin layer chromatography.

LO5	Employ the separation techniques for separating biomolecules based on centrifugal force by centrifugation.	
UNIT	Contents	No.of Hours
I	Preparation of Buffer (Phosphate Buffer) Determination of pH of biological samples using pH meter	6
II	UV spectra of Nucleic acids and proteins.	6
III	Chromatography analysis of sugar, amino acids, lipids by paper chromatography.	6
IV	Chromatography analysis of sugar, amino acids, lipids by Thin layer chromatography.	6
V	Fractionation of biological material into its various components by Centrifuge.	6
Total		30
Text Books		
1	Sharda University Abstract Laboratory Manual for Bio-instrumentation, Biochemistry, Microbiology, Cell Biology and Enzyme Technology.2018	
2	Bhomwik (2011), <i>Analytical techniques in Biotechnology– A complete laboratory manual</i> , MGH Publisher, ISBN-13 : 978-0070700130	
Reference Books		
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	

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

CLO5	3	3	3	3	3	3	3	2	3
TOTAL	15	15	15	15	14	14	15	14	14
AVERAGE	3	3	3	3	2.8	2.8	3	2.8	2.8

SKILENHANCEMENTCOURSE (SEC-4)

AQUACULTURE

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	2				2	2	25	75	100
Learning Objective									
LO1	Understand the morphology and characteristics of cultivable fishes and culture practice								
LO2	Study about the different types of culture methods of fishes and seaweeds.								
LO3	Understand the different types of fish feed formulation.								
LO4	Study the diseases and study the methods of packing and transport.								
LO5	Learn fishing technology, home aquarium and agency involved in aquaculture.								
UNIT	Contents								No. of

		Hours
I	Aquaculture- Origins and growth of aquaculture, Fish pond construction- site selection; types of ponds, water quality analyses, liming and fertilization, morphology and commercial characteristics of cultivable fishes, culture practice.	5
II	Fin fish culture - Composite fish culture (Indian Major Carps and Murrels); Sewage fed fish culture and integrated fish culture, Marine water fish culture. Shellfish and seaweed culture - Culture of marine prawns, edible and pearl oysters, Seaweeds- types and their culture practices	7
III	Live feed organisms – Artemia and rotifers culture; Fish feed - types, formulation and preparation, techniques, Consequences of artificial feeding;	6

	Natural, supplementary and artificial breeding; Breeding – Bundh breeding and induced breeding.	
IV	Fungus infections. Protozoan diseases. Worm diseases. Non parasitic diseases. Methods for packaging and transport. Use of chemicals in live fish transport. Anesthetic drugs. Antiseptics and Antibiotics	6
V	Applied aquaculture: Identification of cultivable fish species; Morphometry of pond (Enclosed rectangular method/Shore length/ shore area and shore line development).Fishing technology (crafts and gears). Home aquarium and agency involved in aquaculture	6
Total		30
TextBooks		
1	Biswas, K. P. 2000. Prevention and control of fish and prawn diseases. Narendra publishing house, New Delhi	
2	Hute, M. and Kahn, H. (2000) Textbook of fish culture, Blackwell Scientific Publication, Australia.	
3	Ninawe, A. S and Khadkar, G. D. 2009. Nutrition in Aquaculture, First Edition, Narendra publishing House, New Delhi.	
4	Jameson, J.D. and Santhanam. R. 1996, Manual of ornamental fishes and farming, Technologies Peejay, Thoothukkudi.	

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

SEMESTER –IV
CORE PAPER VII- GENETIC ENGINEERING AND rDNA TECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			4	4	25	75	100
Learning Objective									
LO1	Demonstrate the basic principles of genetic engineering techniques and illustrate the specificity of vectors for cloning and advantages.								
LO2	Enumerate various recombinant techniques and gene probes and molecular markers identification.								
LO3	Understand Gene transfer techniques by Viral and Nonviral mediated gene transfer mechanisms.								
LO4	Exhibit knowledge in sequencing technologies and protein engineering techniques.								
LO5	Explore the strategies of Recombinant DNA Technology in r medicine, Industry and agriculture.								
UNIT	Contents								No.of Hours
I	Genetic Engineering – Introduction. Tools in recombinant DNA technology – recombinant DNA cloning strategies: Enzymes, Vectors, Host, Transformation- 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, Non viral mediated gene transfer. Physical methods: Microinjection, Electroporation, Particle Bombardment. Chemical methods: Calcium phosphate, DEAE dextran, Liposomes. Selectable markers and reporter genes								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

CLO3	3	3	3	3	2	3	3	3	3
CLO4	3	3	3	2	3	2	3	3	2
CLO5	3	3	3	3	3	3	3	2	3
TOTAL	15	15	15	14	14	14	15	14	14
AVERAGE	3	3	3	2.8	2.8	2.8	3	2.8	2.8

ELECTIVE PAPER IV - BIOINFORMATICS AND BIOSTATISTICS

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			4	4	25	75	100
Learning Objective									
LO1	Acquire knowledge about the Developments and Applications of Bioinformatics.								
LO2	Gain knowledge about the importance of the bioinformatics, databases, tools and software of bioinformatics and explain different types of Biological Databases.								
LO3	Understand the basics of sequence alignment, sequence analysis and Protein structure prediction method.								
LO4	Demonstrate the basic methods of data collection, graph construction and sampling techniques and Calculate measures of central tendency								
LO5	Correlate and analyze biological data through various statistical methods and interpret biological data via various probabilistic distribution methods.								
UNIT	Contents								No. of Hours
I	Introduction to Bioinformatics – Genome, Transcriptome and Proteome, Gene prediction rules and software. Nucleic acid Databases – Primary and Secondary Databases. Structure Database – CATH, SCOP, Data base 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								15

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 VIII- PRACTICAL IV

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
			4		4	4	50	50	100

i. GENETIC ENGINEERING AND rDNA TECHNOLOGY

Learning Objective		
LO1	Isolate the Plasmid DNA and Genomic DNA. and predict the molecular weight of DNA by agarose gel electrophoresis.	
LO2	Demonstrate working principles of PCR, RFLP and other important Genetic Engineering techniques.	
LO3	Prepare the competent cells and perform bacterial transformation.	
LO4	Determine the restriction digestion of DNA	
LO5	Determine the restriction fragment length polymorphism.	
UNIT	Contents	No. of Hours
1	Isolation of genomic DNA Isolation of plasmid DNA	6

II	Isolation of RNA	6
III	Production of competent cells for transformation Bacterial transformation	6
IV	Restriction Digestion of DNA	6
V	Restriction Fragment Length Polymorphism(DEMO) PCR(Demonstration)	6
Total		30
Text Books		
1	Laboratory Manual for GENETIC ENGINEERING 1st Edition, Kindle Edition by S. JOHN VENNISON (Author) 2009.	

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

ii. BIOINFORMATICS AND BIOSTATISTICS

Learning Objective	
LO1	Analyse the Biological databases
LO2	Able to perform BLAST and FASTA

LO3	Represent data in to graphical form	
LO4	Test the level of significance of biological data and interpret the results.	
LO5	Determine averages of the biological data	
UNIT	Contents	No. of Hours
I	Biological databases (NCBI, Swissprot and PDB)	6
II	BLAST FASTA	6
III	Identification of functional domains in nucleotide binding proteins using a domain analysis server like SMART	6
IV	Preparation of bar diagram, line diagram and pie diagram using MS EXCEL. Calculation of Central tendency- mean, geometric mean, median using MS EXCEL	6
V	Calculation of dispersion – Mean deviation, quartile deviation and standard deviation using MS EXCEL Calculation of student's t test using MS EXCEL	6
Total		30
Text Books		
1	Pennington, S.R. and Punn, M.J. 2002. Proteomics: from protein sequence to function. Viva books Pri. Ltd.	
2	Maleolm and Goosfship. J. 2001. Genotype to phenotype, 2nd edition. Bios Scientific Publishers Ltd	
3	Misener, S. and Krawetz. S.A. 2000. Bioinformatics: Methods and Protocols. Humana press.	
4	Attwood, T.K. and Parry-Smith, D.J. 1999. Introduction to Bioinformatics. Pearson Education Asia.	
5	Trimrose, 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
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MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

SKILENHANCEMENTCOURSE (SEC-5)

HERBAL MEDICINE

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

Learning Objective

LO1	The student can analyses the importance of herbal medicine
LO2	Learn the role of herbal medicines for health
LO3	Can explain about Tribal medicine
LO4	Analyses the role of traditional medicine for today's health

LO5	Demonstrate the use of medicinal herbs to health	
UNIT	Contents	No.of Hours
I	Ethnomedicine – definition, history and its scope, Inter disciplinary approaches in ethnobotany, Collection of ethnic information.	5
II	Importance of medicinal plants – role in human health care, health and balanced diet (Role of proteins, carbohydrates, lipids and vitamins).	5
III	Tribal medicine – methods of disease diagnosis and treatment, Plants in folk religion – <i>Aegle marmelos</i> , <i>Ficus benghalensis</i> , <i>Curcuma domestica</i> , <i>Cynodon dactylon</i> and <i>Sesamum indicum</i> .	6
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> .	7
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).	7
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	

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

THIRD YEAR- SEMESTER –V

CORE PAPER-IX-PLANT BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			4	5	25	75	100
Learning Objective									
LO1	Explore the history of Biotechnology and state the importance of organization of plant genome								
LO2	Be acquainted with the molecular basis of action of plant hormones and gene expression								
LO3	Illustrate about various culture medium preparations, haploid, triploid plant production and its applications								
LO4	Exploit symbiotic organisms as a vector for gene transfer to produce transgenic plants								
LO5	Develop molecular technique skills for crop improvement.								
UNIT	Contents								No.of Hours
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								15

	and triploid, Protoplast isolation, fusion and culture, hybrid and cybrid production, Synthetic seed production. Secondary metabolite production.	
IV	Agrobacterium and crown gall tumors – Mechanism of T-DNA transfer to plants, Tiand Ri Plasmid vectors and their utility, Plant viral vectors. Symbiotic nitrogen fixation in Rhizobia, nif gene.	15
V	Crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors. Transgenic plants- plant vaccines, genetically modified food - future perspectives & ecological impact of transgenic plants.	15
Total		75
Text Books		
1	Sudhir, M. 2000. Applied Biotechnology and plant Genetics. Dominant publishers and distributors.	
2	Trivedi, P.C.2000. Applied Biotechnology: Recent Advances. PANIMA Publishing corporation.	
3	Ignacimuthu. 1996. Applied Plant Biotechnology. Tata McGraw – Hill.	
4	Narayanaswamy S. 1994. Plant cell and tissue culture. Tata McGraw Hill Publishing Company limited, New Delhi.	
5	Chawla, H.S., “Introduction to Plant Biotechnology”, 3rd Edition, Science Publishers, 2009.	
Reference Books		
1	Kojima, Lee, H. and Kun, Y. 2001. Photosynthetic microorganisms in Environmental Biotechnology. Springer – Verlag.	
2	Stewart Jr., C.N., “Plant Biotechnology and Genetics: Principles, Techniques and Applications” Wiley-Interscience, 2008.	
3	Heldt HW. Plant Biochemistry & Molecular Biology, Oxford University Press. 1997.	
4	Trigiano, R.N. and Gray, D.J. 1996. Plant tissue culture concepts and laboratory exercise. CRC Press. BocaRatin, New York.	
5	Street, H.E. 1977. Plant tissue culture. Blackwell Scientific Publications, oxford, London.	
Web Resources		
1	https://nptel.ac.in/courses/102103016	
2	https://science.umd.edu/classroom/bsci124/lec41.html	
3	https://www.nifa.usda.gov/grants/programs/biotechnology-programs/plant-biotechnology	
4	http://mydunotes.blogspot.com/p/plant-biotechnology.html	
5	https://nptel.ac.in/courses/102103016	

MAPPING WITH PROGRAMME OUTCOME AND PROGRAMME SPECIFIC OUTCOME

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

CORE PAPER X - ANIMAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks			
							CIA	External	Total	
	4	1			4	5	25	75	100	
Learning Objective										
LO1	Understand the basic concepts of Animal cell culture and cell laboratory									
LO2	Describe the media preparation, preservation, trypsinization, counting, maintenance and application of cell lines.									
LO3	Discuss the strategies for gene transfer and gene expressions with their applications.									
LO4	Be acquainted with genetic modification and stem cell technology in production of transgenic animals.									
LO5	Learn the Assisted reproductive technology and its applications.									
UNIT	Contents							No.of Hours		
1	Animal cell culture – History and development, Pluripotency, Media, balanced salt solutions, Physical, chemical and metabolic functions of							15		

	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.	
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

CORE PAPER XI - ENVIRONMENTAL & INDUSTRIAL BIOTECHNOLOGY

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

Learning Objective		
LO1	Know about the environment, its issues and management of the environment.	
LO2	Explain the process of waste water treatment, drinking water treatment and solid waste management in various industries.	
LO3	Illustrate the significance of bioreactors in bioprocess engineering and culture methods.	
LO4	Explain Downstream processing, Fermented Products production and advanced methods	
LO5	Speculate the role and importance of microorganisms behind the ore leaching, production of food products and Biofertilizers.	
UNIT	Contents	No. of Hours
I	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. Disposal of industrial effluent (Paper, Tannery, Textile) and Pesticide waste disposal- Biotechnological approach.	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	15

	microbial toxin production and their applications - Biosurfactants, Vitamins-Folic acid & Vitamin B12, Organic acids.	
Total		75
Text Books		
1	Chatterji, A.K., 2002. Introduction to Environmental Biotechnology, Prentice-Hall of India, New Delhi.	
2	Anil Kumar De., 2000. Environmental Chemistry, 4th Edition. New Age International, New Delhi.	
3	Murugesan, A G., Rajakumari, C., 2005. Environmental Science and Biotechnology Theory and Techniques., MJP publishers, Chennai.	
4	T.Satyanarayana, Bhavdish Narain Johri, Anil Prakash(2012), Microorganisms in Sustainable Agriculture and Biotechnology.	
5	Madigan, Michael and Martinko, John, Brock biology of microorganism, 11th edition, (2005).	
Reference Books		
1	Alan Scragg, 1999. Environmental Biotechnology, Pearson Education Limited, England,	
2	Peter F. Stanbury, Allan Whitaker, Stephen J. Hall (2013). Principles of Fermentation Technology Second Edition, Elsevier Science Ltd	
3	Michael J. Waites, Neil L. Morgan, John S. Rockey Gary Higton (2001.), Industrial Microbiology: An Introduction. . Blackwell Science Ltd	
4	Nduka Okafor, Modern Industrial Biotechnology & Microbiology ((2017, Science Publishers, Edenbridge Ltd.	
5	Waites, Morgan, Rockey and Higton, Industrial Microbiology: An Introduction, Blackwell Science (2001).	
Web Resources		
1	https://nptel.ac.in/courses/120/108/120108004/	
2	https://www2.hcmuaf.edu.vn/data/quoctuan/Environmental%20Biotechnology%20-%20Theory%20and%20Application,%20G%20M%20Evans%20&%20J%20C%20Furlong.pdf	
3	www. Prenhall.com/Madigan	
4	www.e-bug.eu/	
5	www.microbeworld.org/	

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

CORE XII- PRACTICAL V- PLANT BIOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	-	-	4		4	4	50	50	100
Learning Objectives									
LO1	Explain plant tissue culture and Illustrate Callus development.								
LO2	Develop technical skills in Protoplast isolation and Nucleus localization.								
LO3	Make use of the techniques used in preparing tissue culture medium and membrane filtration in culturing animal cells and prepare single cell suspension and evaluate cell counting and viability.								
LO4	Develop technical skills in isolation of DNA and RNA from plants and microorganisms.								
LO5	Examine the importance of trypsinization in monolayer and subculture and cryopreservation.								
UNIT	Contents								No. of Hours
1	Plant tissue culture media preparation & sterilization techniques.								9

	Callus induction	
II	Isolation of plant protoplast & viability test. Localization of nucleus using nuclear stain.	9
III	Preparation of Animal Tissue culture medium and membrane filtration Preparation of Single Cell Suspension & Cell counting Cell viability Test	9
IV	Isolation of plant DNA and plant RNA(Demo) Isolation of Agrobacterium plasmid DNA (Demo)	9
V	Trypsinization of monolayer and subculturing (Demo) Measurement of phagocytic activity (Demo) MTT Assay (Demo) Cryopreservation and thawing (Demo)	9
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
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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 XIII- PRACTICAL VI - ENVIRONMENTAL AND INDUSTRIAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	-	-	4	-	3	4	50	50	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
I	Isolation of Air borne Pathogens Study of Growth Curve and Generation time of Bacteria/ Yeast using turbidometry.	9
II	Water analysis – MPN and BOD. Immobilization of whole yeast cells/ enzyme by Alginate beads. Production of wine Production of Biogas – <i>In vitro</i> & Compost Making.	9
III	Biofertilizer production/Spirulina production - field visit. (Report should be included in the record) Isolation and identification of starter organisms from Idli batter/ curd	9
IV	Grading of raw milk (Dye reduction test). Determination of efficiency of Pasteurization by quantitative phosphatase test.	9
V	Preparation and Efficiency testing of Biofertilizer/ Biopesticide. (Demo) Production of microbial Polysaccharide. (Demo)	9
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=tUCfkNKvQvc	

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 V - NANO BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			3	5	25	75	100
Learning Objective									
LO1	The students will get an outline about Nano biotechnology and its research in India.								
LO2	To know about nanoparticles and their analysis using Advanced Instrumentation.								
LO3	To get an insight about Nano devices								
LO4	The students will know about the Applications of Nano biotechnology								
LO5	The students will know about the Nano Biosensors and their applications.								
UNIT	Contents								No. of Hours
I	Glimpse of Nanotechnology based material in ancient India: Wootz steel (iron carbide) and the Delhi iron pillar (anticorrosive nanomaterial), Bhasma (nanomaterial as medicine). Contributions of Indian Research Institutes in the field of nanobiotechnology.								15
II	Metals: Silver nanoparticle synthesis and its analyses by UV-spectroscopy and FTIR. Self-Assembly nanomaterial: Cell membrane and its analyses by SEM								15

III	Nano-thin films: Chitosan thin film, Nanodevices (nanorobots), Nanotubes: Microtubules assembly and its importance, Nanoshells- Dendrimers: Liposomes, Nanofibers: Collagen, Fibronectin & elastin, nanofluidics: Extracellular matrix assembly and its importance.	15
IV	Agriculture: Crop production- Nanofertilizers technology, Biomaterial to improve shelf life of vegetables. Medicine: Collagen thin films in wound healing mechanism, Nanoscale devices – DNA microarray for disease diagnosis, Antibodies and Targeted drug delivery system.	15
V	Nanobiosensors (Firefly-luciferase) and its applications, Introduction to Biomimetics (Gecko foot effect, Lotus leaf effect: Paint and fabrics, Box fishbased Car).	15
Total		75
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), Biochemistry, John Wiley & Sons, New York.	
2	Biochemistry by Lubert Stryer, 4 th Ed., WH.Freeman, 1995.	
3	David S. Goodsell, "Bionanotechnology", John Wiley & Sons Inc., publications, 2004.	
4	Guozhong Cao (2004). Nanostructures and Nanomaterials, synthesis, properties and applications, Imperial College Press, ISBN: 978-1860944802.	
5	C.M.Niemeyer, C.A. Mirkin (2007). <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

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			3	5	25	75	100
Learning Objective									
LO1	The students will learn the Fundamentals of Enzymology.								
LO2	The students will study about the characteristic features of Enzymes.								
LO3	The student will know about the details of Enzyme Kinetics.								
LO4	The student will apply the biochemical techniques for enzyme isolation								
LO5	The Student will understand the process of Immobilization of enzymes , Enzyme engineering and Designer enzymes in various Industrial purposes.								
UNIT	Contents								No. of Hours

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). Transition state theory, standard free energy, activation energy.	15
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.	15
III	Enzyme Kinetics – Michaelis-Menten equation and its derivation, significance of K_m and V_{max} , Lineweaver- Burk plot and Eadie- Hofstee plot, Hanes-Woolf plot. Enzyme inhibition - competitive, Non- competitive, Uncompetitive – (Derivations not included). Allosteric inhibition - sequential model, concerted model, feedback inhibition.	15
IV	Membrane bound proteins – Fluid mosaic model. Extraction of enzymes – Chemical agents and Physical methods of extraction, French pressure cell and ultrasonication. Nature of the extraction medium. Technique for enzyme isolation, separation of cellular organelles by differential centrifugation, purification of enzymes- dialysis, chromatography, electrophoresis. Intracellular localization of enzymes and marker enzymes.	15
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.	15
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 LubertStryer,6th Edition, Freeman Publications, 2006.	
3	Ralph A. Messing (2012) Immobilised Enzymes Academic Press, NY.	

4	Nelson D.L., and Cox, M.M. 2013. Lehninger Principles of Biochemistry. 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
4	https://www.youtube.com/watch?v=0ZiCqwtFMTs

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 - CANCER BIOLOGY

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

4	A. Sarkar, 2011, Biology of Cancer, Discovery Publishing House, New Delhi.
5	Ranajit Sen, 2004, Principles and Management of Cancer, B.I. Publications Pvt Ltd, New Delhi.
Reference Books	
1	Francesco Pezzella, Mahvash Tavassoli, David J. Kerr, 2019, Oxford Textbook of Cancer Biology, Oxford University Press
2	Albert DeNittis, MD, Joel W. Goldwein, MD, and Thomas J. Dilling, MD, 2002, The Biology of Cancer.
3	Robin Hesketh, 2012, Introduction to Cancer Biology, Cambridge University Press
4	Francesco Pezzella, Mahvash Tavassoli, David J. Kerr, 2019, Oxford Textbook of Cancer Biology, Oxford University Press
5	Albert DeNittis, MD, Joel W. Goldwein, MD, and Thomas J. Dilling, MD, 2002, The Biology of Cancer.
Web Resources	
1	http://csbl.bmb.uga.edu/mirrors/JLU/DragonStar2017/download/introduction-to-cancer-biology.pdf
2	http://webserver1.oneonta.edu/faculty/bachman/cancer/207lectures.htm

MAPPING WITH PROGRAMME 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	2	3	3	3	3
CLO5	3	3	3	3	3	3	3	3	3
TOTAL	15	15	15	15	14	15	15	15	15

AVERAGE	3	3	3	3	2.8	3	3	3	3
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ELECTIVE V- BIOETHICS & BIOSAFETY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			3	5	25	75	100
Learning Objective									
LO1	The students will understand the concepts of Bioethics and Biosafety.								
LO2	The students will realize the impact of Gene cloning in societal problems and also understand the need of the Bioethics.								
LO3	The students will know about the importance of Ethical Clearance.								
LO4	The students will get knowledge about Patents Rights in the field of Research.								
LO5	The students will know about Biosafety and GLP.								
UNIT	Contents								No. of Hours
I	Human Rights: Definition, Classification and Scope of Human Rights. United Nations Commission for Human Rights, National and State Human Rights Commission. Article 21 of Indian Constitution – UDHR. Social issues of Human rights.								15
II	Impact of gene cloning & Bioethics-Issues concerning reproduction, Birth, life and Death (Artificial insemination, egg donation, IVF, embryo transplants, Prenatal diagnosis and sex selection & Abortion).								15
III	Bioethics of IPR - ethical criteria in biotechnology- animal ethics; Licensing of animal house - Human cloning - Ethical issues - Ethical clearance norms for conducting studies on human subjects.								15
IV	Patents - Introduction -Treaties and Conventions of Patents, Patent Cooperation Treaty - TRIPS Basis of Patentability – NonPatentable Inventions - Patent Application Procedure in India. Other Forms of IP: Copyright - Trade Mark – Industrial designs – Farmer’s Rights. Patenting of Biotechnology products and processes.								15

CLO3	3								
CLO4	3								
CLO5	3								
TOTAL	15								
AVERAGE	3								

SEMESTER- VI

CORE PAPER XIV - BIOENTREPRENEURSHIP

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			4	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 Vermicomposting and Sericulture								
LO4	Will aspire to set up Mushroom Cultivation								
LO5	Will learn the technique of Single cell protein Cultivation								
UNIT	Contents								No.of Hours
I	Basics of Bio entrepreneurship -Biotechnology in a Global scale; types of Bio-industries – Biopharma, Bioagri and Bioservice innovations – Successful Entrepreneur – Creativity, Leadership, Managerial skills, Team building, Decision making; Public and private funding agencies (MSME, DBT, BIRAC, Startup & Make in India)								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	Vermicomposting–Earthworms-Ecologicaltypes-Vermiculture-Compostpit-Vermibed-applications.Sericulture-Mulberrycultivation-SilkwormRearing-Economicsofsilkworm Production-Chawki Rearing-Sericulture in India.								15

IV	Phases of Mushroom Cultivation; Selection of an acceptable mushroom species/strains, Management of mushroom development, Mushroom harvesting; Mushroom diseases, Medicinal and Nutritional properties of mushroom. Aquaponics- Systems-Fish and Vegetables-Nutrients and Biofilters-Advantages and Disadvantages.	15
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/	

	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 XV - PHARMACEUTICAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			4	5	25	75	100
Learning Objective									
LO1	Students will understand the series of processes involved in drug development, patenting and drug approval.								
LO2	Will learn about Biopharmaceuticals								
LO3	Will become familiar with Biotech protein drugs								
LO4	Will understand about management of drugs								
LO5	Will be familiar with Pharmaceutical sectors								
UNIT	Contents								No.of Hours
1	Objectives of Pharmaceutical Biotechnology - Generic and Biogeneric drugs. Stages in the drug development process -Drug discovery - Drug designing - Drug production - Preclinical trials - Clinical trials - Pharmacokinetics and Pharmacodynamics - Patenting & Drug Approval - Drug Marketing - Post clinical trials.								15

II	Production of recombinant proteins - Development of Nucleic acid based therapies - Biopharmaceutical considerations - Pharmaceutical regulations - Formulation of Biotechnology products - Drug delivery - Pharmacognosy .	15
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).	15
IV	Drug toxicity analysis - Common side effects of drugs and managements - Drugs of abuse - Life changing complications - Prevention and management	15
V	National and International Drug approval agencies - Top National and International pharmaceutical industries - Scope and career opportunities in pharmaceutical sectors.	15
Total		75
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. Corpenner, 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/	

ELECTIVE VI -MARINE BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			3	4	25	75	100
Learning Objective									
LO1	Students will gain knowledge about Marine Ecosystem and Resources.								
LO2	Will learn about bioactive compounds from Marine sources								
LO3	Will learn about medicinal seaweeds								
LO4	Will know about culture of seaweeds and Aquaculture								
LO5	Will know about Marine biotech products								
UNIT	Contents								No. of Hours
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- Trangenesis 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 Fingerman and Rachakonda Nagabhushanam, 1996, Molecular Genetics of Marine Organisms, Science Pub Inc.
3	Y. Le Gal and H.O.Halvorson 1998, New Developments in Marine Biotechnology. Springer.
4	David H. Attaway, 2001. Marine Biotechnology, Volume 1, Pharmaceutical and Bioactive Natural Products.
5	Rita R. Colwell 1984. Biotechnology in the Marine Sciences (Advances in Marine Science & Biotechnology) Wiley Interscience

Reference Books

1	Scheupr, P.J. (Ed.), 1984. Chemistry of Marine Natural Products, ,Chemical and Biological Perspectives. Vol. I III, Academic Press, New York
2	Marine Biology- Lalli C.M. and T.R. Parsons., 1997. Biological Oceanography - An Introduction, Elsevier, 314 pp
3	Marine Pollution- Clark, R. B. 2001. Marine pollution, Fifth edition. Oxford University press, New York Inc., 231pp
4	Gloria Sanchez, Elizabeth Hernandez,(2019), <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 VI- FOOD TECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			3	4	25	75	100
Learning Objective									
LO1	Students will be able to understand the basic concepts of the food industry								
LO2	Will learn about classification of food								
LO3	Will learn about fruits, vegetables and horticulture								
LO4	Will learn about Non vegetarian food								
LO5	Will learn about food adulteration and biosensors to detect them								
UNIT	Contents								No.of Hours
I	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. Rice- and composition, parboiling of rice- advantages and disadvantages. 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, steam deodorization, hydrogenation. 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								15

	during the storage of fruits and vegetables.	
IV	Concept of red meat and white meat, composition of meat, marbling, post-mortem changes in meat- rigor mortis, tenderization of meat, ageing of meat. Aquaculture, composition of fish, characteristics of fresh fish, spoilage of fish - microbiological, physiological and biochemical. Composition and nutritive value of egg, characteristics of fresh egg, deterioration of egg quality, difference between broiler and layers. Milk and Milk Products. Chemical composition of milk, its constituents, processing of milk, pasteurization, homogenization. An overview of types of market milk and milk products.	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., <i>Outlines of Dairy Technology</i> , 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

ELECTIVE VII - MEDICAL BIOTECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			3	4	25	75	100
Learning Objective									
LO1	Student will be able to obtain knowledge on Vaccines, Antibody therapy and diagnostics								
LO2	Will know the Molecular basis of diseases								
LO3	Will know about cytokines and interferons								

LO4	Will learn about clinical trials	
LO5	Will learn about ethics in clinical trials	
UNIT	Contents	No.of Hours
I	Antibodies and vaccines - Therapeutic production of antibodies, antibody mediated drug delivery of vaccines, different kind of vaccines and applications of recombinant vaccines. Diagnosis - Biochemical diagnostics, inborn errors of metabolism, haemoglobinopathies.	15
II	Molecular basis of disease, Recombinant DNA Technology in medicine, gene probes as molecular diagnostic reagents. Polymerase Chain Reaction in clinical diagnostics, DNA sequencing of representative clones to detect mutations.	15
III	Diagnosis of infectious diseases, Viral diseases – HIV, influenza; bacterial diseases - enteric diseases, mycobacterium diseases; immune arrays. FACs immunocytochemical staining, ELISA, FISH techniques.	15
IV	Immunoblot analysis of antigens and allergens. Production of therapeutic agents – Productions and application of therapeutic agents, Production of cytokines and interferons.	15
V	Principles of project management in Clinical trials and its application. Principles of research ethics; Ethical issues in clinical trials; Animal rights and use of animals in the advancement of medical technology. Use of humans in Scientific Experiments; Introduction to ethical codes and conduct.	15
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 VII- FORENSIC SCIENCE

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			3	4	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	
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. Questioned documents – identification of handwriting, signature and detection of forgery.	15
III	Serology - Fresh blood grouping and typing, stains of bloods. Identification of blood stains, collection and storage of allied body fluids (semen, saliva and blood). Case studies.	15
IV	PCR, RFLP, AFLP, Microscopy (Electron, Fluorescent) and Chromatography (Paper, TLC & HPLC) in forensic investigation.	15
V	DNA Profiling, Isolation of DNA from blood samples, DNA testing in cases of disputed paternity and maternity.	15
Total		75
Text Books		
1	Nageshkumar G Rao, Textbook of Forensic Medicine & Toxicology, Jaypee, 2013.	
2	K.S. Narayan reddy and O.P. Murty, The Essentials of Forensic Medicine & Toxicology, 35th Edition, Jaypee, 2017.	
3	Nanda, B.B. and Tiwari R. K. (2014). Forensic Science in India: A Vision for the Twenty First Century, (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 Instrumentation</i> , (2nd Edition), Delhi, PHI, ISBN: 9789387472396.	

Web Resources	
1	http://www.forensicsciencesimplified.org
2	www.nfstc.org
3	https://archive.org/details/FBI_Handbook_of_ForensicScience
4	https://www.soinc.org/forensics-notes

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

ELECTIVE VII -GOOD LABORATORY PRACTICES (GLP)

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

Learning Objective

LO1	The student will know the types of labs associated with Biotechnology
LO2	Will know to use and maintain lab Instruments
LO3	Will know the calculations needed in a laboratory
LO4	Will know about good lab Guidelines
LO5	Will know how to safely dispose bio waste

UNIT	Contents	No.of Hours
I	Types of labs associated with Biotechnology (General lab, microbial culture lab, plant tissue culture lab, Fermentation lab, computational stimulation lab), Types of Chemical (Analytical grade, molecular grade) and its various arrangement (Arrangement of basic chemicals, solvent, acid and base, fine chemicals like dyes, protein and enzyme storage units), Physical chemical characteristics: hygroscopic, corrosive, volatile properties; Fire and explosion hazard data, Health hazards (how to use UV-illuminator), Fumigation technique.	15
II	Methods and types of documentation (pre-lab writes, result recording and post lab report: interpretation of result), Dilution factor calculation, Molarity, percentage, dilution of concentrated solution, metric units (kg to gms and vice - versa).	15
III	Principles, use and maintenance of laboratory instruments like Autoclave, hot air oven, Incubators, Water bath, Refrigerator, Centrifuge, Calorimeter, pH meter, Haemocytometer, Microtomes, Electronic balances, Biosafety cabinets. SOP preparation for instrumentation.	15
IV	Good Laboratory guidelines, Elements of GLP, Standard Operating Procedures and its importance, Quality Assurance & Quality control, Internal audit basics, ISO, BIS and HACCP standards.	15
V	Definition of waste, types of waste: Biological 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.	
3		
1	Milton A. Anderson GLP Essentials: A Concise Guide to Good Laboratory Practice, Second Edition 2nd Edition, Published by CRC press.	
Web Resources		
1	https://www.who.int/tdr/publications/documents/glp-trainer.pdf "tdr	
2	https://www.who.int/tdr/publications/documents/glp-trainer.pdf ">publications > documents	
3	https://www.who.int/tdr/publications/documents/glp-trainer.pdf "glp	
4	https://www.who.int/tdr/publications/documents/glp-trainer.pdf "-trainer	

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

SUBJECT –SPECIFIC SUBSTITUTE PAPERS (NAAN MUDHALVAN ARREAR PAPERS)

1. Food and bioprocess technology -Semester II
2. Global climate change -Semester III
3. Poultry science and management- Semester IV
4. Clinical nutrition and dietary management-Semester V
5. Cryobiology- Semester VI

FOOD AND BIOPROCESS TECHNOLOGY**Course Outcome**

Students will be able to assess nutritional status and apply the knowledge in understanding the metabolism and nutrient functions.

UNIT I

Introduction to Bioprocess Technology: History and Scope- Bioreactor: Design, parts and accessories, functions, Types of reactors .

UNIT II

Fermentation media design, sterilization and media requirement for industrial fermentation, Development

and scale up of bioreactors for production of biological products.

UNIT III

Downstream processing: Cell disruption methods for intracellular products, removal of insolubles, biomass (and particulate debris) separation techniques, flocculation and sedimentation, centrifugation and filtration methods..

UNIT IV

Production of microbial enzymes (Amylase, Protease and Pectinase) applications, production of organic solvents (Ethanol, Methanol) – production of organic acids (Citric acid, Acetic acid).

UNIT V

Processing of Milk – Pasteurization and homogenization - Modifying milk composition – Production of milk products – Curd, cheese, yogurt, and flavoured milk..

References:

1. Shuler, M.L. and Kargi, F. 2008. Bioprocess engineering – Basic concepts. Pearson Education.
2. M.L. Srivastava., 2010. Fermentation Technology, Narosa Publications.
3. Pauline M. Doran., 2009. Bioprocess Engineering Principles. Academic Press Inc.,
4. El-Mansi & Bryce C.F.A., 2007. Fermentation Microbiology and Biotechnology., 2nd edition, Taylor and Francis Publishing.

GLOBAL CLIMATE CHANGE

Course outcome:

On completion of this course, the students will be able to understand the concept and issues of global environmental change. They will gain knowledge about the physical basis of natural greenhouse effect on man and materials.

Unit – I:

Global Environmental change issues. UNFCCC, IPCC, Kyoto protocol, CDM, Carbon foot print and ecological foot print.

Unit – II:

Stratospheric ozone layer: Evolution of ozone layer; Causes of depletion and consequences; Effects of enhanced UV-B on plants, microbes, animals, human health and materials; Global efforts for mitigation ozone layer depletion.

Unit – III:

Climate change: Greenhouse effects; causes; Greenhouse gases and their sources; Consequences on climate, oceans, agriculture, natural vegetation and humans; International efforts on climate change issues.

Unit – IV:

Atmospheric deposition: Past and present scenario; Causes and consequences of excessive atmospheric deposition of nutrients and trace elements; Eutrophication.

Unit – V:

Acid rain and its effects on plants, animals, microbes and ecosystems.

References:

1. Adger, N. Brown, K and Conway, D. 2012. Global Environmental Change: Understanding the Human Dimensions. The National Academic Press.

2. Turekian. K. K. 1996. Global Environmental Change-Past, Present, and Future. Prentice-Hall.
3. Matthew. R.A. 2009. Jon Barnett, Bryan McDonald. Global Environmental Change and Human Security. MIT Press., USA.
4. Hester, R.E and Harrison, R.M. 2002. Global Environmental Change. Royal Society of Chemistry.

POULTRY SCIENCE AND MANAGEMENT

Course outcome:

Students will understand the domestication of fowls, techniques of rearing and management of various breed. They will acquire knowledge on the diseases of poultry and the prophylactic measures.

Unit – I:

External features of fowls – skeletal system – digestive system – endocrine system – feathers – Respiratory system – reproductive system. Genetics of fowls: Breeds of fowls – inheritance of morphological characters (List of autosomal and sex linked character – breeding methods – systems of breeding – modern method of breeding.

Unit – II:

Poultry industry in India– choosing commercial layers and broilers – Poultry housing – deep litter and cage system-merits and demerits.

Unit – III:

Practical aspects of chick rearing –brooding management- grower and layers – management of broilers – lighting, summer winter management – debunking.

Unit – IV:

Poultry Nutrition: Energy – protein and aminoacids – Vitamins – essential organic elements – Non – nutrition feed additives – feed stuffs for poultry – feed formation.

Unit – V:

Diseases: Viral, bacterial, fungal and parasitic disease. Vaccines and vaccination programmes.

References:

1. Gopalakrishnan C.A and G.Murley Mohan Lal 1997, Livestock and Poultry enterprises for rural development, Vikash, New Delhi.
2. Gnaanamani M.R., 1998 Modern aspects of commercial poultry keeping, Giri.
3. Banarjee G.C., 1992 Poultry, Oxford and IBH, New Delhi.
4. Chauhan H.V.S. and S.Roy, Poultry diseases, diagnosis and treatment New Age International, 1996.
5. John William S. (Ed) 2003. Poultry for sustainable Food Production and livelihood. Loyola Publication, Chennai.

CLINICAL NUTRITION AND DIETARY MANAGEMENT

Course outcome:

On completion of the course, the students will understand the need for a Balanced diet, gain insight on Nutrition requirements during different stages of Life. Appreciate the importance of Dietary Management in different diseases. Acquire knowledge on different modes of nutrition

Unit-I:

Definition of Nutrition, Overview of Balanced diet, Collecting and analyzing Nutritional information – Physical examination, Anthropometric measurements.

Unit-II:

Common food allergies, food intolerance – lactose intolerance. Cardiovascular diseases-atherosclerosis, and myocardial infarction, foods that increase LDL and HDL.

Unit-III:

Bulimia and Anorexia Nervosa. Dietary management with reference to Constipation, Diarrhoea, Dehydration, Peptic Ulcer, Hepatitis, Gall bladder diseases and Renal failure.

Unit-IV:

Dietary management with reference to Hypertension, Diabetes Mellitus, AIDS and Cancer, Surgery and Nutritional support, outline of Enteral Nutrition and Parenteral Nutrition.

References:

1. Garrow, JS , James WPT and Ralph A (2000) . Human nutrition and Dietetics (10th ed) Churchill Livingston.
2. PiareyLal Mehta, NeenaVerma, P I Mehta (1999) Human Rights Under the Indian
3. Constitution. Deep & Deep Publications Pvt. Ltd.
4. Handbook of Food and Nutrition –Dr. M. Swaminathan, BappcoPublisher,2014.
5. Nutrition Science- B.Srilakshmi,7th edition, New age International Publisher, 2017.
6. William’s Basic Nutrition and Diet Therapy – Staci Nix McIntosh,First South Asian Edition, Elsevier Publisher, 2016.
7. Nutrition essentials and diet therapy-Packenpaugh,11thedition,Saunders Publishers, 2009.
8. Davidson’s Principles and Practice of Medicine – Sir Stanley Davidson, 21st edition, Elsevier Publishers, 2010

CRYOBIOLOGY

Course Outcomes:

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.

Unit-I

Introduction to Cryobiology, cryopreservation - natural cryopreservation , temperature, risks, slow, permeable freezing, vitrification, uses freezable tissues, equipment, limitations.

Unit-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; neuropreservation.

Unit-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.

Unit-IV

Hibernation , heterothermy, hibernaculum, hypothermia, chilblains, frost bite, trench feet, thermoregulation.

Unit-V

Application of Cryobiology - cloning, molecular cloning, organ transplantation, sperm bank, semen extender, in-vitro fertilization, embryo transfer, cryosurgery, cryoablation.

REFERENCE

1. Colby Gunn, A comprehensive introduction to Cryobiology, 2017 library press publishing, New York.
2. <http://ndl.iitkgp.ac.in/document/>