APPENDIX - AK

MADURAIKAMARAJUNIVERSITY

University with Potential for Excellence)

Syllabus for B.Sc. Biotechnology
CBCS – Semester Pattern

(For the candidates admitted from the academic 2023-2024 onwards)

Vision

Offer high quality education and research through fundamental and applied research in Biotechnology for empowering India's human resources scientifically and technologically to cater the need of people in health and food security.

Mission

- Provide flexible curriculum that allows the students to learn the courses of choice and to and excel in the field of interest.
- Create adequate opportunities to improve the inherent and hidden skills by providing amble opportunities to the students, leading to entrepreneurial ventures in biotechnology.
- Facilitate the students to associate with multidisciplinary and heterogeneous teams to develop ethical, moral and societal and environmental consciousness.

1. Preamble

- Biotechnology is an area of biology that uses living processes, organisms or system to manufacture products or technology intended to improve the quality of human life. It is an integrated science with interdisciplinary knowledge of biochemistry, Molecular Biology, Microbiology, Genetics, Plant and Animal sciences, Environmental and Pharmaceutical sciences.
- Biotechnology has the potential to bring a tremendous change in the socio-economic status of the people by creating a positive impact with food security, Animal husbandry, fisheries, assurance of quality food products to the consumers, environmental protection, health care etc.

- The Biotechnology course has the opportunities in health care sector and diagnostics, Research with Institutes, Universities, Animal health, Vaccine industry, Agriculture, Food technology, Pharmaceutical industry, Industrial and Environmental Sciences, Bioinformatics, Biosafety and Education.
- The syllabus of Biotechnology is framed in such a way so as to give a fundamental understanding in the different inter disciplinary areas of Cell Biology, Biochemistry, Microbiology, Genetics, Immunology, Animal and Plant Science, Environmental and Pharmaceutical sciences. The practical syllabus has been designed to enable the students to link and support with their theory background. This also imparts the knowledge of handling instruments and the understanding of interdisciplinary facet of Biotechnology. The syllabus is also equipped with Entrepreneurial development to help students to start their own enterprises as job providers, which will instill confidence, and to make smarter plans for future development.

2. Aim of the Programme:

The aim of the programme is to provide students with a wide knowledge in different areas of Biotechnology and to prepare them for employment and research in this rapidly growing field. This programme enables the students with innovative ideas for business creation, creating job opportunities, and the importance of entrepreneurship for facing the challenges and to improve the economy of the nation.

3. Nature and extent of the Programme:

The field of Biotechnology is an interdisciplinary science and is growing at a tremendous rate with application in medicine, agriculture, environment and nanotechnology. This tremendous growth is because of the integration of new technologies in biological research. New upcoming thrust areas like Marine Biotechnology, Research Methodology, Bioentrepreneurship and Nanotechnology is introduced in this programme. The programme also offers students the freedom to choose the electives based on their preferences. This will help the students to start, grow their own enterprises and make smarter plans for future development.

4. Graduate attributes:

The graduate after completing the course becomes a full-fledged Bioentrepreneur with a complete understanding of the various concepts of Biotechnology. This course is designed in such a way as to kindle creative thinking abilities with problem solving capacity and also research attitude. This programme will enable the students to be self-employed, and bring constructive changes to their professional life, work place and to the community at large.

5. Eligibility for admission

A candidate who have passed Higher Secondary examination with Biology/ Botany or Zoology background can eligible for admission.

Candidates should have secured at least 55% marks in the above examination.

- A relaxation is permitted for the admission for SC/ST/Physically Challenged candidates as per the norms of Tamil Nadu Government.

Duration of the course

- The students will undergo the prescribed course of study for a period of three academic years (Six semesters)
- The maximum duration for completion of the UG Programme shall not exceed Six Semesters.
- Medium of Instruction: English

6. Programme Outcomes (POs) & Programme specific Outcomes (PEOs)

LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK GUIDELINES BASED REGULATIONS FOR UNDER GRADUATE PROGRAMME	
Programme:	B.Sc. BIOTECHNOLOGY
Programme Code:	
Duration:	3 Years [UG]
Programme Outcomes:	**PO1:** Students understand the need and have the competencies to support local, regional and national development.
	PO2: Students will have a broad foundation in the core subjects of their choice with scientific reasoning, problem solving and analytical skills.
	PO3: Students are trained to apply and adapt appropriate techniques, resources, and instrumentation which will help them to pursue higher education or jobs after the programme.
	PO4: Students develop the ability to effectively communicate scientific information with strong ethics in written and oral formats.
	PO5: Students will understand their roles and responsibilities especially the protection of the people.
	PO6: Students become eligible to pursue higher education in their respective fields and engage in lifelong learning and enduring proficient progress.

Programme Specific Outcomes:	**PSO1:** Recall the fundamentals of Biotechnology which would enable them to comprehend the emerging and advanced biotechnology concepts in life sciences.
	PSO2: Inculcate deeper knowledge in practical skills enabling them to work with disciplinary and interdisciplinary aspects of biotechnology.
	PSO3: Enhance students' learning abilities, technological solutions in domains of biotechnology for their applications in industry and research and entrepreneurial skills.
	PSO4: Evaluate the need and impact of scientific techniques on the environment and the society, keeping in view their sustainable development.
	PSO5: Analyze the knowledge gained in Biotechnology for lifelong learning.

7. COURSE STRUCTURE:

The course is organized on semester basis with a total of six semesters. A candidate has to study 142 credits to qualify for the degree.

Scheme of Examinations
FIRST SEMESTER

Course Content	Name of the Course	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part – I	Language Paper – I	4	3	25	75	100
Part – II	English Paper – I	4	3	25	75	100
Part III	Core Paper I - Cell and Molecular Developmental Biology	5	5	25	75	100
	Core Practical I - Cell and Molecular Developmental Biology	4	2	40	60	100
	Allied Paper I - Biological Chemistry	4	3	25	75	100
	Allied Practical I - Biological Chemistry	4	2	40	60	100
Part IV	* Basic Tamil/Adv. Tamil/**Non Major Elective**	2	2	25	75	100
	Soft skill – I	3	3	50	50	100
			23			

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

SECOND SEMESTER

Course Content	Name of the Course	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part – I	Language Paper – II	4	3	25	75	100
Part – II	English Paper – II	4	3	25	75	100
Part – III	Core Paper II - Genetics	5	4	25	75	100
	Core Practical II - Genetics	4	4	40	60	100
	Allied Paper II - Fundamentals of Microbiology	4	3	25	75	100
	Allied Practical II - Fundamentals of Microbiology	4	2	40	60	100
Part IV	Basic Tamil/Adv. Tamil/ **Non Major Elective**	2	1	25	75	100
	Naan Mudalvan- Effective English	2	2	25	75	100
	Soft skill – II	1	1	50	50	100
			23			

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

THIRD SEMESTER

Course Content	Name of the Course	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part – I	Language Paper – III	4	3	25	75	100
Part – II	English Paper – III	4	3	25	75	100
Part – III	Core Paper III - Immunology and Immunotechnology	5	4	25	75	100

	Core Practical III - Immunology and Immunotechnology	4	4	40	60	100
	Allied Paper III – Bioinstrumentation	4	3	25	75	100
	Allied Practical II – Bioinstrumentation	4	2	40	60	100
PART IV	Soft Skills -III	2	2	25	75	100
	Skill Enhancement (Entreprenerial)	1	1	25	75	100
	● Environmental Studies	1	0	-	-	-
	Library	1	0	-	-	-
			22			

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

FOURTH SEMESTER

Course Content	**Name of the Course**	**Ins. Hrs**	**Credits**	**Int. Marks**	**Ext. Marks**	**Total**
Part – I	Language Paper – IV	4	3	25	75	100
Part – II	English Paper – IV	4	3	25	75	100
Part – III	Core Paper IV – Genetic Engineering and rDNA Technology	5	4	25	75	100
	Core Practical IV - Genetic Engineering and rDNA Technology	4	4	40	60	100
	Allied Paper IV - Bioinformatics and Biostatistics	4	3	25	75	100
	Allied Practical IV - Bioinformatics and Biostatistics	4	2	40	60	100
	Naan Mudalvan - Office Fundamentals	2	2	25	75	100
Part-IV	Soft Skills -IV	2	2	50	50	100
	Environmental Studies	1	2	25	75	100
			25			

FIFTH SEMESTER

Course Content	Name of the Course	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part – III	Core Paper V – Plant Biotechnology	5	4	25	75	100
	Core Paper VI - Animal Biotechnology	5	4	25	75	100
	Core Paper VII - Environmental and Industrial Biotechnology	5	4	25	75	100
	* Elective I - Nano Biotechnology / Enzymology /Bioethics and Biosafety / Cancer Biology	4	3	25	75	100
	Core Practical V – Plant Biotechnology and Animal Biotechnology	5	4	40	60	100
	Core Practical VI – Environmental and Industrial Biotechnology	5	4	40	60	100
Part- IV	■ Internship/Industrial Visit/Training/Laboratory Training	-	2	-	-	-
Part- V	Value Education	1	1	25	75	100
			26			

* Choose Any one Elective

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

SIXTH SEMESTER

Course Content	Name of the Course	Ins. Hrs	Credits	Int. Marks	Ext. Marks	Total
Part-III	Core Paper VIII – Bioentreprenurship	5	4	25	75	100

	Core Paper IX – Pharmaceutical Biotechnology	5	4	25	75	100
	* Elective II - Marine Biotechnology / Food Technology	3	3	25	75	100
	* Elective III - Medical Biotechnology / Forensic science / Good Laboratory Practices	3	3	25	75	100
	Naan Mudalvan – Employability Readiness	2	2	25	75	100
Part IV	Project	10	4	40	60	100
Part V	Skill based Activities - Online Course- NPTEL/MOOC	-	Additional Credit (1)			
Part VI	Extension Activities	2	1			
			21			

*Choose Any one for Elective II & III.

Total Credits - 142

8. SCHEME OF EVALUATION

Evaluation Pattern for Internal Assessment (25 Marks)

- Internal Assessment - Best 2 Exam marks taken out of 3 (10 Marks)
- Assignment / Power point presentation / Case study (10 Marks)
- Attendance (5 Marks)

Evaluation Pattern for External Assessment (75 Marks)

- Section - A (Multiple Choice Questions) (1 x 10 = 10 Marks)
- Section - B (Five Mark Questions with choice) (7 x 5 = 35 Marks)
- Section - C (Ten Mark Questions with choice) (3 x 10 = 30 Marks)

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Practical model QP

Time: 4 Hrs **Maximum: 60 Marks**

I. Major practical [A]– 15 marks
II. Minor Practical [B]– 10 marks
III. Sorters [C,D,E & F] – 4 x 5 = 20 marks
IV. Record work – 10 marks
V. Viva-voce exam – 5 marks

Total = 60 marks

Theory

Time: 3 Hrs **Maximum: 75 Marks**

Section-A (10 x 1 = 10 marks)
Multiple Choice Questions; Answer ALL questions.
Q.No. 01 to Q.No. 10

Section-B (7 x 5 = 35 marks)
Short answer, maximum up to 2 pages.
Answer any SEVEN of the following.
Q.No. 11 to Q No. 20

Section-C (3 x 10 = 30 marks)
Answer any THREE of the following
Essay type questions. Maximum up to 3 pages.
Q.No. 21 to Q.No. 25.

9. 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) Environmental and Industrial Biotechnology	
12) Nano Biotechnology	Any one
13) Enzymology	
14) Bioethics and Biosafety	
15) Cancer Biology	

16)	Bioentrepreneurship	
17)	Pharmaceutical Biotechnology	
18)	Marine Biotechnology	Any one
19)	Food Technology	
20)	Forensic science	Any one
21)	Medical Biotechnology	
22)	Good Laboratory Practices	

SEMESTER – I

Title of the Course		**CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY**					
Paper Number		**CORE I**					
Category	Core	**Year**	I	**Credits**	5	**Course Code**	
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		4	1	--	5		
Learning Objective		Students will understand the structural design of Prokaryotic and Eukaryotic cells. They will have an in-depth knowledge about the synthesis, structure, importance and the inter-relationships between DNA, RNA and Proteins. They will be able to understand the major molecular processes, development which governs all the cellular activities.					
Course Outcome		On successful completion of the course, students will be able to **CO1**: 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. **CO2:** Analyze the structure and obtain a strong foundation about the functional aspects of cell organelles and cell membrane. **CO3:** Study the structure and functions of Nucleic acid and discuss the molecular mechanism of Replication,Transcription and Translation					

	and post translational modifications of proteins. **CO4**: Predict the response of cells to the intra and extracellular environment by studying about the intracellular signaling pathways. **CO5**: Understand the principles and molecular mechanisms involved in cellular differentiation, morphogenesis growth and Potency.
Course Outline	**UNIT 1:** Discovery and diversity of cells - Cell theory - Structure of prokaryotic (bacteria) and eukaryotic cells (plant and animal cells).
	UNIT II: Biomacromolecules and Biomicromolecules (Primary functions in the cell). Structure and Functions of Cell Organelles: Cell wall - Cell membrane - Cytoplasm - Nucleus - chromosomes -Endoplasmic reticulum - Ribosomes - Golgi bodies - Plastids - Vacuoles - Lysosomes - Mitochondria - Microbodies - Flagella - Cilia - Centrosome and Centrioles - Cytoskeleton.
	UNIT III: Structure and functions of DNA and RNA -Central Dogma of the cell. DNA - Replication in prokaryotes - Transcription in Prokaryotes and Eukaryotes - RNA Processing - Genetic code- Translation - Similarities and differences in prokaryotic and eukaryotic translation - Post Translational Modifications - Protein Sorting - Protein degradation.
	UNIT IV: Cell cycle - Cell cycle check points - Cell division - Mitosis and Meiosis - Cellular differentiation - Cell junctions - Cell Adhesion - Extra Cellular Matrix - Cell to cell communications - Signal transduction - G - Protein Coupled Receptors Signal transduction pathways.
	UNIT V: Gametogenesis - Spermatogenesis and Oogenesis in mammals. Fertilization- Types of cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals- Organogenesis.

Recommended Text	1) T. Devasena (2012), Cell Biology, Oxford University Press. 2) Gupta, Renu & Makhija, Seema & Toteja, Ravi. (2018). Cell Biology: Practical Manual. 3) Gilbert, S.F. 2016. Developmental Biology, 11th edition. Sinauer Associates Inc. Publishers, MA. USA. 4) Bruce Alberts, 6th Edition (2014). Molecular Biology of the cell, W. W. Norton & Company. 5) James D. Watson (2001), The Double Helix: A personal account of the Discovery of the Structure of DNA, Touchstone Publishers.
Reference Books	1) Karp's Cell and Molecular Biology: Concepts and Experiments. 8th Edition (2015). Wiley Publications. 2) James D. Watson, 7th Edition (2014), Molecular Biology of the Gene, Pearson Publications. 3) Geoffrey M. Cooper, 7th Edition (2015). The Cell: A Molecular Approach, Sinauer Associates, Qxford University Press. 4) Lodish Harwey, 6th Edition (2016), Molecular Cell Biology, W. H. Freeman Publications. 5) Wolpert L, Tickle C, 2015. Principles of Development, 5th edition, Oxford University Press.
Website and e-Learning Source	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.

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	

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

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2		S			M	
CO3						
CO4				S		S
CO5		S				

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">BIOLOGICAL CHEMISTRY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">Allied Paper I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Allied</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td colspan="2"></td><td>3</td><td colspan="2">1</td><td colspan="2">--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="8">Students will understand and comprehend the importance of Chemistry and Biochemistry through the concepts of acids and bases, chemical bonding, pH and buffers and the metabolic pathways of macromolecules.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="8">On successful completion of the course, students will be able to
CO1: Comprehend the structure of atoms and the gradation of periodic properties of elements, differentiate the properties of various forms of Chemical substances.
CO2: Understand the types of chemical reactions and to calculate the stoichiometry and rate.
CO3: Recall the Structure, Classification, Chemistry and Properties of Carbohydrates and Explain Various Biochemical Cycles involved in Carbohydrate Metabolism.
CO4: Recall the Structure, Classification, Chemistry and Properties of Lipids, Nucleic acid and Explain Various Biochemical Cycles involved in Fatty acid and Nucleic acid Metabolism.
CO5: Understand the Structure, Classification, Chemistry and Properties of proteins aminoacids and Identify and explain nutrients in foods and the specific functions in maintaining health.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="8">UNIT I:
Atomic theory, formation of molecules, electronic configuration of atoms- s & p shapes of atomic orbitals. Periodic table, periodic classification, valency. Types of chemical bonds. Classification of organic compounds -. Hybridization in methane, ethane, acetylene, and benzene. Definition with examples- electrophiles, nucleophiles and free radicals. Types of reactions with an example: addition, substitution, elimination, condensation and polymerization. Electrophilic substitution reaction in benzene, nitration and sulphonation.</td></tr>
</table>

	UNIT II: Acids & Bases properties and differences, Concepts of acids and bases- Arrhenius, Lowry-Bronsted and Lewis. Concentration of solution, ways of expressing concentrations of solutions – per cent by weight, normality, molarity, molality, mole fraction. pH of solution, pH scale, measurement of pH. Buffer solutions, properties of buffers, Henderson-Hasselbalch equation, mechanism of buffer action of acidic buffer and basic buffer.
	UNIT III: Importance to Biochemistry-the chemical foundation of life. Water: its unique properties, ionization of water, buffering action in biological system, properties and characteristics of water. Classification of carbohydrates. Properties of carbohydrates. Ring structure of sugars and conformations of sugars. Metabolism of Carbohydrates – Glycogenesis, Glycogenolysis, Cori's cycle, Glycolysis, TCA cycle, bioenergetics of carbohydrate metabolism.
	UNIT IV: Classification of Lipids. Characteristics, Properties and Biological importance of lipids. Metabolism of Fatty acids, triglycerides, phospholipids, cholesterol. B-oxidation of fatty acids. Classification of nucleic acids. Purine and Pyrimidine bases. Classification of DNA & RNA. Metabolism of Nucleic acids, Salvage pathway.
	UNIT V: Classification and structure of amino acids. Structural conformation of proteins. Classification of proteins. Properties and biological importance of amino acids and proteins. Degradation of Amino acids and Urea Cycle. Vitamins and Hormones. Role of hormones in metabolism. ATP production. Oxidative phosphorylation, Electron transport chain and Photophosphorylation.
Recommended Text	1) P.L. Soni , A Text-book of Inorganic Chemistry, 11th Edition, S. Chand & Sons publications 2) Abhilasha Shourie, Shilpa S, Chapadgoankar & Anamika Singh (2020) Textbook of Biochemistry 1st Edition 3) J.L. Jain, 2016, Fundamentals of Biochemistry, S. Chand publication, 7th

	edition. 4) A.C. Deb, 2016, Fundamentals of Biochemistry, New central book agencies, 7th edition. 5) Satyanarayana .U, 2016, Biochemistry, MJ publishers 3rd edition (2006).
Reference Books	1) Lehninger (2013) Principles of Biochemistrty 4 th edition WH Freeman and Company NY 2) Murray *et al.*, (2003) Harper's biochemistry 26 th edition Appleton and Lange Publishers Florida USA 3) Geoffrey L. Zubay, William W. Parson, Dennis E. Vance, 1995, Principles of Biochemistry, W.C. Brown Publishers, 1995, 3rd edition. 4) Lubert Stryer (2007) Biochemistry –Stanford University 5 th Edition-W H Freemann and company San Francisco 5) Bahl Arun, Bahl B. S. (2016), A Textbook of Organic Chemistry, 22nd Edition, S. Chand & Sons publications
Website and e-Learning Source	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...

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	

Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2	S	S			M	
CO3		S	S			
CO4			S	S		S
CO5		S		S	S	S

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">Core Practical I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core Practical</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>-</td><td colspan="2">-</td><td colspan="2">4</td><td>4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="7">To learn, understand & develop skill and handson training in basics of cell and Molecular developmental biology.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="7">On successful completion of the course, students will be able to
CO1: Use microscopy and micrometry in biotechnological applications.
CO2: Know and perform cell counting techniques and be able to prepare the Blood smear and Buccal smear.
CO3: Isolate and identify the Plant cells & animal cells.
CO4: Mounting of chick embryo - 24 hrs, 48 hrs, 72 hrs, 96 hrs
CO5: Demonstrate the basic principles of Cell fractionation and Identification of cell organelles.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="7">Components of a Compound / Light Microscope.</td></tr>
<tr><td colspan="7">Blood smear preparation and Identification of Blood cells
Buccal smear preparation and Identification of squamous epithelial cells.</td></tr>
<tr><td colspan="7">Isolation and Identification of plant cells, animal cells.</td></tr>
<tr><td colspan="7">Observation of sperm & Egg
Mounting of chick embryo - 24 hrs, 48 hrs, 72 hrs, 96 hrs.
Types of placenta in mammals.</td></tr>
<tr><td colspan="7">Cell fractionation and Identification of cell organelles (Demo)</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="7">1) K.V. Chaitanya, (2013), Cell and molecular biology: Lab manual, PHI publishers,. ISBN 978-81-203-800-4</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="7"></td></tr>
</table>

Website and e-Learning Source	

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	40 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	60 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions, Understand the principles	
Understand/ Comprehend (K2)	MCQ, Concept explanations, Positive, negative results, Short interpretation or overview	
Application (K3)	Suggest idea/concept with examples, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various observations, Map knowledge	
Evaluate (K5)	Evaluation assay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2		S			M	
CO3		S	S	S		
CO4	S	S	S	S		S
CO5		S		S	S	S

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">BIOLOGICAL CHEMISTRY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">Allied Practical I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Allied Practical</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>-</td><td colspan="2">-</td><td>4</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="6">On taking this course the students will be able to prepare chemical solutions, estimate the amount of chemicals present in unknown solutions.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="6">On successful completion of the course, students will be able to
CO1: Perform and estimate the amount of chemical substance present in a solution qualitatively. To analyze and detect the nature of various organic class of compounds qualitatively.
CO2: Qualitatively analyze the carbohydrates and amino acids and report the type of carbohydrate based on specific tests. Differentiate the carbohydratesbased microscopic examination of the crystal.
CO3: Understand the methods of acidimetry, alkalimetry and permanganometry.
CO4: Quantify Ascorbic acid in lemon by Dichlorophenol indo phenol dye method, Glycine by sorensons formal titration method.
CO5: Estimate Glucose,Cholesterol and Proteins.</td></tr>
<tr><td colspan="2" rowspan="3">Course Outline</td><td colspan="6">Systematic analysis of Organic compounds
1. Functional group tests (Carboxylic acid (Benzoic acid, phthalic acid), Phenol, Urea, Benzaldehyde, Aniline (Aniline not to be given for exam)
2. Detection of elements (N, Halogens)
3. Distinguish between aliphatic and aromatic compounds.
4. Distinguish between Saturated and unsaturated compounds</td></tr>
<tr><td colspan="6">Qualitative Analysis
1. Qualitative analysis of carbohydrates - Glucose, Fructose, Lactose, maltose, sucrose, starch & glycogen.
2. Qualitative analysis of amino acids - Tyrosine, Tryptophan, Arginine, Proline and Cysteine.</td></tr>
<tr><td colspan="6">Volumetric Analysis:
1. Estimation of Glycine- Formal Titration.
2. Determination of Ascorbic acid – DCPIP method.</td></tr>
</table>

	3. Estimation of Ferrous sulphate using standard Mohr's salt
	Colorimetric Analysis 1. Estimation of glucose 2. Estimation of Cholesterol- Zak's method 3.Estimation of proteins – Bradford's method
Recommended Text	1) J. Jayaraman, Laboratory Manual in Biochemistry, New Age International Pvt Ltd Publishers, 2011. 2) S. K. Sawhney Randhir, Singh, Introductory Practical Biochemistry, Alpha Science International Ltd, 2nd edition, 2005. 3) Irwin H.Segel, Biochemical calculations,Liss, Newyork,1991.
Reference Books	1) Dr. O P Panday, D N Bajpai, Dr. S Giri, PRACTICAL CHEMISTRY, S Chand, Revised edition 2016. 2) Hands Thacher Clarke, A hand book of Oraganic:Qualitative and quantitative Analysis, 2007. **3)** N.S. Gnanapragasam and G. Ramamurthy, Organic chemistry Lab manual, S.Viswanathan Co. Pvt. Ltd., 1998.
Website and e-Learning Source	https://www.asbmb.org/education/online-teaching/online-lab-work https://www.olabs.edu.in/ https://www.studysmarter.co.uk/explanations/biology/organ-systems/biomolecule-test/

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	40 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	60 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions, Understand the principles	
Understand/ Comprehend (K2)	MCQ, Concept explanations, Positive, negative results, Short interpretation or overview	
Application (K3)	Suggest idea/concept with examples, Solve problems, Observe, Explain	

Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various observations, Map knowledge
Evaluate (K5)	Evaluation assay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2		S	S	S	M	S
CO3		S	S	S	S	
CO4	S	S	S	S	S	S
CO5		S	S	S	S	S

SEMESTER – II

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">GENETICS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE II</td></tr>
<tr><td>Category</td><td>Core</td><td>Year</td><td>I</td><td>Credits</td><td>5</td><td>Course Code</td><td colspan="2"></td></tr>
<tr><td colspan="2"></td><td>Semester</td><td>II</td><td colspan="4"></td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td colspan="2">Lecture
4</td><td colspan="2">Tutorial
1</td><td colspan="2">Lab Practice
--</td><td>Total
5</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="8">Students will gain the knowledge on the concepts of heredity, genes, Mendelian genetics, Blood group inheritance, genetic map preparation, human and population genetics and Microbial Recombination.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="8">On successful completion of the course, students will be able to
CO1: Learn about the classical genetics and transmission of characters from one generation to the next.
CO2: Obtain a strong foundation for the advanced genetics.
CO3: Explain the properties of genetic materials and storage and processing of genetic information.
CO4: Acquire knowledge about the Mutagens, Mutations, DNA Repairs and Genetic disorders in human.
CO5: Categories the Eugenics, Euphenics and Euthenics.
and indepth Knowledge on population Genetics.</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="8">UNIT 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.</td></tr>
<tr><td colspan="8">UNIT II: Linkage - linkage in Drosophila- Morgan’s experiments, factors affecting linkage. Crossing over- types, mechanism, significance of crossing over. Mapping of Chromosomes, interference and coincidence. Cytoplasmic inheritance -Carbon dioxide sensitivity in Drosophila and milk factor inmice. Sex –Linked Inheritance and Sex- Determination in Man.</td></tr>
</table>

	UNIT 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
	UNIT IV: Mutation – types of mutation, mutagens, DNA damage and Repair Mechanism. Chromosomal aberrations- Numerical and Structural, Pedigree Analysis-Mendelian inheritance in human. (Cystic Fibrosis, Muscular Dystrophy)
	UNIT V: Population Genetics– Hardy Weinberg principle, gene frequency, genotype frequency and factors affecting gene frequency**.** Eugenics, Euphenics and Euthenics.
Recommended Text	1) Dr. Veer Bala Rastogi, 2020, Elements of Genetics, 11 th Revised & Enlarged Edition, Kedar Nath Ram NathPublications,Meerut,250001.www.knrnpublications.com, ISBN-978-81-907011-2-9 2) Verma, P.S. and Agarwal, V.K., 1995. Genetics, 8th edition, S.Chand & Co., New Delhi – 110055. 3) Verma, P.S., and Agarwal, V.K., 1995. Cell and Molecular Biology, 8th edition, S.Chand and Co., New Delhi, 110055.
Reference Books	1) Gardener E.J. Simmons M.J. Slustad D. P. 2006. Principles of Genetics 2) Lewis, R.2001. Human Genetics- Concepts and application. 4th edition. McGraw Hill. 3) Griffiths, Miller, J.H., An Introduction to Genetic Analysis W.H.Freeman. New York. 4) Winter, P.C., Hickey, G.J. and Fletcher, H.L.2000. Instant notes in Genetics. Viva books, Ltd 5) Good enough U. 1985. Genetics. Hold Saunders international.
Website and e-Learning Source	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 5) http://sciencenetlinks.com/lessons/cell-dna/

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 the principles	
Understand/ Comprehend (K2)	MCQ, Concept explanations, Positive, negative results, Short interpretation or overview	
Application (K3)	Suggest idea/concept with examples, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various observations, Map knowledge	
Evaluate (K5)	Evaluation assay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	S	S	S	S	S
CO2		S	S		M	S
CO3		S	S		S	
CO4	S	S		S		S
CO5		S	S			S

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">FUNDAMENTALS OF MICROBIOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">Allied Paper II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Allied Paper</td><td>Year</td><td>I</td><td>Credits</td><td>3</td><td>Course Code</td><td></td></tr>
<tr><td>Semester</td><td>II</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td colspan="2">1</td><td>--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="6">Students can understand the basics of microbiology, types of microbes, classification and characterization, various applied aspects of microbes in biotechnology field and the role of microbes in pathogenicity.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="6">On successful completion of the course, students will be able to
CO1: Understand the classification of Microorganisms and structure of bacteria.
CO2: Understand the various microbiological techniques, different types of media, and techniques involved in culturing microorganisms.
CO3: Categorize the methods of sterilization and identify the significance of culture media in the growth of different microbes.
CO4: Exhibit knowledge in analysing the importance of Bioinsecticides,Biofertilizers prebiotics and probiotics.
CO5: Distinguish between normal flora and pathogens and describe the role of microbes in food intoxications.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">UNIT I: History of Microbiology, Classification of bacteria, fungi, virus, protozoa and algae – classical and molecular approaches. Scope of microbiology – Role of microbes in biotechnology.</td></tr>
<tr><td colspan="2"></td><td colspan="6">UNIT II: Structure of bacteria - Bacterial growth and measurement of growth, Media – types and preparation- plating methods - staining methods (Gram’s, capsule, spore, LCB mount)- methods of preservation and storage of microbes. Culture of fungi, virus and algae.</td></tr>
<tr><td colspan="2"></td><td colspan="6">UNIT III: Sterilization methods - physical and chemical methods-</td></tr>
</table>

	Mode of action – Antibiotic in clinical use - Resistance to antibacterial agents - MRSA, ESBL.
	UNIT IV: Bioinsecticides - *Bacillus thuringiensis*, Baculoviruses- Biofertilizers -*Azospirillum* and blue green algae - single cell protein – prebiotics and probiotics - Dairy products (Cheese and Yoghurt).
	UNIT 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).
Recommended Text	1) Pelczar.M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7th Edition.,McGraw –Hill, New York. 2) Ananthanarayanan, Paniker, Kapil, Textbook book of Microbiology, 9th edition, Orient BlackSwan, 2013. 3) Dubey R.C. and Maheswari, S. (2003). A textbook of Microbiology, New Delhi: S. Chand & Co. 4) Prescott, Harley, Klein, Microbiology, 10th Edition, McGraw – Hill, 2016. 5) Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (Editions) (1994) Methods for General and Molecular Bacteriology. ASM Press, Washington, DC.
Reference Books	1) Madigan, Martinko, Bender, Buckley, Stahl, Brock Biology of Microorganisms, 14th edition, 2017. 2) Gillespie, Bamford, Medical Microbiology and Infection at a Glance, 4th edition, 2012. 3) Boyd, R.F. (1998). General Microbiology,2nd Edition., Times Mirror, Mosby CollegePublishing, St Louis. 4) Tortora, G.J., Funke, B.R., Case,C.L. (2013). Microbiology. An Introduction 11th Edition., A La Carte Pearson. 5) Salle. A.J (1992). Fundamental Principles of Bacteriology. 7th Edition., McGraw Hill Inc.New York.
Website and e-Learning Source	1) Horst W. Doelle (2004). Microbial Metabolism and Biotechnology. Proceedings of an E-seminar organized by the International organization for Biotechnology and Bioengineering (IOBB) 2) www. Biotech.kth.se Electronic Journal of biotechnology 3) http://www ejb.org/content. 4) https://www.cliffsnotes.com/study guides/biology/microbiology/introduction-to- microbiology/a-brief-history-of-microbiology 5) https://bio.libretexts.org/@go/page/9188

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

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2	S	S			M	
CO3		S	S			
CO4			S	S		S
CO5		S		S	S	S

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">GENETICS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE PRACTICAL II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core Practical</td><td>Year</td><td>I</td><td>Credits</td><td>2</td><td>Course Code</td><td colspan="2"></td></tr>
<tr><td>Semester</td><td>II</td><td colspan="4"></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">4</td><td>4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="8">To learn, understand & develop skill and hands on training in genetics.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="8">On successful completion of the course, students will be able to
CO1:Demonstrate the basic principles of important techniques in Molecular biology and Genetics.
CO2:Analyze the Polytene chromosome of the organisms
CO3: Identify Barr bodies from Buccal smear
CO4: Demonstrate the Preparations and maintenance of culture medium.
CO5: Demonstrate Human karyotyping</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">Mitotic stages of onion (Allium cepa) root tip
Meiotic stages of cockroach testes/ Flower bud</td></tr>
<tr><td colspan="8">Giant chromosomes from Chironomus larvae/ Drosophila salivary glands</td></tr>
<tr><td colspan="8">Identification of Barr bodies from Buccal smear</td></tr>
<tr><td colspan="8">Preparations of culture medium and culture of Drosophila – methods of maintenance
Identifications of mutants of Drosophila</td></tr>
<tr><td colspan="8">Human karyotyping (Demo)</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">Practical Manual on "Fundamentals of Genetics" (PBG-121). 2019, Edition: First Publisher: Odisha University of Agriculture & Technology. Editor: Kaushik Kumar Panigrahi</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="8"></td></tr>
<tr><td colspan="2">Website and e-Learning Source</td><td colspan="8">https://r.search.yahoo.com/_ylt=AwrjaUf0gnNjsI0L8pVXNyoA;_ylu=Y29sbwNncTEEcG9zAzEEdnRpZAMEc2VjA3Ny/RV=2/RE=16685</td></tr>
</table>

	43348/RO=10/RU=https%3a%2f%2fwww.researchgate.net%2fpublication%2f334330459_Practical_Manual_on_Fundamentals_of_Genetics_PBG-121/RK=2/RS=5od7iXwxRYJ6dx8wR0Wz7ZLdV0o-

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	40 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	60 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions, Understand the principles	
Understand/ Comprehend (K2)	MCQ, Concept explanations, Positive, negative results, Short interpretation or overview	
Application (K3)	Suggest idea/concept with examples, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various observations, Map knowledge	
Evaluate (K5)	Evaluation assay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2		S	S	S	M	S
CO3		S	S	S	S	
CO4	S	S	S	S	S	S
CO5		S	S	S	S	S

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">FUNDAMENTALS OF MICROBIOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ALLIED PRACTICAL II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Allied Practical</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">4</td><td>4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="8">To understand fundamental practical principles and apply the techniques involved in identification, characterization and differentiation of microbial cells.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="8">On successful completion of the course, students will be able to
CO1: Describe the general Laboratory safety & Sterilization Techniques
CO2: Develop Skills in Media Preparation, Isolation & Serial Dilution Techniques and Pure Culture Techniques
CO3: Microscopically analyze the morphological features of Bacteria and fungi and define various Staining Techniques.
CO4: Perform the Motility of organisms
CO5: Able tocharacterize and identify bacteria using Biochemical tests.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">Sterilization techniques – Preparation of Media</td></tr>
<tr><td colspan="8">Inoculation techniques- Pour plate, spread plate
Isolation of bacteria from various sources and dilution techniques.</td></tr>
<tr><td colspan="8">Staining techniques: Simple, Gram’s, Capsule (Negative), Spores,
Preparation of temporary mounts- Lacto phenol cotton blue staining.</td></tr>
<tr><td colspan="8">Motility tests: Hanging drop technique, motility agar test.</td></tr>
<tr><td colspan="8">Biochemical characterization - catalase, oxidase, IMVIC test and TSI.
Antibiotic sensitivity test (demonstration).</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">1) James G Cappucino and N. Sherman MB(1996). A lab manual Benjamin Cummins, New York 1996.
2) Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications.
3) Sundararaj T (2005). Microbiology Lab Manual (1st edition) publications.
4) Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ld., Publishers, New Delhi.</td></tr>
</table>

	5) R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishing.
Reference Books	1) Atlas.R (1997). Principles of Microbiology, 2nd Edition, Wm.C.Brown publishers. 2) Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India. 3) Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS. 4) Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication. 5) Lim D. (1998). Microbiology, 2nd Edition, WCB McGraw Hill Publications.
Website and e-Learning Source	**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**

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	40 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	60 Marks
	Total	100 Marks
Methods of Assessment		
Understand/ Comprehend (K2)	MCQ, Concept explanations, Positive, negative results, Short interpretation or overview	
Application (K3)	Suggest idea/concept with examples, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various observations, Map knowledge	
Evaluate (K5)	Evaluation assay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or	

	Presentations

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2		S	S	S	M	S
CO3		S	S	S	S	
CO4	S	S	S	S	S	S
CO5		S	S	S	S	S

SEMESTER – III

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">IMMUNOLOGY AND IMMUNOTECHNOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="8">Students will gain knowledge about the structure, functions and integration of immune system, immune response, reactions, cells involved in immunity, vaccines and tissue rejection.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="8">On successful completion of the course, students will be able to
CO1: Explain the role of immune cells and their mechanism in body defense mechanism.
CO2: Demonstrate the antigen –antibody reactions in various immune techniques.
CO3: Gain new insights into Antigen -Antibody interactions and to demonstrate immunological techniques.
CO4: Gain knowledge of production of vaccines.
CO5: Apply the knowledge of immune associated disease, hypersensivity reactions.</td></tr>
<tr><td colspan="2" rowspan="3">Course Outline</td><td colspan="8">UNIT 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.</td></tr>
<tr><td colspan="8">UNIT 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.</td></tr>
<tr><td colspan="8">UNIT III: Antigen – Antibody interactions, Immunodiffusion and Immuno electrophoresis. Principle and application of ELISA and RIA and</td></tr>
</table>

	Flourescent antibody technique and Western Blotting. Purification of antibodies.
	UNIT IV: The complement system and activation and regulation. Types – Classical, alternative and Lectin pathway. Biological function of C' proteins. Cytokines- Structure and Function. Vaccines – Types, Production and application.
	UNIT V: Hypersensitivity Reactions and Types. Major Histocompatability Complex – MHC genes, MHC in immune responsiveness, Structure and function of Class I and Class II MHC molecules. HLA tissue typing.
Recommended Text	1) Thomas J. Kindt, Barbara A. Osborne and Richard A Goldsby, 2006. Kuby Immunology. 6th edition, W. H . Freeman and Company. 2) Kannan, I., 2010. Immunology. MJP Publishers, Chennai. 3) Abbas, A.K., A.H.L., Lihtman and S. Pillai, 2010. Cellular and Molecular Immunology, 6th Edition. Saunders Elsevier Publications, Philadelphia. 4) NandiniShetty, 1996, Immunology : introductory textbook – I. New Age International, New Delhi. 5) Fahim Halim K.,2009. The Elements of Immunology. Pearson Education.
Reference Books	1) Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, 2011. Roitt.s Essential Immunology, 12 edition, Wiley- Blackwell. USA. 2) Janeway Travers. (1997). Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York. 3rd Edition. 3) William R Clark. (1991). The Experimental Foundations of Modern Immunology. 3rdEdition. John Wiley and Sons Inc. New York. 4) Frank C. Hay, Olwyn M. R. Westwood. (2002). Practical Immunology, 4thEdition., Wiley-Blackwell. 5) Noel R. Rose, Herman Friedman, John L. Fahey. (1986). Manual of Clinical Laboratory Immunology. ASM.3rd Edition.
Website and e-Learning Source	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 | ScienceDirect Topics

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

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2	S	S			M	
CO3		S	S			
CO4			S	S		S
CO5		S		S	S	S

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">BIOINSTRUMENTATION</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">Allied Paper III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Allied Paper</td><td>Year</td><td>II</td><td>Credits</td><td>3</td><td>Course Code</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</td><td></td><td></td><td></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td colspan="2">1</td><td colspan="2">--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="8">Students will gain in-depth knowledge about analytical techniques and principles. They will gain expertise in handling instruments and understand their applications.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="8">On successful completion of the course, students will be able to
CO1: Practice, experiment with and apply the basic instruments in the laboratory.
CO2: Predict the functionality of Beer – Lambert’s law in identifying and quantifying a biomolecule
CO3:Employ the separation techniques for separating biomolecules based on chromatography and electrophoretic techniques.
CO4: Understand the clinical important isotopes and detection of isotopes.
CO5:Employ the separation techniques for separating biomolecules based on centrifugal force by centrifugation</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="8">UNIT 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.</td></tr>
<tr><td colspan="8">UNIT 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).</td></tr>
</table>

	UNIT III: Chromatography - Principles – Paper Chromatography, TLC, Gel filtration, Ion-Exchange, Affinity Chromatography Gas Liquid Chromatography and HPLC. Electrophoresis: Principle, Paper Electrophoresis – Cellulose Acetate Electrophoresis - Agarose Gel Electrophoresis – SDS- PAGE and Iso-electric focusing.
	UNIT IV: Radioactivity – Isotopes – Clinically important isotopes – Measurement of Radioactivity – GM Counters, Scintillation Counters – Autoradiography – Applications. SOPs for Radioactive materials.
	UNIT V: Centrifugation – Principles - RCF, Sedimentation concept - - Different types of centrifuge – Types of rotors – Centrifugation types: Differential and Density gradient centrifugation – Ultra Centrifuge.
Recommended Text	1) Upadhyay and UpadhyayNath. (2009). "Biophysical Chemistry", Principles and Techniques.Himalaya Publishing House. 2) L.Veerakumari, (2006) "Bioinstrumentation" MJP publishers , Kindle Edition. 3) SkoogD.A.F.James Holler and Stanky,R.Crouch, (2007) "Instrumental Methods of Analysis" Cengage Learning. 4) Palanivelu P, 2000. Analytical Biochemistry & Separation Techniques, 4th edition, Twenty first century publications. 5) Prakash M, 2009. Understanding Bioinstrumentation, 1st edition, Discovery Publishing House Pvt Ltd.,
Reference Books	1) Keith Wilson,John Walker,(2010).Principles and techniques of Biochemistry and Molecular Biology"(7^{th} edition).Cambridge University Press. 2) David L.Nelson, Michael M Cox.Lehninger(2008)."Principles of Biochemistry",Fifth edition W.H.Freeman,Newyork. 3) Khandpur R S, 2014. Handbook of Biomedical Instrumentation, 3rd edition, McGraw Hill Education (India). 4) L.A Geddes and L.E.Baker (2008) "Principles of Applied Biomedical Instrumentation"WileyIndia Third Edition. 5) Sharma B K, 2005. Instrumental Methods of Chemical Analysis, 24th Edition, GOEL Publishing House.
Website and e-Learning Source	

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

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2	S	S			M	
CO3		S	S			
CO4			S	S		S
CO5		S		S	S	S

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">IMMUNOLOGY AND IMMUNOTECHNOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">Core Practical III</td></tr>
<tr><td>Category</td><td>Core Practical</td><td>Year</td><td>II</td><td>Credits</td><td>2</td><td>Course Code</td><td></td></tr>
<tr><td colspan="2"></td><td>Semester</td><td>III</td><td colspan="4"></td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td colspan="2"></td><td>-</td><td>-</td><td colspan="2">4</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="7">On taking this course the student will be able to employ the immunological techniques.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="7">On successful completion of the course, students will be able to
CO1:Perform blood grouping and determine blood type.
CO2: Able to count WBC and RBC.
CO3: Conduct serological diagnostic tests such as ASO, CRP, RA and Widal test.
CO4: Acquire technical skills required for immunodiffusion and know the principle behind the techniques.
CO5: Able to Demonstrate ELISA, Handling of Laboratory animals.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="7">Separation of Serum and Plasma.
Blood grouping and Rh typing.</td></tr>
<tr><td colspan="7">WBC counting
RBC counting
Differential blood count</td></tr>
<tr><td colspan="7">WIDAL Slide test
ASO test</td></tr>
<tr><td colspan="7">Double Immunodiffusion
Single Radial Immunodifusion</td></tr>
<tr><td colspan="7">ELISA – Demonstration
Handling of Laboratory animals - Demonstration
Skin test - Demonstration</td></tr>
</table>

Recommended Text	1) Talwar. (2006). Hand Book of Practical and Clinical Immunology, Vol. I, 2nd edition, CBS. **2)** Asim Kumar Roy. (2019). Immunology Theory and Practical, Kalyani Publications.
Reference Books	1) Frank C. Hay, Olwyn M. R. Westwood. (2008).Practical Immunology, 4th Edition, Wiley-Blackwell. 2) Rose. (1992). Manual of Clinical Lab Immunology, ASM. 3) Wilmore Webley. (2016). Immunology Lab Manual, LAD Custom Publishing. 4) Janeway Travers. (1997). Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York. 3rd Edition. 5) Peter J. Delves, Seamus Martin, Dennis R. Burton, Ivan M. Roitt. (2006). Roitt's Essential Immunology, 11thEdition., Wiley-Blackwell.
Website and e-Learning Source	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

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	40 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	60 Marks
	Total	100 Marks
Methods of Assessment		
Understand/ Comprehend (K2)	MCQ, Concept explanations, Positive, negative results, Short interpretation or overview	
Application	Suggest idea/concept with examples, Solve problems, Observe, Explain	

(K3)	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various observations, Map knowledge
Evaluate (K5)	Evaluation assay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2		S	S	S	M	S
CO3		S	S	S	S	
CO4	S	S	S	S	S	S
CO5		S	S	S	S	S

<table>
<tr><td>Title of the Course</td><td colspan="8">BIOINSTRUMENTATION</td></tr>
<tr><td>Paper Number</td><td colspan="8">Allied Practical III</td></tr>
<tr><td>Category</td><td>Allied Practical</td><td>Year</td><td>I</td><td>Credits</td><td>4</td><td>Course Code</td><td colspan="2"></td></tr>
<tr><td></td><td></td><td>Semester</td><td>I</td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td></td><td colspan="2">4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td>Learning Objective</td><td colspan="8">The course gives a strong foundation and advanced information on the application of bioinstrumentation.</td></tr>
<tr><td>Course Outcome</td><td colspan="8">On successful completion of the course, students will be able to
CO1:Practice, experiment with and apply the basic instruments in the laboratory such as weighing balance, pH meter, shaker, incubator etc. in various research processes.
CO2:Predict the functionality of Beer – Lambart’s law in identifying and quantifying a biomolecules.
CO3:Employ the separation techniques for separating biomolecules based on chromatography.
CO5:Employ the separation techniques for separating biomolecules based on centrifugal force by centrifugation.</td></tr>
<tr><td rowspan="5">Course Outline</td><td colspan="8">Preparation of Buffer (Phosphate Buffer)
Determination of pH of biological samples using pH meter</td></tr>
<tr><td colspan="8">UV spectra of Nucleic acids and proteins.</td></tr>
<tr><td colspan="8">Chromatography analysis of sugar, amino acids, lipids by paper chromatography.</td></tr>
<tr><td colspan="8">Chromatography analysis of sugar, amino acids, lipids by Thin layer chromatography.</td></tr>
<tr><td colspan="8">Fractionation of biological material into its various components by Centrifuge.</td></tr>
<tr><td>Recommended Text</td><td colspan="8">Himanshu Sharma, Pramod K. Singh, 2018. Laboratory Manual for Bioinstrumentation, Biochemistry, Microbiology, Cell Biology and Enzyme Technology For PG and UG students. Excellent Publishing House New Delhi India</td></tr>
<tr><td>Reference Books</td><td colspan="8">Sharda University Abstract Laboratory Manual for Bio-instrumentation, Biochemistry, Microbiology, Cell Biology and</td></tr>
</table>

	Enzyme Technology.2018
Website and e-Learning Source	

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	40 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	60 Marks
	Total	100 Marks
Methods of Assessment		
Understand/ Comprehend (K2)	MCQ, Concept explanations, Positive, negative results, Short interpretation or overview	
Application (K3)	Suggest idea/concept with examples, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various observations, Map knowledge	
Evaluate (K5)	Evaluation assay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	S	S	S	S	S
CO2		S	S	S	M	S
CO3		S	S	S	S	
CO4	S	S	S	S	S	S
CO5		S	S	S	S	S

SEMESTER –IV

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Genetic Engineering and rDNA Technology</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">Core Paper IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core Paper</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td>Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td colspan="2"></td><td>5</td><td>1</td><td>--</td><td colspan="3">6</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="6">Students will assimilate the concepts of genes, manipulation techniques involved in cloning and understand the applications in Genetic Engineering.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="6">On successful completion of the course, students will be able to
CO1: Demonstrate the basic principlesof genetic engineering techniques and illustrate the specificity of vectors for cloning and advantages.
CO2: Enumerate various recombinant techniques and gene probes and molecular markers identification.
CO3: Understand Gene transfer techniques by Viral and Nonviral mediated gene transfer mechanisms.
CO4: Exhibit knowledge in sequencing technologies and protein engineering techniques.
CO5:Explore the strategies of Recombinat DNA Technology in r medicine, Industry and agriculture.</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="6">UNIT I:
Genetic Engineering – Introduction. Tools in recombinant DNA technology – recombinant DNA – cloning strategies (enzymes, vectors, host) – introduction of rDNA into host cells.</td></tr>
<tr><td colspan="6">UNIT 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.</td></tr>
</table>

	UNIT III: Gene transfer techniques – Viral mediated gene transfer, Selectable markers and reporter genes - Non viral mediated gene transfer - Physical methods: Microinjection - Electroporation - Particle Bombardment, Chemical methods: Calcium phosphate - DEAE dextran - Liposomes.
	UNIT 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).
	UNIT V: Application of Recombinant DNA technology in medicine, industry, agriculture and r-DNA technology - merits and demerits.
Recommended Text	1) Brown T.A, 2015. Gene Cloning and DNA Analysis: An Introduction, 7th edition, Wiley - Blackwell. 2) Desmond S.T. Nicholl, 2008. An Introduction to Genetic Engineering, 3rd edition, Cambridge university press. 3) R.W. Old & S.B. Primrose, Principles of Gene Manipulation, Fifth Edition, Blackwell Science. 4) Genetic Engineering Principles and Methods by Setlow, Jane K. (Volume 24). 5) Keya Chaudhuri, 2012. Recombinant DNA Technology.
Reference Books	1) David Clark Nanette Pazdernik Michelle McGehee (2018), *Molecular Biology techniques*,(3rd edition). 2) Anton Byron (2019), *Introduction to Gene Cloning*, Publisher: Oxford Book Company 3) Monika Jain (2012), *Recombinant DNA technology*, (I edition), Alpha Science International. ISBN-13 : 978-1842656679. 4) Primrose.S.B (2014), *Principles of gene manipulation*, (7th edition), Blackwell Scientific limited, Germany. ISBN: 978-1-405-13544-3

Website and e-Learning Source	1) https://www.britannica.com/recombinant-DNA-technology 2) https://www.le.ac.uk/recombinant-dna-and-genetic-techniques 3) https://www..ncbi.nlm.nih.gov

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

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2	S	S			M	
CO3		S	S			
CO4			S	S		S
CO5		S		S	S	S

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">BIOINFORMATICS AND BIOSTATISTICS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">Allied Paper IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Allied Paper</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td colspan="2">1</td><td>--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="6">Students will acquire knowledge on the basic principles and concepts of Bioinformatics and Biostatistics which can be employed in computer modeling, development of new algorithms and analysis methods.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="6">On successful completion of the course, students will be able to
CO1:Acquire knowledge about the Developments and Applications of Bioinformatics.
CO2: Gain knowledge about the importance of the bioinformatics, databases, tools and software of bioinformatics and Explain different types of Biological Databases.
CO3: Understand the basics of sequence alignment, sequence analysis and Protein structure prediction method.
CO4:Demonstrate the basic methods of data collection, graph construction and sampling techniques and Calculate measures of central tendency
CO5: Correlate and analyze biological data through various statistical methods and interpret biological data via various probabilistic distribution methods.</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="6">UNIT 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.</td></tr>
<tr><td colspan="6">UNIT II
Sequence analysis (Proteins and Nucleic acids), Protein Database: Comparison of Protein sequences and Database searching – methods for protein structure prediction - Homology modeling of proteins, visualization tools (RASMOL).</td></tr>
</table>

	UNIT III Multiple Sequences alignment – method of multiple sequences alignment- Evolutionary analysis, clustering methods Phylogenic trees - Methods to generate phylogenetic tree- Tools for multiple sequences alignment and phylogenetic analysis - History of Drug Discovery, Steps in Drug design - Chemical libraries – Role of molecular docking in drug design.
	UNIT IV Statistics – collection, classification, tabulations of Statistical Data – Diagrammatic representation – Graphs – Sampling method and standard error. Measures of central tendency – measures of dispersion.
	UNIT V Correlations and regression. Probability distribution-Binomial, Negative binomial, multinomial distribution, Poisson distribution. Tests of significance – t tests – F tests – Chi square test. Analysis of variance – Statistical Softwares.
Recommended Text	1) Pennington, S.R. and Punn, M.J. 2002.Proteomics: from protein sequence to function. Viva books Pvt. Ltd. 2) Shuba G.,2010. Bioinformatics., Tata McGraw Hill publishing.India. 3) Rastogi, S.C, Mendiratta, N,Rastogi, P., 2004. Bioinformatics methods and application. Prentice-Hall of India private limited, New Delhi. 4) N.Gurumani (2011) "An Introduction to Biostastistics" MJP Publishers 5) VerbalaRastogi.(2011).”Fundamentals of Biostatistics”, Ane books Pvt Ltd Publishers,Chennai.
Reference Books	1) Attwood, T.K. and Parry-Smith, D.J.2008. Introduction to Bioinformatics. Pearson Education. 2) David Mount., Bioinformatics: sequence and genome analysis, second edition., Taylor & Francis, UK; 2009. 3) D.R.Westhead. Instant Notes in Bioinformatics., second edition., Taylor & Francis, UK; 2009. 4) Zar,(J.H.2010).”Biostatistical Analysis” Fifth Edition, Pearson Education Pvt Ltd, Indian Branch,NewDelhi.

	5) P.N.Arora and P.K. Malhan.(2013)"Biostatistics"Himalaya publishing House.
Website and e-Learning Source	

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

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2	S	S			M	
CO3		S	S			
CO4			S	S		S
CO5		S		S	S	S

<table>
<tr><td>Title of the Course</td><td colspan="6">GENETIC ENGINEERING</td></tr>
<tr><td>Paper Number</td><td colspan="6">Core Practical IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core Practical</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">-</td><td colspan="2">-</td><td>4</td><td>4</td></tr>
<tr><td>Learning Objective</td><td colspan="6">Student will be able to acquire knowledge and apply basic biotechnological principles, methods and models to solve Genetic Engineering tasks.</td></tr>
<tr><td>Course Outcome</td><td colspan="6">On successful completion of the course, students will be able to
CO1 : Isolate the Plasmid DNA and Genomic DNA. and Predict the molecular weight of DNA by agarose gel electrophoresis
CO2: Demonstrate working principles of PCR, RFLP and other important Genetic Engineering techniques.
CO3: Prepare the competent cells and perform bacterial transformation
CO4: Determine the restriction digestion of DNA
CO5: Determine the restriction fragment length polymorphism.</td></tr>
<tr><td rowspan="5">Course Outline</td><td colspan="6">Isolation of genomic DNA
Isolation of plasmid DNA</td></tr>
<tr><td colspan="6">Isolation of RNA</td></tr>
<tr><td colspan="6">Production of competent cells for transformation
Bacterial transformation</td></tr>
<tr><td colspan="6">Restriction Digestion of DNA</td></tr>
<tr><td colspan="6">Restriction Fragment Length Polymorphism (DEMO)
PCR (Demonstration).</td></tr>
<tr><td>Recommended Text</td><td colspan="6">Laboratory Manual for GENETIC ENGINEERING 1st Edition, Kindle Edition by S. JOHN VENNISON (Author) 2009.
MOLECULR BIOLOGY AND GENE MANIPULATION LABORATORY MANUAL, SRM University</td></tr>
</table>

Reference Books	Michael R. Green , Joseph Sambrook 2012. Molecular Cloning- A laboratory manual
Website and e-Learning Source	

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	40 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	60 Marks
	Total	100 Marks
Methods of Assessment		
Understand/ Comprehend (K2)	MCQ, Concept explanations, Positive, negative results, Short interpretation or overview	
Application (K3)	Suggest idea/concept with examples, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various observations, Map knowledge	
Evaluate (K5)	Evaluation assay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2		S	S	S	M	S
CO3		S	S	S	S	
CO4	S	S	S	S	S	S
CO5		S	S	S	S	S

<table>
<tr><td>Title of the Course</td><td colspan="6">BIOINFORMATICS AND BIOSTATISTICS</td></tr>
<tr><td>Paper Number</td><td colspan="6">Allied Practical IV</td></tr>
<tr><td>Category</td><td>Allied Practical</td><td>Year
Semester</td><td>II
IV</td><td>Credits</td><td>2</td><td>Course Code</td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td colspan="2">Lecture
-</td><td>Tutorial
-</td><td>Lab Practice
4</td><td>Total
4</td></tr>
<tr><td>Learning Objective</td><td colspan="6">On taking this course the student will be able to represent and interpret the biological data in graphical forms.</td></tr>
<tr><td>Course Outcome</td><td colspan="6">On successful completion of the course, students will be able to
CO1: Analyse the Biological databases
CO2: Able to perform BLAST and FASTA
CO3:Represent data in to graphical form
CO4: Test the level of significance of biological data and interpret the results.
CO5: Determine averages of the biological data</td></tr>
<tr><td>Course Outline</td><td colspan="6">Biological databases (NCBI, Swissprot and PDB)</td></tr>
<tr><td></td><td colspan="6">BLAST
FASTA</td></tr>
<tr><td></td><td colspan="6">Identification of functional domains in nucleotide binding proteins using a domain analysis server like SMART</td></tr>
<tr><td></td><td colspan="6">Preparation of bar diagram, line diagram and pie diagram using MS EXCEL.
Calculation of Central tendency- mean, geometric mean, median using MS EXCEL</td></tr>
<tr><td></td><td colspan="6">Calculation of dispersion – Mean deviation, quartile deviation and standard deviation using MS EXCEL
Calculation of student’s t test using MS EXCEL</td></tr>
<tr><td>Recommended Text</td><td colspan="6"></td></tr>
</table>

Reference Books	
Website and e-Learning Source	

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	40 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	60 Marks
	Total	100 Marks
Methods of Assessment		
Understand/ Comprehend (K2)	MCQ, Concept explanations, Positive, negative results, Short interpretation or overview	
Application (K3)	Suggest idea/concept with examples, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various observations, Map knowledge	
Evaluate (K5)	Evaluation assay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	S	S	S	S	S
CO2		S	S	S	M	S
CO3		S	S	S	S	
CO4	S	S	S	S	S	S
CO5		S	S	S	S	S

SEMESTER –V

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">PLANT BIOTECHNOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">Core Paper V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core Paper</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>V</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="8">Students will gain knowledge about plant tissue culture, transgenic plants, nitrogen fixation mechanism and significance of viral vectors.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="8">On successful completion of the course, students will be able to
CO1: Explore the history of plant biotechnology and state the importance of organization of plant genome.
CO2:Be acquainted with the molecular basics of action of hormones and gene expression.
CO3:Illustrate about various culture medium preparations, haploid, triploid plant production and its application.
CO4:Exploit symbiotic organisms as a vector for gene transfer to produce transgenic plants.
CO5:Develop molecular technique skills for crop improvement and transgenic plant production.</td></tr>
<tr><td colspan="2" rowspan="3">Course Outline</td><td colspan="8">UNIT 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.</td></tr>
<tr><td colspan="8">UNIT II
Auxins, cytokinins and gibberlins – molecular basis of action – phytochrome – role in photomorphogeneisis – abscisic acid – and stress – induced promoter switches in the control of gene expression – Ethylene and fruit ripening.</td></tr>
<tr><td colspan="8">UNIT III
Media composition (MS media) - Micropropagation techniques - direct</td></tr>
</table>

	and indirect organogenesis - somoclonal variation - somatic embryogenesis - haploid and triploid - Protoplast isolation, fusion and culture - hybrid and cybrid production, Synthetic seed production. Secondary metabolite production.
	UNIT 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.
	UNIT 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.
Recommended Text	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.

Website and e-Learning Source	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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">ANIMAL BIOTECHNOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">Core Paper VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core Paper</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>V</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="8">Students will gain knowledge in the concepts of animal and medical biotechnology. They will acquire the skill and confidence to set up an animal tissue culture laboratory. They will learn the molecular techniques in diagnosis and understand the production of vaccines.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="8">On successful completion of the course, students will be able to
CO1: Understand the basic concepts of Animal cell culture and cell laboratory.
CO2:Describe the media preparation, preservation, trypsinization, counting, maintenance and application of cell lines.
CO3:Discuss the strategies for gene transfer and gene expressions with their applications.
CO4:Be acquainted with genetic modification and stem cell technology in production of transgenic animals.
CO5:Learn the Assisted reproductive technology and its applications.</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="8">UNIT I
Animal cell culture – History and development, Pluripotency, Media, balanced salt solutions, Physical, chemical and metabolic functions of constituents of culture media, Role of carbon dioxide, Serum, growth factors and amino acids in media. Serum containing and serum free media. Constitution of a media for cell line. Essential equipments required for animal cell culture.</td></tr>
<tr><td colspan="8">UNIT 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</td></tr>
</table>

	procedures. Biology of cultured cells- Apoptosis and cell death.
	UNIT 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.
	UNIT IV Protein production by genetically engineered mammalian cell lines, Stem cells and their applications-; Cell culture as a source of valuable products -Transgenic Animals.
	UNIT V Collection and preservation of embryos, Semen banking, AI, IVF and ICSI. Case Study-any two relevant studies.
Recommended Text	1) Ramasamy.P. 2002.Trends in Biotechnology, University of Madras of Publications, Pearl Press 2) Ignacimuthu. 1996. Basic Biotechnology. Tata McGraw-Hill. 3) K. Srivastava *et al.*, 2009, Animal Biotechnology, Oxford & IBH Publishing Co. Pvt. Ltd. 4) B.C. Currell *et al.*, 1994, In vitro Cultivation of Animal Cells (Biotol), Butterworth-Heinemann Ltd. 5) Jenkins, N. (ed). 1999 Animal cell Biotechnology: Methods and protocols. Humana press, New Jesey.
Reference Books	1) R. Ian Freshney, Culture of Animal cells – A Manual of Basic Technique Fourth Edition, WILEY LISS & Publications. 2) Glick, B.R. and Pasternark. 2002. Molecular Biotechnology: Principle and applications of recombinant DNA. 3) Kreuzer, H. and Massey, A. 2001. Recombinant DNA and Biotechnology: A guide for teachers, 2nd edition. ASM Press Washington. 4) Traven. 2001. Biotechnology. Tata McGraw – Hill. 5) Walker,J.M. and Gingold, E.B. 1999.Molecular biology and Biotechnology, 3rd edition. Panima Publishing Corporation.
Website and e-Learning Source	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

<table>
<tr><td>Title of the Course</td><td colspan="7">ENVIRONMENTAL & INDUSTRIAL BIOTECHNOLOGY</td></tr>
<tr><td>Paper Number</td><td colspan="7">Core Paper VI</td></tr>
<tr><td rowspan="2">Category Core Paper</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>V</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>1</td><td colspan="2">--</td><td colspan="2">6</td></tr>
<tr><td>Learning Objective</td><td colspan="7">This course is planned to provide the learner an idea about Global environmental changes, Biotechnological methods of handling recent environmental problems and the students to explore the beneficial potentials of microbes in the fermentation industry.</td></tr>
<tr><td>Course Outcome</td><td colspan="7">On successful completion of the course, students will be able to
CO1:Know about the environment, its issues and management of the environment.
CO2:Explain the process of waste water treatment, drinking water treatment and solid waste management in various industries.
CO3:Illustrate the significance of bioreactors in bioprocess engineering and culture methods.
CO4:Explain Downstream processing, Fermented Products production and advanced methods.
CO5:Speculate the role and importance of microorganisms behind the ore leaching, production of food products and Biofertilisers.</td></tr>
<tr><td rowspan="2">Course Outline</td><td colspan="7">UNIT 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.</td></tr>
<tr><td colspan="7">UNITII:
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</td></tr>
</table>

	treatment. Biotechnological approach to industrial effluent (Paper, Tannery, Textile) Pesticide waste disposal.
	UNIT 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,
	UNIT 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.
	UNIT V: Ore leaching (methods and examples), MEOR, Production of antibiotics – Penicillin - streptomycin. Alcoholic beverages: Wine, Beer –Biofertilizers-Rhizobium & Azotobacter. Biopesticides – *Bacillus thuringiensis* and microbial toxin production and their applications - Biosurfactants, Vitamins- Folic acid & Vitamin B12, Organic acids.
Recommended Text	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).
Website and e-Learning Source	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/ 6) www.practicalbiology.org/

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">NANO BIOTECHNOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">Elective I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>V</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td colspan="2">1</td><td colspan="2">--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="8">Students will have understanding in the advancement of research and innovation.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="8">CO1: The students will get an outline about Nanobiotechnology and its research in India.
CO2: To know about nanoparticles and their analysis using Advanced Instrumentation.
CO3: To get an insight about nanodevices
CO4: The students will know about the Applications of Nanobiotechnology.
CO5: The students will know about the Nano Biosensors and their applications.</td></tr>
<tr><td colspan="2" rowspan="3">Course Outline</td><td colspan="8">UNIT 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.</td></tr>
<tr><td colspan="8">UNIT II
Metals: Silver nanoparticle synthesis and its analyses by UV-spectroscopy and FTRI. Self-Assembly nanomaterial: Cell membrane and its analyses by SEM</td></tr>
<tr><td colspan="8">UNIT 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.</td></tr>
</table>

	UNIT 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.
	UNIT V Nanobiosensors (Firefly-luciferase) and its applications, Introduction to Biomimetics (Gecko foot effect, Lotus leaf effect: Paint and fabrics, Box fish based Car).
Recommended Text	Vasantha Pattabhi and N. Gautham (2009), Biophysics, Narosa Publishmg House, New Delhi. Narayanan .P (2010), Essentials of Biophysics, New Age International (P) Ltd. Publishers, New Delhi. Niemeyer, C.M. Mirking C.A., "Nanobiotechnology concepts, Applications and Perpectives", 2004. Shanmugam.S, "Nanotechnology", MJP publishers, 2010.
Reference Books	D.Voet & J.G.Voet (2010), Biochemistry, John Wiley &Sons, New York. Biochemistry by Lubert Stryer, 4th Ed., WH.Freeman, 1995. David S. Goodsell, "Bionanotechnology", John Wiley &Sons Inc., publications, 2004.
Website and e-Learning Source	1) http://vvm.org.in/study_material/ENG%20-%20Indian%20Contributions% 20to% 20 Science. 2) https://www.jabonline.in/admin/php/uploads/16_pdf.pdf 3) https://www.youtube.com/watch?v=gSpHINVmgoE 4) https://www.youtube.com/watch?v=ITtGJUGXFKc 5) https://www.youtube.com/watch?v=4cGROrskvLM 6) https://www.youtube.com/watch?v=0lZRAShqft0 7) https://www.youtube.com/watch?v=_5i_QJyL3mI 8) https://www.youtube.com/watch?v=OwkKw53dBtQ 9) https://www.youtube.com/watch?v=Zd78VgngR3c 10) https://www.youtube.com/watch?v=tss8zYFiodQ

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">ENZYMOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">Elective I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>V</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td colspan="2">1</td><td colspan="2">--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="8">This course aims to impart knowledge about Enzyme and kinetics. They will be able to conceptualize enzyme immobilization and its applications.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="8">CO1: The students will know about the Fundamentals of Enzymology.
CO2: The students will know about the characteristic features of Enzymes.
CO3: The student will know about the details of Enzyme Kinetics.
CO4: The students will know about the various methods of extraction of enzymes.
CO5: The students will be familiar with Application of Enzymology techniques in Industries.</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="8">UNIT 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.</td></tr>
<tr><td colspan="8">UNIT 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.</td></tr>
</table>

	UNIT III Enzyme Kinetics – Michaelis-Menten equation and its derivation, significance of Km and Vmax, 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.
	UNIT 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.
	UNIT 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.
Recommended Text	1) Satyanarayana. U. 2013. Biochemistry.4th edition, Elsevier India. 2) Jain J L, 2014, Fundamentals of Biochemistry, 7th edition, S.Chand publishing. 3) Rodwell, V.W, Bender D.A, Botham K.M. 2015, Harper's Illustrated Biochemistry, 30th edition. McGraw-Hill Education. 4) Fundamentals of Enzymology - Nicholas C. Price and Lewis Stevens., Oxford University Press, New Delhi. 5) Voet, D. and Voet, J.G. 2016. Biochemistry, 5th edition. John Wiley and Sons, Inc.,
Reference Books	1) Enzyme – Palmer, 18th edition, 2004.London: Portland Press

	2) Biochemistry- Jeremy M Berg, John L Tymoczko, and LubertStryer,6th Edition, Freeman Publications, 2006. 3) Ralph A. Messing (2012) Immobilised Enzymes Academic Press, NY. 4) Nelson D.L., and Cox, M.M. 2013. Lehninger Principles of Biochemistry. 6th edition.W.H. Freeman & Company. 5) Jeremy M Berg, Stryer, L. 2015. Biochemistry, 8th edition. Macmillan Learning.
Website and e-Learning Source	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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">BIOETHICS & BIOSAFETY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">Elective I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
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<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td colspan="2">1</td><td colspan="2">--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="8">This course aims to introduce the student to human rights and ethical issues related to biotechnological experiments. They will gain an in-depth understanding about artificial reproductive processes and their implications. A sound knowledge on IPR, GLP and GMP will be acquired.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="8">CO1: The students learn about important concepts in Bioethics and Biosafety.
CO2: The students will know about Gene cloning and Bioethics.
CO3: The students will know about the Ethical Clearance.
CO4: The students will get knowledge about Patents.
CO5: The students will know about Biosafety and GLP.</td></tr>
<tr><td colspan="2" rowspan="4">Course Outline</td><td colspan="8">UNIT 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.</td></tr>
<tr><td colspan="8">UNIT 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).</td></tr>
<tr><td colspan="8">UNIT 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.</td></tr>
<tr><td colspan="8">UNIT IV:
Patents - Introduction -Treaties and Conventions of Patents, Patent</td></tr>
</table>

	Cooperation Treaty - TRIPS Basis of Patentability - Non Patentable Inventions - Patent Application Procedure in India. Other Forms of IP: Copyright - Trade Mark – Industrial designs – Farmer's Rights. Patenting of Biotechnology products and processes.
	UNIT V: Biosafety - General guidelines - DBT guidelines on biosafety in conducting research in biology / biotechnology - Risk assessment studies- Hazardous materials used in Biotechnology- Handling and Disposal - Good manufacturing practices & Good Laboratory practices, Containment facilities and Biosafety practices - Regulation on field experiments and release of GMO's - Labelling of GM foods - Guidelines for research in transgenic plants and Animals.
Recommended Text	1) Ignacimuthu, S(2009), *Bioethics*, Narosa Publication house, ISBN: 978-81-7319-966-0 2) V. Sree Krishna . V (2007), *Bioethics and Biosafety in Biotechnology*, (1st ed.), New Age International Private Limited. 3) Rhona Smith.(2003), *International Human rights*, Blackstone Press. 4) Manual of patent practice and procedure. IPR India, 2005. 5) Ministry of commerce and industry, New Delhi, pp.163.
Reference Books	1) Trayer, P.C, Fredrick.R., and Koch, M.(2002), *Biosafety*. Michigan State University 2) Biosafety, Traylor, Fredric & Koch, 2002. Michigan sate University pub., USA. 3) Contemporary issues in Bioethics, Beauchamp & Leroy, 1999. Wardsworth Pub. Co. Belmont, California. 4) Biotechnology and safety assessment, John.A.Thomas, 2004. pp.333
Website and e-Learning Source	1) www.ipr-helpdesk.org/ 2) www.patentoffice.nic.in/ipr/patent/patents.htm 3) www.bangalorebio.com/GovtInfo/ipr.htm

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">CANCER BIOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">Elective I</td></tr>
<tr><td>Category</td><td>Elective</td><td>Year</td><td>III</td><td>Credits</td><td>4</td><td>Course Code</td><td></td></tr>
<tr><td></td><td></td><td>Semester</td><td>V</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2"></td><td colspan="2">3</td><td colspan="2">1</td><td>--</td><td>4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="7">Students will gain an in-depth knowledge on types of cancer, detection, treatment and prevention.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="7">CO1: The students will learn about the Basics of Cancer Biology.
CO2: The students will study about Cancer at the Molecular level.
CO3: The students will learn about the types of Cancer.
CO4: The students will learn about the Detection and Treatment of Cancer.
CO5: The students will know about the Prevention of Cancer.</td></tr>
<tr><td colspan="2" rowspan="4">Course Outline</td><td colspan="7">UNIT I
Cancer: Introduction; Origin of Cancer- The Mutation Concept, The Epigenetic Concept, Viral Concept, Unified genetic concept of cancer; Difference between Normaland Cancer cells; Signs and symptoms.</td></tr>
<tr><td colspan="7">UNIT II
Cancer as a genetic disease; Genetic Alterations in Cancer cells, Point mutation, splice mutation, alternating splicing; Mutation in regulatory sequences, deletions, Insertion, Chromosome abnormalities, Genetic defects and the time course of hereditary cancer.</td></tr>
<tr><td colspan="7">UNIT 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.</td></tr>
<tr><td colspan="7">UNIT IV
Detection and Treatment:- Early detection, Molecular detection of</td></tr>
</table>

	Carcinomas, Cancer warning signals; Markers in blood urine; Therapies- Chemotherapy, Gene therapy, Radiotherapy, Biological therapy(Immuno therapy).
	UNIT V Prevention:- Tobacco smoking, sunlight, diet, ionizing radiation, alcohol drugs, promiscuity, lifestyle and cancer prevention, Environmental factors and cancer, potentially carcinogenic substances for humans.
Recommended Text	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.
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
Website and e-Learning Source	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

<table>
<tr><td>Title of the Course</td><td colspan="7">PLANT BIOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY</td></tr>
<tr><td>Paper Number</td><td colspan="7">CORE PRACTICAL V</td></tr>
<tr><td>Category</td><td>Core Practical</td><td>Year
Semester</td><td>III
V</td><td>Credits</td><td>2</td><td>Course Code</td><td></td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td colspan="2">Lecture
-</td><td colspan="2">Tutorial
-</td><td>Lab Practice
4</td><td>Total
4</td></tr>
<tr><td>Learning Objective</td><td colspan="7">Students will be able to illustrate the tissue culture techniques for plant and animal cells.</td></tr>
<tr><td>Course Outcome</td><td colspan="7">On successful completion of the course, students will be able to
CO1:Explain plant tissue culture and Illustrate Callus development.
CO2:Develop technical skills in Protoplast isolation and Nucleus localization.
CO3: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.
CO4:Develop technical skills in isolation of DNA and RNA from plants and microorganisms.
CO5:Examine the importance of trypsinization in monolayer and subculture and cryopreservation.</td></tr>
<tr><td>Course Outline</td><td colspan="7">Plant tissue culture media preparation & sterilization techniques.
Callus induction</td></tr>
<tr><td></td><td colspan="7">Isolation of plant protoplast & viability test.
Localization of nucleus using nuclear stain.</td></tr>
<tr><td></td><td colspan="7">Preparation of Animal Tissue culture medium and membrane filtration
Preparation of Single Cell Suspension & Cell counting
Cell viability Test</td></tr>
<tr><td></td><td colspan="7">Isolation of plant DNA and plant RNA(Demo)
Isolation of Agrobacterium plasmid DNA (Demo)</td></tr>
<tr><td></td><td colspan="7">Trypsinization of monolayer and subculturing (Demo)
Measurement of phagocytic activity (Demo)
MTT Assay (Demo)
Cryopreservation and thawing (Demo)</td></tr>
<tr><td>Recommended Text</td><td colspan="7">1) Madhavi Adhav, 2009, Practical Biotechnology and Plant Tissue Culture, S.Chand & Company Ltd.</td></tr>
</table>

	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.
Reference Books	1) S. Lal, Vikas. (2018), *Public Health Management Principles And Practice*, (2nd Edition), CBS Publishers and Distributors Pvt Ltd,ISBN 13: 9789387742932 2) S. Harisha. (2012), *Biotechnology procedures and experiments handbook*,ISBN13 9781934015117
Website and e-Learning Source	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

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	40 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	60 Marks
	Total	100 Marks
Methods of Assessment		
Understand/ Comprehend (K2)	MCQ, Concept explanations, Positive, negative results, Short interpretation or overview	
Application (K3)	Suggest idea/concept with examples, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various observations, Map knowledge	
Evaluate (K5)	Evaluation assay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2		S	S	S	M	S
CO3		S	S	S	S	
CO4	S	S	S	S	S	S
CO5		S	S	S	S	S

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">ENVIRONMENTAL AND INDUSTRIAL BIOTECHNOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE PRACTICAL VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core Practical</td><td>Year</td><td>III</td><td>Credits</td><td>2</td><td>Course Code</td><td></td></tr>
<tr><td>Semester</td><td>V</td><td colspan="4"></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>-</td><td colspan="2">-</td><td>4</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="6">Students will be able to perform microbial, water and raw milk analysis, biofertilizer production and efficiency test.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="6">On successful completion of the course, students will be able to
CO1: Isolate the microorganisms and determine their growth curve, generation time.
CO2: Analyze the water samples, perform immobilization and compost production.
CO3: Develop skills in biofertilizer production and microbial identification.
CO4:Gain basic skills to analyze raw milk and determine the pasteurization efficacy.
CO5:Develop skills to perform efficiency tests of biofertilizers and biopesticides, microbial polysaccharide production.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">Isolation of Air borne Pathogens
Study of Growth Curve and Generation time of Bacteria/ Yeast using turbidometry.</td></tr>
<tr><td colspan="6">Water analysis – MPN and BOD.
Immobilization of whole yeast cells/ enzyme by Alginate beads.
Production of wine
Production of Biogas – In vitro & Compost Making.</td></tr>
<tr><td colspan="6">Biofertilizer production/Spirulina production - field visit. (Report should be included in the record)
Isolation and identification of starter organisms from Idli batter/ curd</td></tr>
<tr><td colspan="6">Grading of raw milk (Dye reduction test).
Determination of efficiency of Pasteurization by quantitative phosphatase test.</td></tr>
<tr><td colspan="6">Preparation and Efficiency testing of Biofertilizer/ Biopesticide. (Demo)
Production of microbial Polysaccharide. (Demo)</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="6">1) Aneja K R, Laboratory Manual of Microbiology and Biotechnology, MEDTECH, 2014.ISBN-13 : 978-9381714553</td></tr>
</table>

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

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Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	40 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	60 Marks
	Total	100 Marks
Methods of Assessment		
Understand/ Comprehend (K2)	MCQ, Concept explanations, Positive, negative results, Short interpretation or overview	
Application (K3)	Suggest idea/concept with examples, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various observations, Map knowledge	
Evaluate (K5)	Evaluation assay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2		S	S	S	M	S
CO3		S	S	S	S	
CO4	S	S	S	S	S	S
CO5		S	S	S	S	S

SEMESTER- VI

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">BIOENTREPRENEURSHIP</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">Core Paper VIII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core Paper</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>VI</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="7">Students will be able to identify the challenges of being a Bioentrepreneur and understand the current global status of the Bio industry. They will also be able to generate a detailed business plan and identify various funding agencies. They will excel in technical skills such as Vermicomposting, Sericulture, Aquaponics, Mushroom cultivation and SCP Production.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="7">On successful completion of the course, students will be able to
CO1: Gain knowledge about Bioentrepreneurship, biotech industries and funding agencies.
CO2: Understand Business plan for startups, Accounting and IPR.
CO3: Aspire to work in Vermicomposting, vermiculturing and Understand the importance of sericulture.
CO4: Will gain the knowledge of cultivation of different types of Mushroom and Aquaponics.
CO5: Understand the process and technology concerned with the mass production of Single cell protein.</td></tr>
<tr><td colspan="2" rowspan="3">Course Outline</td><td colspan="7">UNIT 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)</td></tr>
<tr><td colspan="7">UNIT 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.</td></tr>
<tr><td colspan="7">UNIT III
Vermicomposting–Earthworms-Ecologicaltypes-Vermiculture-Compostpit-Vermibed-applications.Sericulture-Mulberrycultivation-SilkwormRearing-</td></tr>
</table>

	Economicsofsilkworm Production-Chawki Rearing-Sericulture in India.
	UNIT 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.
	UNIT V Single Cell Protein Production: Source: Algae, Bacteria, Yeast – Cultivation of Single Cell protein: SPIRULINA Cultivation – Production site, Microorganism, Experimental design; harvesting and Drying.
Recommended Text	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 6) Organic Mushroom Farming and Myco remediation: Simple to Advanced and Experimental Techniques for Indoor and Outdoor Cultivation by Trad cotter 7) Aquaponics for Beginners,2018 Nick Brooke 8) Single Cell Protein Production from Lignocellulosic Biomass by P.Bajpai
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
Website and e-Learning Source	1) https://archive.india.gov.in › citizen › agriculture 2) http://www.recirculatingfarms.org/resources/ 3) https://academy.vertical-farming.net/intro-to-mushroom-growing/

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	40 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	60 Marks
	Total	100 Marks
Methods of Assessment		
Understand/ Comprehend (K2)	MCQ, Concept explanations, Positive, negative results, Short interpretation or overview	
Application (K3)	Suggest idea/concept with examples, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various observations, Map knowledge	
Evaluate (K5)	Evaluation assay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	S	S	S	S	S
CO2		S	S	S	M	S
CO3		S	S	S	S	
CO4	S	S	S	S	S	S
CO5		S	S	S	S	S

<table>
<tr><td>Title of the Course</td><td colspan="8">PHARMACEUTICAL BIOTECHNOLOGY</td></tr>
<tr><td>Paper Number</td><td colspan="8">Core Paper IX</td></tr>
<tr><td>Category</td><td>Core Paper</td><td>Year</td><td>III</td><td>Credits</td><td>5</td><td>Course Code</td><td colspan="2"></td></tr>
<tr><td></td><td></td><td>Semester</td><td>VI</td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td></td><td colspan="2">4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td>Learning Objective</td><td colspan="8">Students will understand the series of processes involved in drug development, patenting and drug approval.</td></tr>
<tr><td>Course Outcome</td><td colspan="8">On successful completion of the course, students will be able to
CO1: Discuss about the drugs, its development and Concepts involved in Pharmacokinetics & Pharmacodynamics
CO2:Describe the formulation and production of biotechnology products
CO3:Understand the different biotechnology products of the pharma industry.
CO4:Evaluate drug toxicity and prevention of drug abuse and management.
CO5:Determine the national and international drug approval agencies and pharmaceutical industries.</td></tr>
<tr><td rowspan="3">Course Outline</td><td colspan="8">UNIT I
Objectives of Pharmaceutical Biotechnology - Generic and Biogeneric drugs. Stages in the drug development process -Drug discovery - Drug designing - Drug production - Preclinical trials - Clinical trials - Pharmacokinetics and Pharmacodynamics - Patenting & Drug Approval - Drug Marketing - Post clinical trials.</td></tr>
<tr><td colspan="8">UNIT II
Production of recombinant proteins - Development of Nucleic acid based therapies - Biopharmaceutical considerations - Pharmaceutical regulations - Formulation of Biotechnology products - Drug delivery - Pharmacognosy .</td></tr>
<tr><td colspan="8">UNIT 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).</td></tr>
</table>

	UNIT IV Drug toxicity analysis - Common side effects of drugs and managements - Drugs of abuse - Life changing complications - Prevention and management
	UNIT V National and International Drug approval agencies - Top National and International pharmaceutical industries - Scope and career opportunities in pharmaceutical sectors.
Recommended Text	1) Chandrakant Kokate and Pramod H.J 1st Edition (2011), Text Book of Pharmaceutical Biotechnology, Elsevier 2) Crommelin, Dean J. A., Sindelar, Robert, Meobohm, Bernd (Eds.) (2019), Pharmaceutical Biotechnology: Fundementals and Applications, Springer. 3) Ashish Dixit, Pawan Tiwari and Vivekanand Kishan Chatap (2015), Textbook of Pharmaceutical Biotechnology, Studium Press (India) Pvt. Ltd.
Reference Books	1) Gary Walsh (2003), Biopharmaceuticals ; biochemistry and Biotechnology, John Wiley & Sons Ltd. 2) Oliver Kayser and Heribert Warzecha (2012), Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, Wiley - Blackwell. 3) Simon Wills, 2nd Edition (2005), Drugs of abuse, Pharmaceutical Press
Website and e-Learning Source	1) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5178364/ 2) https://www.patentdocs.org/biotech_news/ 3) https://www.pharmamanufacturing.com/ 4) https://www.parexel.com/ 5) https://nptel.ac.in/courses/102/103/102103013/ 6) https://nptel.ac.in/courses/102106070/ 7) https://nptel.ac.in/courses/102108077/ 8) https://nptel.ac.in/content/storage2/courses/104108056/module9/PNR%20lecture%2034.pdf

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	40 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External	End Semester Examination	60 Marks

Evaluation		
	Total	100 Marks
Methods of Assessment		
Understand/ Comprehend (K2)	MCQ, Concept explanations, Positive, negative results, Short interpretation or overview	
Application (K3)	Suggest idea/concept with examples, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various observations, Map knowledge	
Evaluate (K5)	Evaluation assay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2		S	S	S	M	S
CO3		S	S	S	S	
CO4	S	S	S	S	S	S
CO5		S	S	S	S	S

<table>
<tr><td>Title of the Course</td><td colspan="7">MARINE BIOTECHNOLOGY</td></tr>
<tr><td>Paper Number</td><td colspan="7">Elective II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>III</td><td>Credits</td><td>4</td><td>Course Code</td><td></td></tr>
<tr><td>Semester</td><td>VI</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">3</td><td colspan="2">1</td><td colspan="2">--</td><td>4</td></tr>
<tr><td>Learning Objective</td><td colspan="7">Students will gain knowledge about Marine Resources, Pharmacology and byproducts for Aquaculture and commercial development.</td></tr>
<tr><td>Course Outcome</td><td colspan="7">CO1: The students will know about the Marine Ecosystem and its functioning.
CO2: The students will acquire knowledge about Marine microbial habitats.
CO3: The students will know about the Bioactive compounds from Marine Ecosystem.
CO4: The students will learn about the Manipulations done in Marine organisms.
CO5: The students will learn about the Economic importance of Marine Seaweeds.</td></tr>
<tr><td rowspan="4">Course Outline</td><td colspan="7">UNIT 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.</td></tr>
<tr><td colspan="7">UNIT 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.</td></tr>
<tr><td colspan="7">UNIT – III
Definitions- Medicinal compounds from flora (Seaweeds, Seagrass and Mangrove) and fauna (Sponges, Sea anemone and Corals)- marine toxins- antiviral and antimicrobial agents.</td></tr>
<tr><td colspan="7">UNIT IV
Culture aspect-Seaweed (Kappaphycus alvarezii), Fish chromosome manipulation in aquaculture- Hybridization- Gynogenesis-</td></tr>
</table>

	Androgenesis- Polyploidy, Artificial Insemination, Eyestalk ablation- Trangenesis and Cryopreservation.
	UNIT V Agar- Agarose - Alginate- Carrageenan- Chitin- Chitosan- Heparin.
Recommended Text	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
Website and e-Learning Source	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/ 6) http://www.rcsb.org/pdb/

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	40 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	60 Marks
	Total	100 Marks
Methods of Assessment		
Understand/	MCQ, Concept explanations, Positive, negative results, Short interpretation or	

Comprehend (K2)	overview
Application (K3)	Suggest idea/concept with examples, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various observations, Map knowledge
Evaluate (K5)	Evaluation assay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2		S	S	S	M	S
CO3		S	S	S	S	
CO4	S	S	S	S	S	S
CO5		S	S	S	S	S

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">FOOD TECHNOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">Elective II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>VI</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>3</td><td colspan="2">1</td><td colspan="2">--</td><td>4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="6">Students will be able to understand the basic concepts of the food industry and evolution of food processing. The learner will be able to analyze the structure, composition of food and food safety.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="6">CO1: The students will gain insight about the relationship between Biotechnology and the Food Industry.
CO2: The students will learn about the Classification of Food and their Processing.
CO3: The students will learn about the Classification of Fruits and Vegetables and their changes during Processing.
CO4: The students will learn about the concept of Non Vegetarian foods and their types.
CO5: The students will learn about the different food adulterants.</td></tr>
<tr><td colspan="2" rowspan="3">Course Outline</td><td colspan="6">UNIT 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.</td></tr>
<tr><td colspan="6">UNIT 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.</td></tr>
<tr><td colspan="6">UNIT III:
Classification of fruits and vegetables, general composition, enzymatic browning, names and sources of pigments, Dietary fibre. Post harvest changes</td></tr>
</table>

	in fruits and vegetables – Climacteric rise, horticultural maturity, physiological maturity, physiological changes, physical changes, chemical changes, pathological changes during the storage of fruits and vegetables.
	UNIT 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.
	UNIT V: Types of food adulterants – test to detect adulterants in foods – metal contaminants - contaminants of processed foods- Food products as analytical samples, general aspects of biosensors- biosensors for food contaminant analysis, commercially available biosensors for food analysis. Food additivies, FSSAI regulations, Methods of fortifying and enriching foods.
Recommended Text	Bawa. A.S, O.P Chauhan et al. Food Science. New India Publishing agency, 2013. B. Srilakshmi, Food science, New Age Publishers,2002 Joshi, V.K. and Singh, R.S., A. (2013), *Food Biotechnology- Principles and practices,* I.K.International Publishing House Pvt. Ltd., New Delhi,. RavishankarRai, V,(2015), *Advances in Food Biotechnology*, (First edition), John Wiley & Sons, Inc, ISBN 9781118864555. Perry Johnson-Green.(2018), *Introduction to Food Biotechnology*, Special Indian Edition, *CRC Press*, ISBN 9781315275703.
Reference Books	Roday,S. Food Science, Oxford publication, 2011. Meyer, Food Chemistry, New Age,2004 5. De Sukumar., Outlines of Dairy Technology, Oxford University Press, 2007 Foster, G.N., (2020), *Food Biotechnology*, (First edition), CBS Publishers & Distributors Pvt Ltd, ISBN 9789389396348. Anthony Pometto, Kalidas Shetty, Gopinadhan Paliyath, Robert E. Levin(2005), *Food Biotechnology*, (2nd edition), *CRC Press*,ISBN 9780824753290.
Website and e-Learning Source	

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	40 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	60 Marks
	Total	100 Marks
Methods of Assessment		
Understand/ Comprehend (K2)	MCQ, Concept explanations, Positive, negative results, Short interpretation or overview	
Application (K3)	Suggest idea/concept with examples, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various observations, Map knowledge	
Evaluate (K5)	Evaluation assay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2		S	S	S	M	S
CO3		S	S	S	S	
CO4	S	S	S	S	S	S
CO5		S	S	S	S	S

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">MEDICAL BIOTECHNOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">Elective III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>VI</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td colspan="2">1</td><td colspan="2">--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="8">Student will be able to obtain knowledge on the advanced research in Medicine, Molecular diagnosis, Immuno-diagnostic techniques and ethical issues concerned inresearch.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="8">CO1:The students will study about Antibodies and Vaccines
CO2:The students will study about the molecular Diagnosis of diseases
CO3:The students will know about the Diagnosis of Infectious Diseases.
CO4:The Students will know about the production of therapeutic agents.
CO5: The students will study about Clinical Trials and Ethic codes.</td></tr>
<tr><td colspan="2" rowspan="4">Course Outline</td><td colspan="8">UNIT 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.</td></tr>
<tr><td colspan="8">UNIT 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.</td></tr>
<tr><td colspan="8">UNIT III
Diagnosis of infectious diseases, Viral diseases – HIV, influenza; bacterial diseases - enteric diseases, mycobacterium diseases; immunoarrays. FACs immunocytochemical staining, ELISA, FISH techniques.</td></tr>
<tr><td colspan="8">UNIT IV
Immunoblot analysis of antigens and allergens.Production of therapeutic agents – Productions and application of therapeutic agents, Production of cytokines and interferons.</td></tr>
</table>

	UNIT 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.
Recommended Text	Roli, M. (2017). *National Ethical Guidelines for Biomedical and Health Research Involving Human Participants,*ISBN: 978-81-910091-94 Lela, B. and Maribeth, L. F. (2011). *Molecular Diagnostics: Fundamentals, Methods and Clinical Applications*, (1st Edition) . Philadelphia, USA. F A Davis Company. ISBN-13: 978-0803626775
Reference Books	Bernard, R. G. Terry, L.D. and Cherryl, L.P. (2014). *Medical Biotechnology*, (2nd edition). Patrick, R.M. Kenneth, S.R. and Michael, A.P. (2016). *Medical Microbiology*, (8th edition). USA. Elsevier Publishers, eBook ISBN: 9780323388504 Pamela, G. Michelle, M, (2009). *Molecular Therapeutics: 21st century medicine*, (1st Edition). Hoboken, New Jersey. Wiley Publishers.
Website and e-Learning Source	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

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	40 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	60 Marks
	Total	100 Marks
Methods of Assessment		
Understand/ Comprehend (K2)	MCQ, Concept explanations, Positive, negative results, Short interpretation or overview	

Application (K3)	Suggest idea/concept with examples, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various observations, Map knowledge
Evaluate (K5)	Evaluation assay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2		S	S	S	M	S
CO3		S	S	S	S	
CO4	S	S	S	S	S	S
CO5		S	S	S	S	S

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">FORENSIC BIOTECHNOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">Elective III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>VI</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>3</td><td colspan="2">1</td><td colspan="2">--</td><td>4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="7">Students will demonstrate analytical capabilities and scientific principles required in a Forensic laboratory.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="7">CO1: The student will know about the scope of Forensic Biotechnology
CO2: The student will study about crime scene investigations
CO3:The student will learn about Serology
CO4:The Student will learn Techniques used in Forensic Biotechnology
CO5:The Students Will about the applications of Forensic Biotechnology</td></tr>
<tr><td colspan="2" rowspan="4">Course Outline</td><td colspan="7">UNIT I
Definition and scope of Forensic Biotechnology, History and development, Forensic genetics, Forensic agriculture.</td></tr>
<tr><td colspan="7">UNIT II
Crime scene investigation; collection, preservation, packing and forwarding of physical and trace evidence. Questioned documents – identification of handwriting, signature and detection of forgery.</td></tr>
<tr><td colspan="7">UNIT 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.</td></tr>
<tr><td colspan="7">UNIT IV
PCR, RFLP, AFLP, Microscopy (Electron, Fluorescent) and Chromatography (Paper, TLC & HPLC) in forensic investigation.</td></tr>
</table>

	UNIT V DNA Profiling, Isolation of DNA from blood samples, DNA testing in cases of disputed paternity and maternity.
Recommended Text	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.
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.
Website and e-Learning Source	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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">GOOD LABORATORY PRACTICES (GLP)</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">Elective III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>VI</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">3</td><td colspan="2">1</td><td colspan="2">--</td><td>4</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="8">Enhances student’s knowledge on essential practices that need to be followed in a laboratory or industry, awareness on safety measures and Industry standards.</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="8">CO1 : The students learn about types of Labs associated with Biotechnology.
CO2: The students will learn about the methods and types of Documentations.
CO3: The students will learn to maintain Lab Instruments .
CO4: The students will learn about Good Lab Guidelines.
CO5: The students will study about the Management and Disposal of wastes.</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="8">UNIT 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.</td></tr>
<tr><td colspan="8">UNIT 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).</td></tr>
</table>

	UNIT 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.
	UNIT 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.
	UNIT V Definition of waste, types of waste: Biological andchemical waste, methods of Safe Disposal of biological and chemical waste: treatment methods of Ethidium Bromide solutions, Electrophoresis Gels, Contaminated Gloves, debris, Wastes containing sodium azide, Silver staining solutions, Perchloric acid, Nanoparticle wastes, Spill management, Awareness and training for personnel.
Recommended Text	WHO training manual on Good Laboratory Practices, 2nd Edition.
Reference Books	Milton A. Anderson GLP Essentials: A Concise Guide to Good Laboratory Practice, Second Edition 2nd Edition, Published by CRC press.
Website and e-Learning Source	1) https://www.who.int/tdr/publications/documents/glp-trainer.pdf"tdr 2) https://www.who.int/tdr/publications/documents/glp-trainer.pdf"›publications › documents 3) https://www.who.int/tdr/publications/documents/glp-trainer.pdf"glp 4) https://www.who.int/tdr/publications/documents/glp-trainer.pdf"-trainer 5) www.who.int/tdr/publications/documents/glp-handbook.pdf 6) www.intechopen.com. 7) https://www.oecd.org/chemicalsafety/testing/overview-of-good-laboratory-practice.htm

NON-MAJOR ELECTIVES (NME)

1. Food and Nutrition	Semester-1 [select any one]
2. Herbal Medicine	
3. Public Health and Hygiene	
4. Environment Management in Industries	
5. Good Laboratory Practices	Semester-II [select any one]
6. Organic Farming and Health Management	
7. Biotechnology for Society	
8. Computational Biology	

NON MAJOR ELECTIVE
Semester -I
FOOD AND NUTRITION

Course outcome:

Students will be able to assess nutritional status of individuals in various life cycle stages and determine nutrition related conditions and diseases by applying knowledge ofmetabolism and nutrient functions, food sources and physiologic system.Ability to identify nutrition related public health problems, integrates information from basic nutrition sciences, critically analyze data and develop appropriate conclusions.

Unit–I:

Definition of food, Nutrition, Nutrient, Nutritional status, Dietetics, Balance diet, Malnutrition, Energy (Unit of energy-Joule, Kilocalorie). Health, Immunity by food and function of food.

Unit–II:

Carbohydrate, Protein, Fat, Vitamin and Minerals(Calcium, Phosphorous, Sodium, Potassium, Iron, Iodine, Fluorine) -Sources, Classification, Function, Deficiencies of these nutrients. Function of water and dietary fiber.

Unit– III:

BMR: Definition, factors affecting BMR and total energy requirements (Calculation of energy ofindividuals)

Unit–IV:

Basic five food groups, nutritional significance of cereals, pulses, milk, meat, fish,vegetables,egg, nuts , oils and sugars. Food toxins, Food additives, Food quality, Safe food handling, Foodadulteration, Preservatives and Packaging.

Unit– V:

Principles and Objectives of meal planning. Diet for an infant, preschool child, School child, normal male and female of different occupations.

REFERENCES

1. Vidya & D.B. Rao, 2010. A textbook of nutrition by, Discovery Publishing house,.

2. Handbook of Nutrition & Food, third edition, CRC Press (Taylor and Francis group) by Carolyn D.Berdanier

3. Food science and Nutrition, Oxford publication by Sunetra Roday

4. Janet D Ward & Larry T Ward , Principles of food science by, Good heart-Wilcox publishing.

5. Dr. M. Swaminathan, 2018. Hand Book of Food & Nutrition, Second edition Bangalore press

HERBAL MEDICINE

Course outcome:

The subject introduces students to the incredible world of plants and their medicinal uses. This programme explores the history of plant-based therapies and identify andcultivate herbs, use plant-based foodsand herbal remedies to restore and maintain health.

Unit–I:

Ethnomedicine – definition, history and its scope – Inter disciplinary approaches in ethnobotany – Collection of ethnic information.

Unit–II:

Importance of medicinal plants – role in human health care – health and balanced diet (Role of proteins, carbohydrates, lipids and vitamins).

Unit–III:

Tribal medicine – methods of disease diagnosis and treatment – Plants in folk religion – *Aegle marmelos, Ficus benghalensis, Curcuma domestica, Cynodon dactylon* and Sesamumindicum.

Unit–IV:

Traditional knowledge and utility of some medicinal plants in Tamil Nadu – *Solanum trilobatum, Cardiospermum halicacabum, Vitex negundo, Adathoda vasica, Azadirachta indica*, *Gloriosa superba*, *Eclipta alba*, *Aristolochia indica* and *Phyllanthus fraternus*.

Unit– V:

Plants in day today life – *Ocimum sanctum*, *Centella asiatica*, *Cassia auriculata*, *Aloe vera*. Nutritive and medicinal value of some fruits (Guava, Sapota, Orange, Mango, Banana, Lemon, Pomegranate) and Vegetables - Greens (Moringa, *Solanum nigrum* Cabbage).

REFERENCES:

1. R.K.Sinha&ShwetaSinha (2001), Ethnobiology. Surabhe Publications – Jaipur.
2. D.C. Pal & S.K. Jain NayaPrakash, (1998), Tribal medicine, BidhanSarani, Calcutta ,
3. S.K. Jain (2001) Contribution to Indian Ethnobotany – S.K. Jain, 3rd edition, scientificpublishers, B.No.91, Jodhpur, India.
4. Andrew Chevallie, (2000) Encyclopedia of Herbal Medicine
5. James Green (2000). The Herbal Medicine-Maker's Handbook: A Home Manual
6. Steven Horne and Thomas Easley (2016), Modern Herbal Dispensatory: A MedicineMaking Guide
7. M.C. Joshi (2007) Handbook of Indian Medicinal Plants Hardcover.

PUBLIC HEALTH AND HYGIENE

Course outcome

Students will be able to identify national and global health problems and be aware about the issues of food safety, water safety, vaccination, exercise and obesity, exposure totoxins.

Unit–I:

Scope health and hygiene – Concept of health and disease - Pollution and health hazards; water and airborne diseases. Radiation hazards: Mobile Cell tower and electronic. Role of health education inenvironment improvement and prevention of diseases. Personal hygiene, oral hygiene and sex hygiene.

Unit–II:

Classification of food into micro and macro nutrients. Balanced diet, Importance of dietary fibres.Significance of breast feeding. Malnutrition anomalies – Anaemia, Kwashiorkar, Marasmus, Rickets, Goiter (cause, symptoms, precaution and cure).

Unit–III:

Communicable viral diseases- measles, chicken pox, poliomyelitis, swine flu, dengue, chickungunya, rabies, leprosy and hepatitis. Communicable bacterial diseases- tuberculosis, typhoid, cholera, tetanus,plague, whooping cough, diphtheria, leprosy. sexually transmitted diseases- AIDS, syphilis and gonorrhoea. Health education and preventive measures for communicable diseases.

Unit– IV:

Non-communicable diseases such as hypertension, stroke, coronary heart disease, myocardial infarction.Osteoporosis, osteoarthritis and rheumatoid arthritis-cause, symptom, precautions. Diabetes- types andtheir effect on human health. Gastrointestinal disorders- acidity, peptic ulcer, constipation, piles (cause,symptoms, precaution and remedy) etc. Obesity (Definition and consequences). Mental illness(depression and anxiety). Oral and lung cancer and their preventive measures.

REFERENCES:

1. Mary Jane Schneider (2011) Introduction to Public Health.
2. Muthu, V.K. (2014) A Short Book of Public Health.
3. Detels, R. (2017) Oxford Textbook of Public Health (6th edition).
4. Gibney, M.J. (2013) Public Health Nutrition.
5. Wong, K.V. (2017) Nutrition, Health and Disease

ENVIRONMENT MANAGEMENT IN INDUSTRIES

Course outcome

The students will understand the dairy processing technologies, types of workplace hazards and apply risk management principles to anticipate, identify, evaluate and control physical, chemical, biological and psychosocial hazards.

Unit–I:

Introduction to life science, computer in life science-Medical imaging, Genomics and phylogenetics, Drug design and discovering, Assistive robotics, Brain-computer interfaces, Simulation of biological systems and Medical treatment optimization.

Unit–II:

Introduction to Dairy industries, The Structure of Dairying in Developing Countries, Application of Computer in Dairy Industry, Milk Procurement & Billing, Plant Automation, Computerized Accounting System, Applications of Management Information System (MIS), Packaging, Supply Chain Integration and Traceability.

Unit–III:

Agribusiness - Application of marketing and decision making in contemporary agribusiness firms. Marketing strategies, marketing research and information, segmentation and targeting, Professional selling skills and knowledge – Rural Development – NABARD.

Unit–IV:

Hazards in the workplace: Pressure, Biological, Chemical, Electricity, Fire, Heat & Cold, Indoor Air Quality, Lighting, Noise, ergonomics, Radiation (ionizing & non ionizing), Vibrations, hours of work, violence in work place, Understanding of Material Safety Data Sheets, Accidents and Safety Management: Accident Prevention methods, Safety Management and audit, Personal Protection Approaches.

Unit– V:

Occupational Health & Industrial Hygiene: Scientific and engineering basis for occupational health, biological monitoring (e.g. BEI), Occupational Hygiene, Concept of First Aid, Preventive Measures, and Occupational Health & Safety Management System: OHSAS – 18000.

REFERENCES:

1. LalatChander, 2010. Text book of Dairy Plant Layout and Design, ICAR, New Delhi.
2. Larry R. Collins, 2001.Physical Hazards of the Workplace, CRC Press, Taylor&Francis group.
3. Andrew Barkley, 2013, Principles of Agricultural Economics, Taylor&Francis group.

4. Mishra R.K., 2015. Occupational health management, Aitbs Publishers and Distributors-Delhi.

Semester – II

GOOD LABORATORY PRACTICES (GLP)

Course outcome:

This course enhances student's knowledge on essential practices in a laboratory / industry, awareness on safety measures and Industry standards.

Unit–I:

Biotechnology lab organization - 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.

Unit–II:

Lab ethics - Regulatory affairs: Methods and types of documentation (pre-lab writes, result recording and post lab report: interpretation of result), Dilution factor calculation, Molarity, percentage, dilution of concentrated solution, metric units (kg to gms and vice -versa).

Unit–III:

Instrument calibration and importance - Principles, use and maintenance of laboratory instruments like Autoclave, hot air oven, Incubators, Water bath, Refrigerator, Centrifuge, Calorimeter, pH meter, Haemocytometer, Microtome, Electronic balances, Bio safety cabinets. SOP preparation for instrumentation

Unit–IV:

GLP & Biotechnology Industry standards - Good Laboratory guidelines, Elements of GLP, Standard Operating Procedures and its importance, Quality Assurance & Quality control, Internal audit basics, ISO, BIS and HACCP standards.

Unit– V:

Types of wastes and safe disposal methods - Definition of waste, types of waste: Biological and chemical waste, methods of Safe Disposal of biological and chemical waste: 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.

REFERENCES:

1. Milton A. Anderson GLP Essentials: A Concise Guide to Good Laboratory Practice, SecondEdition 2nd Edition, Published by CRC press.
2. https://www.oecd.org/chemicalsafety/testing/overview-of-good-laboratory-practice.htm
3. https://www.intechopen.com/chapters/22127

ORGANIC FARMING AND HEALTH MANAGEMENT

Course outcome

On completion, of course the student will value the concepts of ecology, environment and importance of vermicompost and the role of physical activity and nutrition for healthy living.

Unit–I:

Ecology and Environment – Principles of ecology – Ecosystem - Biotic and abiotic components and interaction – Energy flow –Nutrient cycle – Biodiversity – Endemic – Exotic - Interrelationships.

Unit–II:

Composting – Microbial Compost – Vermicompost – Setup for vermicompost unit - Nutrition garden – Ring garden – Double digging – Cultivating vegetables – Common medicinal herbs – Identification and Cultivation.

Unit–III:

Organic farming – Principles and Policies – Certification agencies – AGMARK, fssai, Halal certification – Participatory grading system (PGS) – Storage – Packing – Transportation – Marketing. Micro-enterprises – Self Help Groups – Economics of cultivations - Sustainability

Unit–IV:

Health: Concept of Health, changing concepts definitions of health, dimensions of health, concept of well being, spectrum of health, determinants of health, ecology of health, right to health, responsibility for health, indicators of health.

Unit– V:

Exercise and Health related fitness: Health related fitness, health promotion, physical activity for health benefits. Sports related fitness: Role of nutrition in sports, nutrition to athletic performance.

REFERENCES:

1. G.K. Veeresh, 2006. Organic farming , First edition, New Delhi, India Foundation Books in association with Centre for Environment Education.
2. Mangala rai, 2012.Hand Book of Agriculture, Sixth Edition, ICAR New Delhi.
3. B.B. Sharma , 2007. A Guide to Home Gardening, Second Edition, MIB India, New Delhi.
4. Adrianne E. Hardman, 2009. Physical Activity and Health – The evidence explained, Second edition, Taylor and Francis Group.
5.

BIOTECHNOLOGY FOR SOCIETY

Course outcome:

On completion of this course the students will be able to gain knowledge about the biotechnological products and their implications in the society

Unit–I:

Introduction to Biotechnology- Role of Biotechnology in sericulture- Rearing of silkworms- Importance and applications- Role of Biotechnology in apiculture- Bee hive hierarchy- Bee keeping process- Products obtained- Mushroom farming stages- Cultivation of paddy straw mushroom- Importance of mushroom cultivation.

Unit– II:

Biofertilizer- Definition- Mass production of *Rhizobium*-Advantages and disadvantages- Biopesticides- Definition- Microbial biopesticides- *Bacillus thuringiensis*- Single cell protein- Introduction- history- production of *Spirulina* SCP- Applications- Advantages & disadvantages.

Unit– III:

Biodegradation- Definition- Process-role of microorganisms in biodegradation - biodegradable plastics-advantages- Bio weapons- introduction- history- potential agents- delivery methods- harmful effects.

Unit–IV:

Antibiotics- Definition- Introduction and history of antibiotics- sources- classification- spectrum- production of penicillin- definition of antibiotic resistance.

Unit– V:

Transgenic plants – Definition of transgene and transgenesis - BT Cotton, Flavr-Savr tomato and Golden rice- history – importance, applications, advantages and disadvantages.

REFERENCE

1. Sathyanarayana, U., Chakrapani, U., (2008). *Biotechnology*, First edition, Books and allied (P) Ltd, Kolkata.
2. A.K. Chatterji, (2011).*Introduction to Environmental Biotechnology,* Third edition, PHI Learning Pvt Ltd. New Delhi. ISBN-978-81-203-4298-9
3. R.C. Dubey, (2014*). A text book of Biotechnology, S.Chand& Company, New Delhi.* ISBN 9788121926089
4. H. Patel, (2011).*Industrial Microbiology*,(2nd edition), MacMillan Publishers
5. Thakur, I.S., (2019).*Environmental Biotechnology- Basic principles and applications-(*2nd edition)- Dreamtech Press, ISBN 978-93-89307-55-9

COMPUTATIONAL BIOLOGY

Course Outcome:

The students will be able to extract information from large databases and use this information in computer modeling and develop new algorithms and analysis methods.

Unit I

Overview and Definition, Application of Bioinformatics, Sequences format used in Bioinformatics- Biological Database: Introduction, Classification of biological databases, Primary database- Nucleic acids- NCBI-DDBJ-EMBL. Protein- PDB- SWISSPORT. Secondary database- PROSITE, PFAM. Structure and classification-SCOP-CATH, Metabolic pathway database.

Unit II

Sequences similarity, Identify & homology- Definition of homologues, Orthologues, Paralogues. Scoring matrices, Pairwise Sequences alignment. Dot Matrix, BLAST, FASTA- Needleman Wunsch – Smith and waterman Algorithm.

Unit III

Multiple Sequences alignment – Different method of multiple sequences alignment- Evolutionary analysis, clustering methods Phylogenic trees- rooted and unrooted tree- Methods to generate phylogenetic tree- Tools for multiple sequences alignment and phylogenetic analysis (PHYLIP)

Unit IV

History of Drug Discovery, Steps in Drug design - Chemical libraries – Role of molecular docking in drug design.

Unit V

Protein prediction - Study of internet resources in Bioinformatics -Tools for primary (Compute PT/Mw, Protparam), secondary (PROSITE), Tertiary (Swiss Model), Structure prediction of proteins, Homology modeling of proteins. Visualization tools (RASMOL), Gene prediction tools (Genscan, Grail).

References:

1. Rastogi, S.C, Mendiratta, N,Rastogi, P., 2004. Bioinformatics methods and application. Prentice-Hall of India private limited, New Delhi.
2. David Mount., Bioinformatics: sequence and genome analysis, second edition., Taylor & Francis, UK; 2009.
3. D.R.Westhead. Instant Notes in Bioinformatics., second edition., Taylor & Francis, UK; 2009.
4. Gautam B. Singh., Fundamentals of Bioinformatics and Computational Biology, Oakland University Rochester, Michigan USA.
5. Arthur M.Lesk., Introduction to bioinformatics., Oxford University Press.
6. www.expasy.org

SOFT SKILL COURSES

1. Food and bioprocess technology	SEM-1
2. Food chemistry	
3. Mushroom cultivation	SEM-2
4. Global climate change	
5. Aquaculture	SEM-3
6. Vermitechnology	
7. Poultry science and management	
8. Basics in research methodology	SEM-4
9. Clinical nutrition and dietary management	
10. Cryobiology	

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- Modes of Operation of fermenter – Batch & continuous - Types of reactors - Bubble column, Fluidized bed reactor, plug flow reactor.

UNIT II

Fermentation media design, sterilization and media requirement for industrial fermentation, Main parameters to be monitored and controlled in fermentation processes, aerobic and anaerobic fermentation processes. Development and scale up of bioreactors for production of biological products. Immobilization – Types of immobilization, various methods - Applications of immobilized enzyme technology.

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. Enrichment operations: Membrane – based separations. Product finishing: precipitation/crystallization, mixing, dialysis, distillation and drying.

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) -

Single cell protein production – Spirulina, Yeast, Actinomycetes protein. Beverages production – Beer and Wine.

UNIT V

Processing of Milk – Pasteurization and homogenization - Modifying milk composition – Production of milk products – Curd, cheese, yogurt, and flavoured milk. Bakery products – Bread making. Probiotics and Role of Food technology in bio-defense programs.

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.

FOOD CHEMISTRY

Course outcome:

On completion of the course the learner will know about adulterants, usage of pesticides and their effect.

Unit – I:

Sources of food, types, advantages and disadvantages. Food adulteration - contamination of Wheat, Rice, Milk, Butter etc. with clay stones, water and toxic chemicals - Common adulterants. Common adulterants Ghee adulterants and their detection. Detection of adultered Foods by simple analytical techniques.

Unit – II:

Food Poisons - natural poisons (alkaloids - nephrotoxin) - pesticides, (DDT, BHC, Malathion)- Chemical poisons - First aid for Poison consumed victims.

Unit – III:

Food additives - artificial sweeteners- Saccharin - Cyclamate and aspartame. Food flavours - esters, aldehydes and heterocyclic compound. Food colours - Emulsifying agents-preservatives - leavening agents. Baking powder - yeast - taste makers - MSG vinegar.

Unit – IV:

Beverages - soft drinks - soda - fruit juices - alcoholic beverages. Carbonation - addiction to alcohol - diseases of liver and social problems.

Unit – V:

Fats, Oils - Sources of oils - Production of refined vegetable oils - Preservation. Saturated and unsaturated fats - iodine value - role of MUFA and PUFA in preventing heart diseases - determination of iodine value, RM value, saponification values and their significance.

References:

1. Swaminathan M., Food Science and Experimental foods, Ganesh and Company.
2. Jayashree Ghosh, Fundamental concepts of Applied chemistry, S. Chand & Co. Publishers.
3. Thangamma Jacob, Text Books of applied chemistry for Home Science and Allied Sciences, Macmillan.

MUSHROOM CULTIVATION

Course outcome:

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

Unit – I:

Introduction: Morphology, Types of Mushroom, identification of edible and poisonous mushroom, Nutritive values, life cycle of common edible mushrooms.

Unit – II:

Mushroom cultivation, prospects and scope of Mushroom cultivation in small scale Industry.

Unit – III:

Life cycle of Pleurotus spp and Agaricus spp.

Unit – IV:

Spawn production, growth media, spawn running and harvesting of mushrooms and marketing.

Unit – V:

Diseases and post harvest technology, Insect pests, nematodes, mites, viruses, fungal competitors and other important diseases.

References:

1. Handbook of Mushroom Cultivation. 1999. TNAU publication.

2. Marimuthu, T., Krishnamoorthy, A.S., Sivaprakasam, K. and Jayarajan. R. (1991). Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.

3. Swaminathan, M. 1990. Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.

4. Nita Bahl. 2002. Handbook on Mushroom 4th edition Vijayprimlani for oxford & IBH publishing co., Pvt., Ltd., New Delhi. Dr.C. Sebastian Rajesekaran Reader in Botany Bishop Heber College, Trichy – 17.

5. Suman. 2005. Mushroom Cultivation Processing and Uses, M/s. IBD Publishers and Distributors, New Delhi.

6. Sing. 2005. Modern Mushroom Cultivation, International Book Distributors, Dehradun.

7. Handbook of Edible Mushroom Today and Tomorrows printers and publishers.

8. Sharma V.P. 2006. Diseases and Pests of Mushrooms, M/s. IBD Publishers and Distributors, New Delhi.

9. Tewari, P and Kapoor, S.C.1988. Mushroom cultivation, Mittal Publications New Delhi.

10. Bahl, N. (1984-1988). Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

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 green gashouse effect on man and materials.

Unit – I:

Global Environmental change issues. UNFCC, IPCC, Koyoto 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.

AQUACULTURE

Course outcome:

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

Unit – I:

Aquaculture-Global scenario, Origins and growth of aquaculture, Present status in India and Tamil Nadu; Fish pond construction- site selection; types of ponds, water quality analyses, liming and fertilization, morphology and commercial characteristics of cultivable fishes, culture practice, predator fishes, weed fishes control, Sources of pollution, Environmental impacts.

Unit – II:

Fin fish culture - Composite fish culture (Indian Major Carps and Murrels); Sewage fed fish culture and integrated fish culture, Marine water fish culture. Shellfish and seaweed culture - Culture of marine prawns, edible and pearl oysters, adaptive management; Seaweeds- types and their culture practices.

Unit – III:

Live feed organisms – Artemia and rotifers culture; Fish feed - types, formulation and preparation, techniques, Consequences of artificial feeding; Natural, supplementary and artificial breeding; Breeding – Bundh breeding and induced breeding; rearing of hatchlings, fry and fingerlings.

Unit – IV:

Fungus infections. Protozoan diseases. Worm diseases. Non parasitic diseases. Transport of fish seed and Brood fish. Causes of mortality in transport. Methods for packaging and transport. Use of chemicals in live fish transport. Anesthetic drugs. Antiseptics and Antibiotics.

Unit – 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.

References:

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

VERMITECHNOLOGY

Course outcome:

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

Unit – 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 *Lampito maruitti*; Collection and Preservation of Earthworms; Flow sheet for vermi technology.

Unit – 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.

Unit – 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.

Unit – IV:

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

Unit – V:

Vermiwash and Economics - Chemical composition of vermiwash; Techniques of vermiwash production: Advantages of Vermicomposting; Prospects of vermi-culture as self employment venture.

References:

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.

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.

BASICS IN RESEARCH METHODOLOGY

Course outcome:

This course aims to inculcate a clear idea of research among students, understand the existing social issues in research, frame hypothesis, design the wet lab procedures and interpret the results.

Unit-I:

Objectives, Motivation to perform research. Types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.

Unit-II:

Basic concepts of Statistical sampling methods, Sample Size, Sampling Frame, Sampling Error, Characteristics of a good sample, Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages)

Unit –III:

Research Question & Investigation Question, Hypothesis, Qualities of a good Hypothesis, Features of a good research design, Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

UNIT IV:

Layout of a Research Paper, Journals in Life Science, Impact factor of Journals, Ethical issues related to publishing: Plagiarism and Self-Plagiarism. Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.

UNIT V:

Methods to search required information effectively, Reference Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Softwares for detection of Plagiarism.

References:

1. Research Methods for the Biosciences. Holmes, Moody & Dine. Oxford University Press.
2. Experimental Design for the Life Sciences. Ruxton & Colegrave. Oxford University Press.

3. C.R.Kothari Research methodology.
4. Robert A. Day (1998), How To Write & Publish a Scientific Paper. Oryx Press; 5 edition
5. Frank D. Bell (1995), Basic Biostatistics: Concepts for the Health Sciences. William C. Brown
6. Judith Bell. Doing your research, A guide for first-time researchers in education, health and social science. 4th edition. Open University press. McGraw Hill education (2005).
7. https://explorable.com/quantitative-research-design

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, BappcoPubisher,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 Tg, 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/

3. ----------