2023 T

DEPARTMENT OF BIOTECHONOLOGY
RAJAH SEFROJI GOVT. COLLEGE (AUTONOMOUS),
THANJAVUR-613005

FROM THE ACADEMIC YEAR
2023 - 2024

Syllabus for
B.Sc., Biotechnology

TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION, CHENNAI – 600 005

DEPARTMENT OF BIOTECHNOLOGY
RAJAH SERFOJI GOVERNMENT COLLEGE (Autonomous)
THANJAVUR-613005
BOARD OF STUDIES MEETING

The board of studies meeting for the Department of Biotechnology was conducted on **Monday (24.07.2023)** at **11:00 am** during the academic year 2022-2023 in the presence of the following board members under the chairmanship of **Dr. M. SUKUMARAN**

S.No	Name		Address	Signature
1	**Dr. M. SUKUMARAN**	Chairperson	Head, Department of Biotechnology	
2	**Dr. S. ACHIRAMAN**	University Representative Nominee	Professor Dept. of Environmental Biotechnology Bharathidasan University Tiruchirappalli-620024	24/7/23
3	**Dr. P. GANESH**	Subject Expert	Assistant Professor of Microbiology Faculty of Science Annamalai University Chidambaram-608003	24.07.23
4	**Dr. P. PONMANICKAM**	Subject Expert	Assistant Professor Dept. of Zoology, Ayya Nadar Janaki Ammal College, Sivakasi	ABSENT
5	**Dr. M. LOGANATHAN**	Industrialist	Associate professor and Head, IIFPT, Thanjavur-613005	24/7/23
6	**Mr. AJITH SIVASANGAR**	Meritorious Alumnus	Ph.D., scholar, Dept. of Human genetics and Molecular biology, Bharathiar University, Coimbatore	24/7/23
7	**Dr. J. RAJESH SINGH**	Faculty Member	Assistant Professor, Dept of Biotechnology	24/7/23
8	**Dr. K. GIRIJA**	Faculty Member	Guest Lecturer, Dept of Biotechnology	24/7/23
9	**Dr. A. SATHYA**	Faculty Member	Guest Lecturer, Dept of Biotechnology	24/07/23

The syllabi for B.Sc. Biotechnology (Major) under CBCS system were discussed and necessary corrections/modifications were made in the paper and finalized. The finalized syllabi are approved and appended herewith

CHAIRMAN

(M. SUKUMARAN)

AGENDA OF THE MEETING

The meeting of the Board of Studies in Biotechnology, for the Academic Year 2023-24, will be held on 24.07.2023 at 11:00 am at Department of Biotechnology, Rajah Serfoji Government College, Thanjavur-613 005

The following agenda will be discussed in the meeting:

1) Revamping of the syllabus for the I year

2) To discuss the new additions and changes in the existing curriculum for B.Sc., Programme applicable for the students admitted from 2023-2024 onwards.

3) To discuss the revision of the course outline of this programme incorporating the assessment pattern of these Course.

4) To discuss and approve the Course Outcomes and Learning Outcomes of individual subjects.

5) Panel of Question paper setters and Examiners.

6) Action plan of the Department for 2023-24 including Seminars.

7) Any other proposal with the permission of the chair.

Dr. M. Sukumaran
Chairperson, BoS and
Head, Department of Biotechnology

Minutes for Board of Studies in Biotechnology

The Board of Studies (BOS) meeting in Biotechnology subject is conducted in Department of Biotechnology, Rajah Serfoji Govt. College (Autonomous), Thanjavur on 24.07.2023 at 11.00 am. The Board members have discussed the agenda of the meeting and unanimously passed the following resolutions:

1. Discussions were made on the proposed Course Outcomes and Learning Outcomes of individual subjects.

2. Discipline Specific Major electives of the particular semester (5^{th} & 6^{th} semesters of the UG), unanimously resolved to give ratification for the introduction of the Extra Credit Courses for Advanced Learners which will be implemented from the present academic year itself.

3. To draft and approve the syllabus for the II and III years for the academic year 2023-24.

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B.Sc., Biotechnology

TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION, CHENNAI – 600 005

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

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	an open-minded and reasoned perspective. **PO9: Reflective thinking**: Critical sensibility to lived experiences, with self awareness and reflexivity of both self and society. **PO10 Information/digital literacy:** Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data. **PO 11 Self-directed learning**: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion. **PO 12 Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups. **PO 13: Moral and ethical awareness/reasoning**: Ability toembrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstratingthe ability to identify ethical issues related to one"s work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work. **PO 14: Leadership readiness/qualities:** Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way. **PO 15: Lifelong learning:** Ability to acquire knowledge and skills, including „learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.
Programme Specific Outcomes:	On successful completion of Bachelor of Physics with Computer Applications programme, the student should be able to: **PSO1: Disciplinary Knowledge:** Understand the fundamental principles, concepts, and theories related to physics and computer science. Also, exhibit proficiency in performing experiments in the laboratory. **PSO2: Critical Thinking:** Analyse complex problems, evaluate information, synthesize information, apply theoretical concepts to practical situations, identify assumptions and biases, make informed decisions and communicate effectively **PSO3: Problem Solving:** Employ theoretical concepts and critical reasoning ability with physical, mathematical and technical skills to solve problems, acquire data, analyze their physical significance and explore new design possibilities. **PSO4: Analytical & Scientific Reasoning:** Apply scientific methods, collect and

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	analyse data, test hypotheses, evaluate evidence, apply statistical techniques and use computational models. **PSO5: Research related skills:** Formulate research questions, conduct literature reviews, design and execute research studies, communicate research findings and collaborate in research projects. **PSO6: Self-directed & Lifelong Learning:** Set learning goals, manage their own learning, reflect on their learning, adapt to new contexts, seek out new knowledge, collaborate with others and to continuously improve their skills and knowledge, through ongoing learning and professional development, and contribute to the growth and development of their field.

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

24/7/2023

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2. Highlights of the Revamped Curriculum:

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

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Consolidated Semester wise and Component wise Credit distribution

Parts	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Total Credits
Part I	3	3	3	3	-	-	12
Part II	3	3	3	3	-	-	12
Part III	11	11	11	11	22	18	84
Part IV	6	6	6	7	3	3	31
Part V	-	-	-	-	-	1	1
Total	23	23	23	24	25	22	**140**

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

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

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First Year

Semester-I

Part	Course	Subject Code	List of Courses	Credit	Hours per week (L/T/P)	Exam Hours	Marks		Total
							Int.	Ext.	
I	LT1	T1T1	Tamil I	3	6	3	25	75	100
II	LE1	T1E1	English I (Written exam)	2	4	2	15	45	60
		T1E1P	English Practical	1	2	1	10	30	40
III	CC1	T1BT1	Cell and Molecular developmental biology	5	5	3	25	75	100
III	CC2	T1BT2	Cell and Molecular developmental biology practical	3	3	3	25	75	100
III	EC1	T1GBC1	Biochemistry -I	3	4	3	25	75	100
III	EC2	T2GBC1	Biochemistry practical	-	2	-	-	-	-
IV	SEC1	T1BTSE1	Aquaculture	2	2	3	25	75	100
IV	FC	BTFC	Introduction to Biotechnology	2	2	3	25	75	100
Total				**21**	**30**				

Semester-II

Part	Course	Subject Code	List of Courses	Credit	Hours per week (L/T/P)	Exam Hours	Marks		Total
							Int.	Ext.	
I	LT2	T2T2	Tamil- II	3	6	3	25	75	100
II	LE2	T2E2	English II (Written exam)	2	4	2	15	45	60
		T2E2P	English Practical	1	2	1	10	30	40
III	CC3	T2BT3	Genetics	5	5	3	25	75	100
III	CC4	T2BT4	Genetics Practical	3	3	3	25	75	100
III	EC2	T2GBC1	Biochemistry practical	3	2	3	25	75	100
III	EC3	T2GBC3	Biochemistry II	4	4	3	25	75	100
IV	SEC2	T2BTSE2	Vermitechnology	2	2	3	25	75	100
IV	SEC3	T2BTSE3	Mushroom cultivation	2	2	3	25	75	100
Total				**25**	**30**				

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Second Year

Semester-III

Part	Course	Subject Code	List of Courses	Credit	Hours per week (L/T/P)	Exam Hours	Marks		Total
							Int.	Ext.	
I	LT3	T3T3	Tamil III	3	6	3	25	75	100
II	LE3	T3E3	English II (Written exam)	2	4	2	15	45	60
		T3E2P	English Practical	1	2	1	10	30	40
III	CC5	T3BT5	Immunology and Immunotechnology	5	5	3	25	75	100
III	CC6	T3BT6	Immunology and Immunotechnology Practical	3	3	3	25	75	100
III	EC4	TBTECA	Fundamentals of microbiology I	3	4	3	25	75	100
III	EC5	TBTECB	Fundamentals of microbiology practical	-	2	-	-	-	-
IV	SEC4	T3BTSE4	Basics in Research Methodology	1	1	3	25	75	100
IV	SEC5	T3BTSE5	Food and bioprocess technology	2	2	3	25	75	100
IV	EVS	T4ES	Environmental Studies	-	1	-	-	-	-
Total				**20**	**30**				

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Semester-IV

Part	Course	Subject Code	List of Courses	Credit	Hours per week (L/T/P)	Exam Hours	Marks		Total
							Int.	Ext.	
I	LT4	T4T4	Tamil IV	3	6	3	25	75	100
II	LE4	T4E4 T4E2P	English IV (Written exam) English Practical	2 1	4 2	2 1	15 10	45 30	60 40
III	CC7	T4BT7	Genetic engineering and rDNA technology	4	4	3	25	75	100
III	CC8	T4BT8	Genetic engineering and rDNA technology practical	3	3	3	25	75	100
III	EC5	TBTECB	Fundamentals of microbiology(I&II) practical	3	2	3	25	75	100
III	EC6	TBTECC	Fundamentals of microbiology -II	4	4	3	25	75	100
IV	SEC6	T4BTSE6	Poultry science and management	2	2	3	25	75	100
IV	SEC7	T4BTSE7	Clinical nutrition and dietary management	2	2	3	25	75	100
IV	EVS	T4ES	Environmental Studies	2	1	3	25	75	100
Total				**26**	**30**				

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Third Year

Semester-V

Part	Course	Subject Code	List of Courses	Credit	Hours per week (L/T/P)	Exam Hours	Marks		Total
							Int.	Ext.	
III	CC9	T5BT9	Plant Biotechnology	4	6	3	25	75	100
III	CC10	T5BT10	Animal Biotechnology	4	6	3	25	75	100
III	CC11	T5BT11	Bioenterpreneurship	4	5	3	25	75	100
III	CC12	T5BT11	Plant Biotechnology and Animal Biotechnology practical	3	3	3	25	75	100
III	EC7	TGBC6	Enzymology	3	4	3	25	75	100
III	EC8	TBTECI	Cancer Biology	3	4	3	25	75	100
IV	VE	T5VE	Value Education	2	2	2	25	75	100
IV			Internship / Industrial Training	2	-	-	-	-	-
Total				**25**	**30**				

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Semester-VI

Part	Course	Subject Code	List of Courses	Credit	Hours per week (L/T/P)	Exam Hours	Marks		Total
							Int.	Ext.	
III	CC13	T6BT13	Environmental and Industrial biotechnology	5	6	3	25	75	100
III	CC14	T6BT14	Pharmaceutical Biotechnology	5	6	3	25	75	100
III	CC15	T6BT15	Environmental and Industrial Biotechnology Practical	4	4	3	25	75	100
III	EC9	TBTECE	Medical Biotechnology	3	6	3	25	75	100
III	EC10	TBTECH	Forensic Biotechnology	3	6	3	25	75	100
IV	PCS	T6BTPC	Professional Competency Skill	2	2	2	25	75	100
V			Extension Activity	1	-	-	-	-	-
Total				**23**	**30**				

Total Credits: 140

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nsolidated Semester wise and Component wise Credit distribution

Parts	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Total Credits
Part I	3	3	3	3	-	-	12
Part II	3	3	3	3	-	-	12
Part III	11	14	11	14	22	21	93
Part IV	4	4	3	5	4	2	22
Part V	-	-	-	-	-	1	1
Total	21	24	20	25	26	24	**140**

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

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Credits	5	Hours/Week	5	Sub Code	T1BT1	Semester	I
Medium of Instruction : English						Core Course : 1	

CC1- CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY

Learning Objective: On successful completion of the course, students will be able to		
LO1	Have an insight of the cell as the fundamental unit of life and to compare the structure of the Eukaryotic cell with the primitive prokaryotic cell	
LO2	Analyze the structure and obtain a strong foundation about the functional aspects of cell organelles and cell membrane.	
LO3	Study the structure and functions of Nucleic acid and discuss the molecular mechanism of Replication, Transcription and Translation and post translational modifications of proteins.	
LO4	Predict the response of cells to the intra and extracellular environment by studying about the intracellular signaling pathways.	
LO5	Understand the principles and molecular mechanisms involved in cellular differentiation, morphogenesis, growth and Potency of the cell.	
UNIT	**Contents**	**No. of Hours**
I	Discovery and diversity of cells - Cell theory - Structure of prokaryotic (bacteria) and eukaryotic cells (plant and animal cells).	10
II	Biomacromolecules and Biomicromolecules (Primary functions in the cell). Structure and Functions of Cell Organelles: Cell wall - Cell membrane - Cytoplasm - Nucleus - chromosomes -Endoplasmic reticulum - Ribosomes - Golgi bodies - Plastids - Vacuoles - Lysosomes - Mitochondria - Microbodies - Flagella - Cilia - Centrosome and Centrioles - Cytoskeleton.	20
III	Structure and functions of DNA and RNA -Central Dogma of the cell. DNA - Replication in prokaryotes - Transcription in Prokaryotes and Eukaryotes - RNA Processing - Genetic code- Translation - Similarities and differences in prokaryotic and eukaryotic translation - Post Translational Modifications - Protein Sorting - Protein degradation.	15
IV	Cell cycle - Cell cycle checkpoints - Cell division - Mitosis and Meiosis - Cellular differentiation - Cell junctions - Cell Adhesion - ExtraCellular Matrix - Cell to cell communications - Signal transduction - G - Protein Coupled Receptors Signal transduction pathways.	15

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V	Gametogenesis - Spermatogenesis and Oogenesis in mammals. Fertilization- Types of cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals- Organogenesis.	15
Total		75

Text Books

1	T. Devasena (2012), Cell Biology, Oxford University Press.
2	Gupta, Renu & Makhija, Seema & Toteja, Ravi. (2018). Cell Biology: Practical Manual.
3	Gilbert, S.F. 2016. Developmental Biology, 11th edition. Sinauer Associates Inc. Publishers, MA. USA.
4	Bruce Alberts, 6th Edition (2014). Molecular Biology of the cell, W. W. Norton & Company.
5	James D. Watson (2001), The Double Helix: A personal account of the Discovery of the Structure of DNA, Touchstone Publishers.

Reference Books

1	Karp's Cell and Molecular Biology: Concepts and Experiments. 8th Edition (2015). Wiley Publications.
2	James D. Watson, 7th Edition (2014), Molecular Biology of the Gene, Pearson Publications.
3	Geoffrey M. Cooper, 7th Edition (2015). The Cell: A Molecular Approach, Sinauer Associates, Qxford University Press.
4	Lodish Harwey, 6th Edition (2016), Molecular Cell Biology, W. H. Freeman Publications.
5	Wolpert L, Tickle C, 2015. Principles of Development, 5th edition, Oxford University Press.

Web Resources

1	http://www.cellbiol.com/education.php
2	https://global.oup.com/uk/orc/biosciences/cellbiology/wang/student/weblinks/ch16/
3	https://dnalc.cshl.edu/websites/
4	https://www.cellsignal.com/contents/science/cst-pathways/science-pathways
5	https://nptel.ac.in/courses/102/106/102106025/11.

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MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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Credits	3	Hours/Week	3	Sub Code	T1BT2	Semester	I
Medium of Instruction : English						Core Course : 2	

CC2- Practical I- CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY

Learning Objective		
LO1	Demonstrate the operation of Light Microscope	
LO2	Identify blood cells and its components	
LO3	Isolate and identify plant, and animal cells.	
LO4	Summarizes the concept of gametes	
LO5	Develop skill to perform cell fractionations.	
UNIT	**Contents**	**No. of Hours**
I	Components of a Compound / Light Microscope.	9
II	Blood smear preparation and Identification of Blood cells Buccal smear preparation and Identification of squamous epithelial cells.	9
III	Isolation and Identification of plant cells.	9
IV	Observation of sperm & Egg Mounting of chick Embryo - 24 hrs, 48 hrs, 72 hrs, 96 hrs. Types of placenta in mammals.	9
V	Cell fractionation and Identification of cell organelles (Demo)	9
Total		**45**

Text Books

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

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MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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Credits	5	Hours/Week	5	Sub Code	T2BT3	Semester	II
Medium of Instruction : English						Core Course : 3	

CC3- GENETICS

Learning Objective		
LO1	Learn about the classical genetics and transmission of characters from one generation to the next.	
LO2	Obtain a strong foundation for the advanced genetics.	
LO3	Explain the properties of genetic materials and storage and processing of genetic information.	
LO4	Acquire knowledge about the Mutagens, Mutations, DNA Repairs and Genetic disorders in human.	
LO5	Categories Eugenics, Euphenics and Euthenics and indepth Knowledge on population Genetics.	
UNIT	**Contents**	**No. of Hours**
I	Mendel's experiments, Monohybrid cross, Dihybrid cross, Backcross or Testcross, Mendel's laws. Incomplete dominance. Interaction of Genes- Epistasis -lethal genes. Multiple alleles – In Drosophila, Rabbit and Blood group inheritance in man.	15
II	Linkage - linkage in Drosophila- Morgan's experiments, factors affecting linkage. Crossing over- types, mechanism, significance of crossing over. Mapping of Chromosomes, interference and coincidence. Cytoplasmic inheritance -Carbon dioxide sensitivity in Drosophila and milk factor in mice. Sex –Linked Inheritance and Sex- Determination in Man.	15
III	Fine structure of the gene and gene concept, Operon Concept. Identification of the DNA as the genetic material- Griffith experiments, Avery, McLeod, McCarty and Hershey Chase experiment. Microbial Genetics- bacterial recombination, Conjugation, Transformation, Transduction and sex duction	15

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IV	Mutation – types of mutation, mutagens, DNA damage and Repair Mechanism. Chromosomal aberrations- Numerical and Structural, Pedigree Analysis-Mendelian inheritance in human. (Cystic Fibrosis, Muscular Dystrophy)	15
V	Population Genetics– Hardy Weinberg principle, gene frequency, genotype frequency and factors affecting gene frequency. Eugenics. Euphenics and Euthenics.	15
Total		75
Text Books		
1	Dr. Veer Bala Rastogi, 2020, Elements of Genetics, 11 th Revised & Enlarged Edition, Kedar Nath Ram	
2	Nath Publications, Meerut, 250001. www.knrnpublications.com, ISBN-978-81-907011-2-9	
3	Verma, P.S. and Agarwal, V.K., 1995. Genetics, 8th edition, S.Chand & Co., New Delhi – 10055.	
4	Verma, P.S., and Agarwal, V.K., 1995. Cell and Molecular Biology, 8th edition, S.Chand and Co., New Delhi, 110055.	
Reference Books		
1	Gardener E.J. Simmons M.J. Slustad D. P. 2006. Principles of Genetics	
2	Lewis, R.2001. Human Genetics- Concepts and application. 4th edition. McGraw Hill.	
3	Griffiths, Miller, J.H., An Introduction to Genetic Analysis W.H.Freeman. New York.	
4	Winter, P.C., Hickey, G.J. and Fletcher, H.L.2000. Instant notes in Genetics. Viva books, Ltd	
5	Good enough U. 1985. Genetics. Hold Saunders international.	
Web Resources		
1	https://nptel.ac.in/courses/102/106/102106025/	

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

MAPPING WITH PROGRAMME OUTCOME AND PROGRAMME SPECIFIC OUTCOME

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

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Credits	3	Hours/Week	3	Sub Code	T2BT4	Semester	II
Medium of Instruction : English						Core Course : 4	

CC4- Practical II- Genetics

Learning Objective		
LO1	Demonstrate the basic principles of important techniques in Molecular biology and Genetics.	
LO2	Analyze the Polytene chromosome of the organisms	
LO3	Identify Barr bodies from Buccal smear	
LO4	Demonstrate the Preparations and maintenance of culture medium	
LO5	Demonstrate Human karyotyping	
UNIT	**Contents**	**No. of Hours**
I	Mitotic stages of onion (*Allium cepa*) root tip Meiotic stages of cockroach testes/ Flower bud	9
II	Giant chromosomes from Chironomus larvae/ Drosophila salivary glands	9
III	Identification of Barr bodies from Buccal smear	9
IV	Preparations of culture medium and culture of Drosophila – methods of maintenance Identifications of mutants of Drosophila	9
V	Human karyotyping (Demo)	9
Total		45
Text Books		
1	Practical Manual on "Fundamentals of Genetics" (PBG-121). 2019, Edition: First Publisher: Odisha University of Agriculture & Technology. Editor: Kaushik Kumar Panigrahi	

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MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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SEMESTER –III

Credits	5	Hours/Week	5	Sub Code	T3BT5	Semester	III
Medium of Instruction : English						Core Course : 5	

CC5- IMM MUNOLOGY AND IMMUNOTECHNOLOGY

Learning Objective		
LO1	Explain the role of immune cells and their mechanism in body defense mechanism.	
LO2	Demonstrate the antigen –antibody reactions in various immune techniques.	
LO3	Gain new insights into Antigen -Antibody interactions and to demonstrate immunological techniques.	
LO4	Gain knowledge of production of vaccines.	
LO5	Apply the knowledge of immune associated disease, hypersensitivity reactions.	
UNIT	**Contents**	No.of Hours
I	Introduction to Immunology. Cells involved in immune response. Primary and Secondary lymphoid organs – Thymus, Bone marrow, Lymph nodes and Spleen. Hematopoiesis – development of B and T lymphocytes. Types of immunity – Innate and acquired.	15
II	Antigen: Characteristics and types. Antibody – Structure, Types, Properties and their Biological Function. Production of antibodies- Hybridoma technology: Applications of Monoclonal antibodies in biomedical research.	15
III	Antigen – Antibody interactions, Immunodiffusion and Immuno electrophoresis. Principle and application of ELISA and RIA and Flourescent antibody technique and Western Blotting. Purification of antibodies.	15
IV	The complement system and activation and regulation. Types – Classical, alternative and Lectin pathway. Biological function of C' proteins. Cytokines- Structure and Function. Vaccines – Types, Production and application.	15

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V	Hypersensitivity Reactions and Types. Major Histocompatability Complex – MHC genes, MHC in immune responsiveness, Structure and function of Class I and Class II MHC molecules. HLA tissue typing.	15
Total		**75**
Text Books		
1	Thomas J. Kindt, Barbara A. Osborne and Richard A Goldsby, 2006. Kuby Immunology. 6th edition, W. H . Freeman and Company.	
2	Kannan, I., 2010. Immunology. MJP Publishers, Chennai	
3	Abbas, A.K., A.H.L., Lihtman and S. Pillai, 2010. Cellular and Molecular Immunology, 6th Edition. Saunders Elsevier Publications, Philadelphia	
4	NandiniShetty, 1996, Immunology : introductory textbook – I. New Age International, New Delhi.	
5	Fahim Halim K.,2009. The Elements of Immunology. Pearson Education.	
Reference Books		
1	Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, 2011. Roitt.s Essential Immunology, 12th edition, Wiley- Blackwell. USA.	
2	Janeway Travers. (1997). Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York. 3rd Edition.	
3	William R Clark. (1991). The Experimental Foundations of Modern Immunology. 3rdEdition. John Wiley and Sons Inc. New York.	
4	Frank C. Hay, Olwyn M. R. Westwood. (2002). Practical Immunology, 4thEdition., Wiley-Blackwell.	
5	Noel R. Rose, Herman Friedman, John L. Fahey. (1986). Manual of Clinical Laboratory Immunology. ASM.3rd Edition	
Web Resources		
1	https://www.ncbi.nlm.nih.gov/books/NBK279395/	

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2	https://med.stanford.edu/immunol/phd-program/ebook.html
3	https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/
4	Immunology Overview - Medical Microbiology - NCBI Bookshelf (nih.gov)
5	Immunology - an overview | Science Direct Topics

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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Credits	3	Hours/Week	3	Sub Code	T3BT5	Semester	III
Medium of Instruction : English						Core Course : 6	

CC6-PRACTICAL III - IMMUNOLOGY AND IMMUNOTECHNOLOGY

Learning Objective		
LO1	Perform blood grouping and determine blood type.	
LO2	Able to count WBC and RBC.	
LO3	Conduct serological diagnostic tests such as ASO, CRP, RA and Widal test.	
LO4	Acquire technical skills required for immunodiffusion and know the principle behind the techniques.	
LO5	Able to Demonstrate ELISA, Handling of Laboratory animals.	
UNIT	**Contents**	**No. of Hours**
I	Separation of Serum and Plasma. Blood grouping and Rh typing.	9
II	WBC counting RBC counting Differential blood count	9
III	WIDAL Slide test ASO test	9
IV	Double Immunodiffusion Single Radial Immunodifusion	9
V	ELISA – Demonstration Handling of Laboratory animals - Demonstration Skin test – Demonstration	9
Total		**45**
Text Books		

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

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MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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SEMESTER –IV

Credits	4	Hours/Week	4	Sub Code	T4BT7	Semester	IV
Medium of Instruction : English						Core Course : 7	

CC7- Genetic Engineering and rDNA Technology

Learning Objective		
LO1	Demonstrate the basic principles of genetic engineering techniques and illustrate the specificity of vectors for cloning and advantages.	
LO2	Enumerate various recombinant techniques and gene probes and molecular markers identification.	
LO3	Understand Gene transfer techniques by Viral and Nonviral mediated gene transfer mechanisms.	
LO4	Exhibit knowledge in sequencing technologies and protein engineering techniques.	
LO5	Explore the strategies of Recombinant DNA Technology in r medicine, Industry and agriculture.	
UNIT	**Contents**	**No. of Hours**
I	Genetic Engineering – Introduction. Tools in recombinant DNA technology – recombinant DNA – cloning strategies (enzymes, vectors, host) – introduction of rDNA into host cells.	15
II	Identification of recombinants, selection and screening for Recombinants. DNA sequencing – Construction of Genomic DNA library and cDNA library), Chromosome walking. Human Genome Project. Polymerase Chain reaction- Methodology and its Types.	15
III	Gene transfer techniques – Viral mediated gene transfer, Selectable markers and reporter genes - Non viral mediated gene transfer - Physical methods: Microinjection - Electroporation - Particle Bombardment, Chemical methods: Calcium phosphate - DEAE dextran - Liposomes.	15
IV	Gene Expression – Expression system and their applications - protein based	15

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	products – Protein engineering– production of protein from cloned genes. Site directed Mutagenesis, Restriction Fragment Length Polymorphism (RFLP).	
V	Application of Recombinant DNA technology in medicine, industry, agriculture and r-DNA technology - merits and demerits.	15
Total		**75**

Text Books	
1	Brown T.A, 2015. Gene Cloning and DNA Analysis: An Introduction, 7th edition, Wiley - Blackwell.
2	Desmond S.T. Nicholl, 2008. An Introduction to Genetic Engineering, 3rd edition, Cambridge university press.
3	R.W. Old & S.B. Primrose, Principles of Gene Manipulation, Fifth Edition, Blackwell Science.
4	Genetic Engineering Principles and Methods by Setlow, Jane K. (Volume 24).
5	Keya Chaudhuri, 2012. Recombinant DNA Technology.
Reference Books	
1	David Clark Nanette Pazdernik Michelle McGehee (2018), *Molecular Biology techniques*,(3rd edition).
2	Anton Byron (2019), *Introduction to Gene Cloning,* Publisher: Oxford Book Company
3	Monika Jain (2012), *Recombinant DNA technology*, (I edition), Alpha Science International. ISBN-13 : 978-1842656679.
4	Primrose.S.B (2014), *Principles of gene manipulation*, (7th edition), Blackwell Scientific limited, Germany. ISBN: 978-1-405-13544-3
Web Resource	
1	https://www.britannica.com/recombinant-DNA-technology
2	https://www.le.ac.uk/recombinant-dna-and-genetic-techniques

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3	https://www..ncbi.nlm.nih.gov

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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Credits	3	Hours/Week	3	Sub Code	T4BT8	Semester	III
Medium of Instruction : English						Core Course : 8	

CC8- Practical IV- Genetic Engineering and rDNA Technology

Learning Objective		
LO1	Isolate the Plasmid DNA and Genomic DNA. and predict the molecular weight of DNA by agarose gel electrophoresis.	
LO2	Demonstrate working principles of PCR, RFLP and other important Genetic Engineering techniques.	
LO3	Prepare the competent cells and perform bacterial transformation.	
LO4	Determine the restriction digestion of DNA	
LO5	Determine the restriction fragment length polymorphism.	
UNIT	**Contents**	**No. of Hours**
I	Isolation of genomic DNA Isolation of plasmid DNA	9
II	Isolation of RNA	9
III	Production of competent cells for transformation Bacterial transformation	9
IV	Restriction Digestion of DNA	9
V	Restriction Fragment Length Polymorphism(DEMO) PCR(Demonstration)	9
Total		**45**
Text Books		
1	Laboratory Manual for GENETIC ENGINEERING 1st Edition, Kindle Edition by S. JOHN VENNISON (Author) 2009.	

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MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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SEMESTER –V

Credits	4	Hours/Week	6	Sub Code	T5BT9	Semester	V
Medium of Instruction : English						Core Course : 9	

CC9- PLANT BIOTECHNOLOGY

Learning Objective		
LO1	Explore the history of Biotechnology and state the importance of organization of plant genome	
LO2	Be acquainted with the molecular basis of action of plant hormones and gene expression	
LO3	Illustrate about various culture medium preparations, haploid, triploid plant production an its applications	
LO4	Exploit symbiotic organisms as a vector for gene transfer to produce transgenic plants	
LO5	Develop molecular technique skills for crop improvement.	
UNIT	**Contents**	**No.o Hou**
I	History of plant biotechnology, Conservation of Plant using Biotechnology. Plant genome organization: structural features of a representative plant gene, gene families in plants. Organization of chloroplast genome and mitochondrial genome.	15
II	Auxins, cytokinins and gibberlins – molecular basis of action – phytochrome – role in photomorphogeneisis – abscisic acid – and stress – induced promoter switches in the control of gene expression – Ethylene and fruit ripening.	15
III	Media composition (MS media) - Micropropagation techniques - direct and indirect organogenesis - somoclonal variation - somatic embryogenesis - haploid and triploid - Protoplast isolation, fusion and culture - hybrid and cybrid production, Synthetic seed production. Secondary metabolite production.	15
IV	Agrobacterium and crown gall tumors – Mechanism of T-DNA transfer to plants, Tiand Ri Plasmid vectors and their utility – Plant viral vectors. Symbiotic nitrogen fixation in Rhizobia, nif gene.	15

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V	Crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors. Transgenic plants- plant vaccines, genetically modified food - future perspectives & ecological impact of transgenic plants.	15
Total		75

Text Books	
1	Sudhir, M. 2000. Applied Biotechnology and plant Genetics. Dominant publishers and distributors.
2	Trivedi, P.C.2000. Applied Biotechnology: Recent Advances. PANIMA Publishing corporation.
3	Ignacimuthu. 1996. Applied Plant Biotechnology. Tata McGraw – Hill.
4	Narayanaswamy S. 1994. Plant cell and tissue culture. Tata McGraw Hill Publishing Company limited, New Delhi.
5	Chawla, H.S., "Introduction to Plant Biotechnology", 3rd Edition, Science Publishers, 2009.
Reference Books	
1	Kojima, Lee, H. and Kun, Y. 2001. Photosynthetic microorganisms in Environmental Biotechnology. Springer – Verlag.
2	Stewart Jr., C.N., "Plant Biotechnology and Genetics: Principles, Techniques and Applications" Wiley-Interscience, 2008.
3	Heldt HW. Plant Biochemistry & Molecular Biology, Oxford University Press. 1997.
4	Trigiano, R.N. and Gray, D.J. 1996. Plant tissue culture concepts and laboratory exercise. CRC Press. BocaRatin, New York.
5	Street, H.E. 1977. Plant tissue culture. Blackwell Scientific Publications, oxford, London.
Web Resources	
1	https://nptel.ac.in/courses/102103016
2	https://science.umd.edu/classroom/bsci124/lec41.html
3	https://www.nifa.usda.gov/grants/programs/biotechnology-programs/plant-biotechnology
4	http://mydunotes.blogspot.com/p/plant-biotechnology.html

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5	https://nptel.ac.in/courses/102103016

MAPPING WITH PROGRAMME OUTCOME AND PROGRAMME SPECIFIC OUTCOME

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

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Credits	4	Hours/Week	6	Sub Code	T5BT10	Semester	V
Medium of Instruction : English						Core Course : 10	

CC10- ANIMAL BIOTECHNOLOGY

Learning Objective		
LO1	Understand the basic concepts of Animal cell culture and cell laboratory	
LO2	Describe the media preparation, preservation, trypsinization, counting, maintenance and application of cell lines.	
LO3	Discuss the strategies for gene transfer and gene expressions with their applications.	
LO4	Be acquainted with genetic modification and stem cell technology in production of transgenic animals.	
LO5	Learn the Assisted reproductive technology and its applications.	
UNIT	**Contents**	**No.of Hours**
I	Animal cell culture – History and development, Pluripotency, Media, balanced salt solutions, Physical, chemical and metabolic functions of constituents of culture media, Role of carbon dioxide, Serum, growth factors and amino acids in media. Serum containing and serum free media. Constitution of a media for cell line. Essential equipments required for animal cell culture.	15
II	Types of cell culture- Primary, Secondary, Organ culture and cell lines. Role of feeder layers in cell culture, Cell separation techniques, cell synchronization, Cell counting methods, cryopreservation, Cell banking procedures. Biology of cultured cells- Apoptosis and cell death.	15

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III	Transfection of cells in culture- Animal viral vectors for transfection, Physical methods of transfection, HAT selection, selectable markers. Micro manipulation of cells, Gene targeting, gene silencing and Gene knockout and their applications.	15
IV	Protein production by genetically engineered mammalian cell lines, Stem cells and their applications-; Cell culture as a source of valuable products -Transgenic Animals.	15
V	Collection and preservation of embryos, Semen banking, AI, IVF and ICSI. Case Study-any two relevant studies.	15
Total		**75**

Text Books

1	Ramasamy.P. 2002.Trends in Biotechnology, University of Madras of Publications. Pearl Press
2	Ignacimuthu. 1996. Basic Biotechnology. Tata McGraw-Hill.
3	K. Srivastava *et al.*, 2009, Animal Biotechnology, Oxford & IBH Publishing Co. Pvt. Ltd.
4	B.C. Currell *et al.*, 1994, In vitro Cultivation of Animal Cells (Biotol), Butterworth-Heinemann Ltd.
5	Jenkins, N. (ed). 1999 Animal cell Biotechnology: Methods and protocols. Humana press, New Jesey.

Reference Books

1	R. Ian Freshney, Culture of Animal cells – A Manual of Basic Technique Fourth Edition, WILEY LISS & Publications.

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2	Glick, B.R. and Pasternark. 2002. Molecular Biotechnology: Principle and applications of recombinant DNA.
3	Kreuzer, H. and Massey, A. 2001. Recombinant DNA and Biotechnology: A guide for teachers. 2nd edition. ASM Press Washington.
4	Traven. 2001. Biotechnology. Tata McGraw – Hill.
5	Walker,J.M. and Gingold, E.B. 1999.Molecular biology and Biotechnology. 3rd edition. Panima Publishing Corporation.
Web Resources	
1	http://ecoursesonline.iasri.res.in/course/view.php?id=350
2	https://microbenotes.com/animal-cell-culture/
3	https://biocyclopedia.com/index/biotechnology/animal_biotechnology/manipulation_of_reproduction_and_transgenic_animals/biotech_in_vitro_fertilization_technology.php
4	https://thebiologynotes.com/embryo-transfer/
5	https://people.ucalgary.ca/~browder/transgenic.html

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MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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Credits	4	Hours/Week	5	Sub Code	T5BT11	Semester	V
Medium of Instruction : English						Core Course : 11	

CC11- BIOENTREPRENEURSHIP

Learning Objective		
LO1	Students will be able to identify the challenges of being a Bioentrepreneur	
LO2	Will understand the Business proposal for starting a company	
LO3	Will learn about Vermicomposting and Sericulture	
LO4	Will aspire to set up Mushroom Cultivation	
LO5	Will learn the technique of Single cell protein Cultivation	
UNIT	**Contents**	**No.of Hours**
I	Basics of Bio entrepreneurship -Biotechnology in a Global scale; types of Bio-industries – Biopharma, Bioagri and Bioservice innovations – Successful Entrepreneur – Creativity, Leadership, Managerial skills, Team building, Decision making; Public and private funding agencies (MSME, DBT, BIRAC, Startup & Make in India)	15
II	Business plan preparation; business feasibility analysis by SWOT, business plan proposal for virtual startup company; statutory and legal requirements for starting a company/venture; basics in accounting practices. Market Conditions, Identifying the need of the customers.	15
III	Vermicomposting–Earthworms-Ecologicaltypes-Vermiculture-Compostpit-Vermibed-applications. Sericulture-Mulberrycultivation-SilkwormRearing-Economicsofsilkworm Production-Chawki Rearing-Sericulture in India.	15

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IV	Phases of Mushroom Cultivation; Selection of an acceptable mushroom species/strains, Management of mushroom development, Mushroom harvesting; Mushroom diseases, Medicinal and Nutritional properties of mushroom. Aquaponics- Systems-Fish and Vegetables-Nutrients and Biofilters-Advantages and Disadvantages.	15
V	Single Cell Protein Production: Source: Algae, Bacteria, Yeast – Cultivation of Single Cell protein: SPIRULINA Cultivation – Production site, Microorganism, Experimental design; harvesting and Drying.	15
Total		75
Text Books		
1	Shimasaki, C. D. (2014). Biotechnology entrepreneurship: Starting, managing, and leading biotech companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.	
2	Onetti, A., & Zucchella, A. (n.d.). Business modeling for life science and biotech companies: Creating value and competitive advantage with the milestone bridge. Routledge.	
3	The Earthworm book,Ismail,S.A.,other India Press,Goa	
4	An Introduction to sericulture by G.Ganga,J.Sulochana Chetty.	
5	Silk: Processing, Properties and Applications Book by K. Murugesh Babu	
Reference Books		
1	Adams, D. J., & Sparrow, J. C. Enterprise for life scientists: Developing innovation and entrepreneurship in the biosciences. Bloxham: Scion.	
2	Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.	

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3	Desai, V.The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.
4	The Essential Guide to Cultivating Mushrooms: Simple and Advanced Techniques for Growing Shiitake, Oyster, Lion's Mane, and Maitake Mushrooms at Home by Stephen Rusell
5	Neutraceutical spirulina: Commercial cultivation using rural technology in india by Pushpa Srivastava
Web Resources	
1	https://archive.india.gov.in › citizen › agriculture
2	http://www.recirculatingfarms.org/resources/
3	https://academy.vertical-farming.net/intro-to-mushroom-growing/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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Credits	3	Hours/Week	3	Sub Code	T5BT12	Semester	V
Medium of Instruction : English						Core Course : 12	

CC12- Practical V- PLANT BIOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY

Learning Objectives		
LO1	Explain plant tissue culture and Illustrate Callus development.	
LO2	Develop technical skills in Protoplast isolation and Nucleus localization.	
LO3	Make use of the techniques used in preparing tissue culture medium and membrane filtration in culturing animal cells and prepare single cell suspension and evaluate cell counting and viability.	
LO4	Develop technical skills in isolation of DNA and RNA from plants and microorganisms.	
LO5	Examine the importance of trypsinization in monolayer and subculture and cryopreservation.	
UNIT	**Contents**	**No. of Hours**
I	Plant tissue culture media preparation & sterilization techniques. Callus induction	9
II	Isolation of plant protoplast & viability test. Localization of nucleus using nuclear stain.	9
III	Preparation of Animal Tissue culture medium and membrane filtration Preparation of Single Cell Suspension & Cell counting Cell viability Test	9

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IV	Isolation of plant DNA and plant RNA(Demo) Isolation of Agrobacterium plasmid DNA (Demo)	9
V	Trypsinization of monolayer and subculturing (Demo) Measurement of phagocytic activity (Demo) MTT Assay (Demo) Cryopreservation and thawing (Demo)	9
Total		45

Text Books

1	Madhavi Adhav, 2009, Practical Biotechnology and Plant Tissue Culture, S.Chand & Company Ltd.
2	C. C. Giri, Archana Giri, 2007, Plant Biotechnology: Practical Manual, I.K. International Pvt Ltd.
3	Karl-Hermann Neumann, Ashwani Kumar, Jafargholi Imani, 2009, Plant Cell and Tissue Culture - A Tool in Biotechnology: Basics and Application, Springer.
4	Debajit Borah (2018), *Environmental Biotechnology Theory and Lab Practices*, (2nd edition), Hardcover – Global Vision Publishing House, ISBN: 9788182205840

Reference Books

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

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Web Resources	
1	https://www.plantcelltechnology.com/pct-blog/different-types-of-tissue-culture-processes/
2	https://www.thermofisher.com/in/en/home/references/gibco-cell-culture-basics.html

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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Credits	3	Hours/Week	4	Sub Code	TGBC6	Semester	V
Medium of Instruction : English						Elective Course : 7	

EC7- ENZYMOLOGY

Learning Objective		
LO1	The students will learn the Fundamentals of Enzymology.	
LO2	The students will study about the characteristic features of Enzymes.	
LO3	The student will know about the details of Enzyme Kinetics.	
LO4	The student will apply the biochemical techniques for enzyme isolation	
LO5	The Student will understand the process of Immobilization of enzymes . Enzyme engineering and Designer enzymes in various Industrial purposes.	
UNIT	**Contents**	**No. of Hours**
I	Nomenclature and classification of enzymes according to the International Union of Biochemistry and Molecular Biologists Convention. Properties of enzymes and factors that influence rate of enzyme action (pH, temperature, substrate concentration, enzyme concentration, activators and inhibitors). Definitions - Apoenzyme, holoenzyme, zymogens. Coenzymes – (Vitamin and Non vitamin origin). Transition state theory, standard free energy, activation energy.	15
II	Active site (definition, characteristic features), Enzyme specificity. Bisubstrate and multisubstrate reactions. ES complex formation, lock and key model and induced fit model. Enzyme units - IU & Katal. Turnover number. Isoenzymes (LDH & CPK), Definition – Ribozymes & Abzymes.	15

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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.	15
IV	Membrane bound proteins – Fluid mosaic model. Extraction of enzymes – Chemical agents and Physical methods of extraction, French pressure cell and ultrasonication. Nature of the extraction medium. Technique for enzyme isolation, separation of cellular organelles by differential centrifugation, purification of enzymes- dialysis, chromatography, electrophoresis. Intracellular localization of enzymes and marker enzymes.	15
V	Immobilization of enzymes- Chemical and Physical methods. Clinical and industrial applications of immobilized enzymes. Enzyme engineering and Designer enzymes. Pharmaceutical, Clinical and Industrial uses of enzymes.	15
Total		75

Text Books

1	Satyanarayana. U. 2013. Biochemistry.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

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CONTROLLER OF EXAMINATIONS
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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.
Web Resources	
1	https://www.youtube.com/watch?v=AD3-v1oKjSk
2	https://www.youtube.com/watch?v=tPCOEUo6J8s
3	https://www.youtube.com/watch?v=ALwziZSRiqM
4	https://www.youtube.com/watch?v=0ZiCqwtFMTs
5	

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MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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Credits	3	Hours/Week	4	Sub Code	TBTECI	Semester	V
Medium of Instruction : English						Elective Course : 8	

EC8- CANCER BIOLOGY

Learning Objective		
LO1	The students will understand the Basics of Cancer Biology.	
LO2	The students will comprehend the Cancer at the Molecular level.	
LO3	The students will learn about the types of Cancer.	
LO4	The students will realize the different techniques of Detection and Treatment of Cancer.	
LO5	The students will know about the Prevention of Cancer.	
UNIT	**Contents**	**No.of Hours**
I	Cancer: Introduction; Origin of Cancer- The Mutation Concept, The Epigenetic Concept, Viral Concept, Unified genetic concept of cancer; Difference between Normal and Cancer cells; Signs and symptoms.	15
II	Cancer as a genetic disease; Genetic Alterations in Cancer cells, Point mutation, splice mutation, alternate splicing; Mutation in regulatory sequences, deletions, Insertion, Chromosome abnormalities, Genetic defects and the time course of hereditary cancer.	15
III	Types of Cancer: - Blood & Lymph – Leukemia, Malignant lymphoma, Bone- Soft tissue Sarcoma, Thorax- Breast cancer, Male genitalia- Prostate cancer, Female genitalia- Cervical cancer; Tumor suppressor genes; Classification of	15

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	Tumor suppressor genes.	
IV	Detection and Treatment:- Early detection, Molecular detection of Carcinomas, Cancer warning signals; Markers in blood urine; Therapies- Chemotherapy, Gene therapy, Radiotherapy, Biological therapy(Immuno therapy).	15
V	Prevention:- Tobacco smoking, sunlight, diet, ionizing radiation, alcohol drugs, promiscuity, lifestyle and cancer prevention, Environmental factors and cancer, potentially carcinogenic substances for humans.	15
Total		**75**

Text Books

1	A. Sarkar, 2011, Biology of Cancer, Discovery Publishing House, New Delhi.
2	Ranajit Sen,2004, Principles and Management of Cancer, B.I. Publications Pvt Ltd, New Delhi.
3	Dr M.R.Ahuja, 1997, Cancer- Causes and Prevention, UBS Publishers Distributors Pvt. Ltd.
4	A. Sarkar, 2011, Biology of Cancer, Discovery Publishing House, New Delhi.
5	Ranajit Sen,2004, Principles and Management of Cancer, B.I. Publications Pvt Ltd, New Delhi.

Reference Books

1	Francesco Pezzella, Mahvash Tavassoli, David J. Kerr, 2019, Oxford Textbook of Cancer Biology, Oxford University Press
2	Albert DeNittis, MD, Joel W. Goldwein, MD, and Thomas J. Dilling, MD, 2002, The

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	Biology of Cancer.
3	Robin Hesketh, 2012, Introduction to Cancer Biology, Cambridge University Press
4	Francesco Pezzella, Mahvash Tavassoli, David J. Kerr, 2019, Oxford Textbook of Cancer Biology, Oxford University Press
5	Albert DeNittis, MD, Joel W. Goldwein, MD, and Thomas J. Dilling, MD, 2002, The Biology of Cancer.
Web Resources	
1	http://csbl.bmb.uga.edu/mirrors/JLU/DragonStar2017/download/introduction-to-cancer-biology.pdf
2	http://webserver1.oneonta.edu/faculty/bachman/cancer/207lectures.htm

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MAPPING WITH PROGRAMME OUTCOMESAND PROGRAMME SPECIFIC OUTCOME

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

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Credits	5	Hours/Week	6	Sub Code	T6BT13	Semester	VI
Medium of Instruction : English						Core Course : 13	

CC13- ENVIRONMENTAL AND INDUSTRIAL BIOTECHNOLOGY

Learning Objective		
LO1	Know about the environment, its issues and management of the environment.	
LO2	Explain the process of waste water treatment, drinking water treatment and solid waste management in various industries.	
LO3	Illustrate the significance of bioreactors in bioprocess engineering and culture methods.	
LO4	Explain Downstream processing, Fermented Products production and advanced methods	
LO5	Speculate the role and importance of microorganisms behind the ore leaching, production of food products and Biofertilizers.	
UNIT	**Contents**	**No. of Hours**
I	Environmental Pollution – Sources and types - Water, Air, Thermal, Industrial and Radiation - Global environmental changes. Global warming, Greenhouse effect, acid rain, ozone depletion, and photochemical smog. Environmental issues, management strategies and safety, Biotechnological approaches for management.	15
II	Waste water treatment: Aerobic and anaerobic methods (Primary, Secondary and Tertiary) –Use of aquatic plants in waste water treatment. Solid waste management. Bioenergy and SCP from waste. Drinking water treatment. Biotechnological approach to industrial effluent (Paper, Tannery, Textile) Pesticide waste disposal.	15

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III	Bioprocess Engineering-Steps in bioprocess development. Design of bioreactors - Basic objective of fermenter design, aseptic operation & containment, body construction, agitator and sparger design, baffles, stirrer glands and bearings. Bioreactor configurations and types: Bubble column, airlift reactor, packed bed, fluidized bed, trickle bed, Membrane reactor, Photobioreactor, Animal and plant cell bioreactors. Factors affecting broth viscosity, Mixing in Fermenters. Fermentation systems Batch culture, Continuous culture, Fed-batch culture,	15
IV	Downstream processing Filtration, Centrifugation, Cell disruption, Liquid-liquid extraction, Chromatography, membrane processes, Drying, Crystallization, Whole broth processing. Different types of fermented foods produced from microorganisms- Idli, Sauerkraut - Dairy products- Cheese and Yoghurt. Microbial biomass, Microbial enzymes– Amylase & protease, Immobilization of enzymes: Methods, Properties, Applications, Advantages and Disadvantages of Immobilization, Biosensors and Biochips -Types and applications. Microbial Polysaccharide production: Xanthan, Dextran.	15
V	Ore leaching (methods and examples), MEOR, Production of antibiotics – Penicillin - streptomycin. Alcoholic beverages: Wine, Beer – Biofertilizers- Rhizobium & Azotobacter. Biopesticides – *Bacillus thuringiensis* and microbial toxin production and their applications - Biosurfactants, Vitamins- Folic acid & Vitamin B12, Organic acids.	15
Total		75

Text Books

1	Chatterji, A.K., 2002. Introduction to Environmental Biotechnology, Prentice-Hall of India, New Delhi.
2	Anil Kumar De., 2000. Environmental Chemistry, 4th Edition. New Age International, New Delhi.
3	Murugesan, A G., Rajakumari, C., 2005. Environmental Science and Biotechnology

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	Theory and Techniques., MJP publishers, Chennai.
4	T.Satyanarayana, Bhavdish Narain Johri,Anil Prakash (2012), Microorganisms in Sustainable Agriculture and Biotechnology.
5	Madigan, Michael and Martinko, John. Brock biology of microorganism, 11th edition. (2005).
Reference Books	
1	Alan Scragg. 1999. Environmental Biotechnology, Pearson Education Limited, England,
2	Peter F. Stanbury, Allan Whitaker, Stephen J. Hall (2013). Principles of Fermentation Technology Second Edition, Elsevier Science Ltd
3	Michael J. Waites, Neil L. Morgan, John S. Rockey Gary Higton (2001.), Industrial Microbiology: An Introduction. . Blackwell Science Ltd
4	Nduka Okafor, Modern Industrial Biotechnology & Microbiology ((**2017**, Science Publishers, Edenbridge Ltd.
5	Waites, Morgan, Rockey and Higton, Industrial Microbiology: An Introduction, Blackwell Science (2001).
Web Resources	
1	https://nptel.ac.in/courses/120/108/120108004/
2	https://www2.hcmuaf.edu.vn/data/quoctuan/Environmental%20Biotechnology%20-%20Theory%20and%20Application,%20G%20M%20Evans%20&%20J%20C%20Furlong.pdf
3	www. Prenhall.com/Madigan

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CONTROLLER OF EXAMINATIONS
RAJAH SERFOJI GOVERNMENT COLLEGE (AUTONOMOUS)
THANJAVUR - 613 005.

4	www.e-bug.eu/
5	www.microbeworld.org/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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Credits	5	Hours/Week	6	Sub Code	T6BT14	Semester	VI
Medium of Instruction : English						Core Course : 14	

CC14- PHARMACEUTICAL BIOTECHNOLOGY

Learning Objective		
LO1	Students will understand the series of processes involved in drug development, patenting and drug approval.	
LO2	Will learn about Biopharmaceuticals	
LO3	Will become familiar with Biotech protein drugs	
LO4	Will understand about management of drugs	
LO5	Will be familiar with Pharmaceutical sectors	
UNIT	**Contents**	**No.of Hours**
1	Objectives of Pharmaceutical Biotechnology - Generic and Biogeneric drugs. Stages in the drug development process -Drug discovery - Drug designing - Drug production - Preclinical trials - Clinical trials - Pharmacokinetics and Pharmacodynamics - Patenting & Drug Approval - Drug Marketing - Post clinical trials.	15
II	Production of recombinant proteins - Development of Nucleic acid based therapies - Biopharmaceutical considerations - Pharmaceutical regulations - Formulation of Biotechnology products - Drug delivery - Pharmacognosy .	15
III	Human Insulin (Humulin), Growth hormones (Humatrope) - Blood coagulating factor (factor VIII - Kogenate) - Erythropoietin - (Epogen)	15

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	Granulocyte colony stimulating factors (Neulasta) - Interferons (Avonex) - Antimicrobial peptides (β - defensin 2) - Vaccines (Pentavac), Biologics (Humira - Adalimumab), - Cancer based biologics (rituximab).	
IV	Drug toxicity analysis - Common side effects of drugs and managements - Drugs of abuse - Life changing complications - Prevention and management	**15**
V	National and International Drug approval agencies - Top National and International pharmaceutical industries - Scope and career opportunities in pharmaceutical sectors.	**15**
Total		**75**

Text Books

1	Chandrakant Kokate and Pramod H.J 1st Edition (2011), Text Book of Pharmaceutical Biotechnology, Elsevier
2	Crommelin, Dean J. A., Sindelar, Robert, Meobohm, Bernd (Eds.) (2019), Pharmaceutical Biotechnology: Fundementals and Applications, Springer.
3	Ashish Dixit, Pawan Tiwari and Vivekanand Kishan Chatap (2015), Textbook of Pharmaceutical Biotechnology, Studium Press (India) Pvt. Ltd.
4	John F. Corpenter, Mark C. Manning (2012). *Rational Design of stable formulation.Theory and Practice,* (1st edition), US: Springer Science, ISBN: 9781461351313.

Reference Books

1	Gary Walsh (2003), Biopharmaceuticals ; biochemistry and Biotechnology, John Wiley & Sons Ltd.
2	Oliver Kayser and Heribert Warzecha (2012), Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, Wiley - Blackwell.

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CONTROLLER OF EXAMINATIONS
RAJAH SERFOJI GOVERNMENT COLLEGE (AUTONOMOUS)
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3	Simon Wills. 2nd Edition (2005). Drugs of abuse. Pharmaceutical Press
4	Hiten J. Gutka, Harry Yang, Shefali Kakar (2018). *Biosimilars: Regulatory, Clinical, and Biopharmaceutical Development*. (1st ed). USA: Springer. ISBN: 978-3-319-99679-0.
5	Yui-Wing F. L. and Stuart S. (2019). *Pharmacogenomics: Challenges and Opportunities in Therapeutic Implementation*. (2nd Ed). TX, USA: Academic Press. ISBN: 9780128126264.
Web Resources	
1	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5178364/
2	https://www.patentdocs.org/biotech_news/
3	https://www.pharmamanufacturing.com/
4	https://www.parexel.com/
5	https://nptel.ac.in/courses/102/103/102103013/

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MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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Credits	4	Hours/Week	4	Sub Code	T6BT15	Semester	VI
Medium of Instruction : English						Core Course : 15	

CC15- PRACTICAL VI- ENVIRONMENTAL & INDUSTRIAL BIOTECHNOLOGY

Learning Objective		
LO1	Students can able to isolate the microorganisms and determine their growth curve. generation time.	
LO2	To analyze the water samples, perform immobilization and production of Wine, Biogas and compost.	
LO3	Develop skills in bio fertilizer production and microbial identification.	
LO4	Gain basic skills to analyze raw milk and determine the pasteurization efficacy.	
LO5	Develop skills to perform efficiency tests of biofertilizers and biopesticides, microbial polysaccharide production.	
UNIT	**Contents**	**No.of Hours**
1	Isolation of Air borne Pathogens Study of Growth Curve and Generation time of Bacteria/ Yeast using turbidometry.	9
II	Water analysis – MPN and BOD. Immobilization of whole yeast cells/ enzyme by Alginate beads.	9

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	Production of wine Production of Biogas – *In vitro* & Compost Making.	
III	Biofertilizer production/Spirulina production - field visit. (Report should be included in the record) Isolation and identification of starter organisms from Idli batter/ curd	9
IV	Grading of raw milk (Dye reduction test). Determination of efficiency of Pasteurization by quantitative phosphatase test.	9
V	Preparation and Efficiency testing of Biofertilizer/ Biopesticide. (Demo) Production of microbial Polysaccharide. (Demo)	9
Total		45

Text Books

1	Aneja K R, *Laboratory Manual of Microbiology and Biotechnology*, MEDTECH, 2014.ISBN 13 : 978-9381714553
2	Vijaya Ramesh, (2007), *Food Microbiology*, MJP Publishers, Chennai, ISBN-13 : 978-8180940194

Reference Books

1	Raghuramulu, N., Madhavan Nair, K., and Kalyanasundaram, S. Ed., (1983), *A Manual of Laboratory Techniques*, National Institute of Nutrition, ICMR, Hyderabad.

Web Resources

1	**https://www.youtube.com/watch?v=3UafRz3QeO8**

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2	https://www.youtube.com/watch?v=jpuNYpvBmDM
3	https://www.youtube.com/watch?v=tUCfkNKyQyc

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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Credits	3	Hours/Week	6	Sub Code	TBTECE	Semester	VI
Medium of Instruction : English						Elective Course : 9	

EC9- MEDICAL BIOTECHNOLOGY

Learning Objective		
LO1	Student will be able to obtain knowledge on Vaccines, Antibody therapy and diagnostics	
LO2	Will know the Molecular basis of diseases	
LO3	Will know about cytokines and interferons	
LO4	Will learn about clinical trials	
LO5	Will learn about ethics in clinical trials	
UNIT	**Contents**	**No. of Hours**
I	Antibodies and vaccines - Therapeutic production of antibodies, antibody mediated drug delivery of vaccines, different kind of vaccines and applications of recombinant vaccines. Diagnosis - Biochemical diagnostics, inborn errors of metabolism, haemoglobinopathies.	**15**
II	Molecular basis of disease, Recombinant DNA Technology in medicine, gene probes as molecular diagnostic reagents. Polymerase Chain Reaction in clinical diagnostics, DNA sequencing of representative clones to detect mutations.	**15**
III	Diagnosis of infectious diseases, Viral diseases – HIV, influenza; bacterial diseases - enteric diseases, mycobacterium diseases; immune arrays. FACs immunocytochemical staining, ELISA, FISH techniques.	**15**

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IV	Immunoblot analysis of antigens and allergens. Production of therapeutic agents – Productions and application of therapeutic agents, Production of cytokines and interferons.	15
V	Principles of project management in Clinical trials and its application. Principles of research ethics; Ethical issues in clinical trials; Animal rights and use of animals in the advancement of medical technology. Use of humans in Scientific Experiments; Introduction to ethical codes and conduct.	15
Total		75

Text Books

1	Roli, M. (2017). *National Ethical Guidelines for Biomedical and Health Research Involving Human Participants,*ISBN: 978-81-910091-94
2	Lela, B. and Maribeth, L. F. (2011). *Molecular Diagnostics: Fundamentals, Methods and Clinical Applications*, (1st Edition) . Philadelphia, USA. F A Davis Company. ISBN-13: 978-0803626775
3	*Clinical Applications*, (1st Edition) . Philadelphia, USA. F A Davis Company. ISBN-13: 978-0803626775

Reference Books

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

Web Resources

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CONTROLLER OF EXAMINATIONS
RAJAH SERFOJI GOVERNMENT COLLEGE (AUTONOMOUS)
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1	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2881260/
2	https://www.nature.com/articles/s41577-021-00542-x
3	https://www.ncbi.nlm.nih.gov/books/NBK26837/
4	https://www.sciencedirect.com/topics/medicine-and-dentistry/dna-sequencing
5	http://aquafind.com/articles/Elisa.php

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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Credits	3	Hours/Week	6	Sub Code	TBTECH	Semester	VI
Medium of Instruction : English						Elective Course :10	

EC10- FORENSIC BIOTECHNOLOGY

Learning Objective		
LO1	Students will gain insight into Forensic Biotechnology.	
LO2	Will know about various investigations protocol	
LO3	Will know about blood related issues	
LO4	Will know the use of molecular approaches to investigation	
LO5	Will understand DNA fingerprinting	
UNIT	**Contents**	**No.of Hours**
1	Definition and scope of Forensic Biotechnology, History and development, Forensic genetics, Forensic agriculture.	15
II	Crime scene investigation; collection, preservation, packing and forwarding of physical and trace evidence. Questioned documents – identification of handwriting, signature and detection of forgery.	15
III	Serology - Fresh blood grouping and typing, stains of bloods. Identification of blood stains, collection and storage of allied body fluids (semen, saliva and blood). Case studies.	15
IV	PCR, RFLP, AFLP, Microscopy (Electron, Fluorescent) and Chromatography (Paper, TLC & HPLC) in forensic investigation.	15

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V	DNA Profiling, Isolation of DNA from blood samples, DNA testing in cases of disputed paternity and maternity.	15
Total		**75**

Text Books

1	Nageshkumar G Rao, Textbook of Forensic Medicine & Toxicology, Jaypee, 2013.
2	K.S. Narayan reddy and O.P. Murty, The Essentials of Forensic Medicine & Toxicology, 35th Edition, Jaypee, 2017.
3	Nanda, B.B. and Tiwari R. K. (2014). Forensic Science in India: A Vision for the Twenty First Century, (2nd edition), Select Publishers, New Delhi, ISBN: 9788190113526.
4	Barbara H. Stuart (2013). Forensic Analytical Techniques (Analytical Techniques in the Sciences (AnTs), (1st edition), UK, Wiley, ISBN: 978-0-470-68727-7.
5	C. Champod, C. Lennard, C. Margot, P. and Stoilovic (2015). Fingerprints and otherRidge Skin Impressions, (7th edition), Boca Raton, CRC Press, ISBN: 9781498728959.

Reference Books

1	Jim Fraser, " Forensic Science: A very short introduction", Oxford university press, 2010.
2	William Goodwin, Adrian Linacre, SibteHadi, "An introduction to Forensic Genetics", John Wiley & Sons Ltd 2007.
3	Harralson H. and Miller S. (2017). *Huber and Headrick's Handwriting Identification: Facts and Fundamentals,* (2nd Edition), Boca Raton, CRC Press, ISBN: 9781498751308.
4	Ghosal S. and Avasthi A.S. (2018). *Fundamentals of Bioanalytical Techniques and*

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CONTROLLER OF EXAMINATIONS
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	Instrumentation, (2nd Edition), Delhi, PHI, ISBN: 9789387472396.
Web Resources	
1	http://www.forensicsciencesimplified.org
2	www.nfstc.org
3	https://archive.org/details/FBI_Handbook_of_ForensicScience
4	https://www.soinc.org/forensics-notes

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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Elective Courses

FIRST YEAR :FIRST SEMESTER
ALLIED BIOCHEMISTRY I

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
T1GBC1	Allied Biochemistry I	(Theory)Allied I	2	1	-	-	3	4	25	75	100

Learning objectives

The objectives of this course are to

- Introduce the structure and classification of carbohydrates
- Comprehend the metabolism of carbohydrates
- Study the classification and properties of amino acids
- Elucidate the various levels of organization of Proteins
- Study functions and deficiency diseases of vitamins

Module I: Definition and classification of carbohydrates, linear and cyclic forms (Haworth projection) for glucose, fructose and mannose and disaccharides (maltose, lactose, sucrose).General properties of monosaccharides and disaccharides. Occurrence andsignificance of polysaccharides.12Hrs

Module II:Metabolism- Catabolism and Anabolism.Carbohydrate metabolism- Glycolysis, TCA cycle, HMP shunt and glycogen metabolism and energetics 12Hrs

Module III: Amino acids -Classifications, physical properties -amphoteric nature, isoelectric point and chemicalreactions of carboxyl ,amino and both groups. Amino acid metabolism- transamination, deamination and decarboxylation.12Hrs

Module IV : Proteins- classification - biological functions ,physical properties- ampholytes, iso electric point, salting in and salting out, denaturation, nature of peptide bond. Secondary structure, α-helix and β-pleated sheet, tertiary structure, various forces involved- quaternary structure. 12Hrs

Module V: Vitamins- Fat(A,D,E and K) and water soluble vitamins(B complex and C)- sources, RDA, biological functions and deficiency diseases12 Hrs

Course Outcome

CO	On completion of this course, students will be able to	Programme Outcome
CO1	Classify the structure of carbohydrates and its properties	PO1
CO2	Explain the metabolism of carbohydrates and its significance	PO1
CO3	Classify amino acids and its properties	PO1
CO4	Explain the classification and elucidate the different levels of structural organization of proteins	PO1
CO5	Identify the disease caused by the deficiency of vitamins	PO1

Text Books

1 Satyanarayan,U (2014) Biochemistry (4th ed), Arunabha Sen Books & Allied (P) Ltd, Kolkata.

2.Jain J.L.(2007) Fundamentals of Biochemistry,S.Chand publishers 311

Reference books

1. David L.Nelson and Michael M.Cox (2012) Lehninger Principles of Biochemistry (6th ed) W.H. Freeman.

2. Voet.D&Voet. J.G (2010) Biochemistry , (4th ed), John Wiley & Sons, Inc.

3. Lubert Stryer (2010) Biochemistry,(7th ed), W.H.Freeman

4. Satyanarayan,U (2014) Biochemistry (4th ed), Arunabha Sen Books & Allied (P) Ltd, Kolkata.

5.Jain J.L.(2007) Fundamentals of Biochemistry,S.Chand publishers 31

Web sources

1.onlinecourses.swayam2.ac.in/cec20_bt12

2 onlinecourses.swayam2.ac.in/cec20_bt19

Mapping with Program Outcome

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO1	PSO2	PSO3	PSO4
CO 1	3						3			3
CO 2	3						3			3
CO 3	3						3			3
CO 4	3						3			3
CO5	3						3	3		3

S - Strong (3) M - Medium (2) L -Low(1)

FIRST YEAR : SEMESTER I

ALLIED BIOCHEMISTRY PRACTICAL-I

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
T2GBC1	AlliedBiochemistry Practical I	Allied Practical I	-	-	3	-	3	4	25	75	100

Learning objectives

- Identify carbohydrates by qualitative test
- Estimate biomolecules volumetrically
- Estimate protein quantitatively

I Qualitative analysis of carbohydrates- 25Hrs

a) Monosaccharides-Glucose, Fructose
b) Disaccharides- Lactose, Maltose, Sucrose
c) Polysaccharides-Starch

II Volumetric analysis 15 Hrs

a) Estimation of ascorbic acid using 2,6dichlorophenolindophenol as link solution
b) Estimation of Glucose by Benedicts method
c)Estimation of Glycine by Sorenson Formal titration

III Quantitative analysis(Demonstration Expt)5 hrs

a)Colorimetric estimation of protein by Biuret method

Course Outcome

CO	On completion of this course, students will be able to	Program Outcomes
CO1	Qualitatively analyze and report the type of carbohydrate based on specific tests	PO1,PO2.PO3
CO2	Quantitatively estimate the carbohydrates, amino acids and ascorbic acid	PO1,PO2,PO3
CO3	Estimate protein by colorimetric method	PO1,PO2,PO3

Text books

1.Laboratory manual in Biochemistry, J. Jayaraman, 2nd edition, New Age International Publishers, 2011,
2. An Introduction to Practical Biochemistry, David T. Plummer, 3 rd edition, Tata McGraw-

Hill Publishing Company Limited, 2001.
3. Biochemical Methods, Sadasivam S and Manickam A, 4h edition, New Age International Publishers, 2016

Mapping with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO1	PSO2	PSO3	PSO4
CO 1	2	3	3				3	3	3	3
CO 2	2	3	3				3	3	3	3
CO 3	2	3	3				3	3	3	3

S - Strong (3) M - Medi) L -Low(1)

FIRST YEAR ;SEMESTER II
ALLIED BIOCHEMISTRY II

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
T2GBC3	Allied Biochemistry II	Allied II	2	1	-	-	3	4	25	75	100

Learning objectives

The objectives of this course are to

- Impart knowledge on the classification, properties and characterization of lipids.
- Comprehend the metabolism of Lipids
- Acquaint with the structure, properties and functions of nucleic acids
- Learn about the enzyme kinetics and inhibition
- Study the importance of Hormones

Module I :Lipids–Bloor's classification of lipids- simple lipids, fatty acids (saturated and unsaturated), compound lipids, derived lipids.Properties of lipids- reduction, oxidation, halogenation,saponification and rancidity .Classification andfunctions of phospholipids, Cholesterol – structure and biological importance.12 Hrs

Module II :Lipid metabolism- Oxidation of fatty acids(Palmitic acid) – Beta oxidation-Role of carnitine,energetics , alpha oxidation and omega oxidation.Biosynthesis of saturated fatty acids.12 Hrs

Module III :Purine and pyrimidine bases, nucleosides, nucleotides, polynucleotides, DNA structure. various types, properties- absorbance, effect of temperature. Different types of RNA, structure and function, Genetic code. 12 Hrs

Module III :Enzymes - Nomenclature, IUB system of enzyme classification,active site, specificity, isoenzymes, units of enzyme activity factors affecting enzyme activity- substrate concentration, pH, temperature.Enzyme Kinetics- Michaelis and Menten equation.Lineweaver- Burk plot. Enzyme inhibition, competitive, uncompetitive and andnon competitive inhibition 12Hrs

Module V: Hormones -classification,Biological functions of Insulin, Thyroid and Reproductive hormones . 12Hr

Course Outcome

CO	On completion of this course, students will be able to	Program Outcomes
CO1	Elaborate on classification, structure, properties, functions and characterization of lipids	PO1
CO2	Discuss the metabolism of lipids and its importance	PO1
CO3	Explain about structure, properties and functions of nucleic acids	PO1
CO4	Derive Michaelis Menten equation and concepts of enzyme inhibition	PO1,PO3
CO5	Classify the Hormones and its biological functions	PO1,PO4

Text books

1.Satyanarayan,U (2014) Biochemistry (4th ed), Arunabha Sen Books & Allied (P) Ltd, Kolkata.

2.Jain J.L.(2007) Fundamentals of Biochemistry,S.Chand publishers

Reference books

1. David L.Nelson and Michael M.Cox (2012) Lehninger Principles of Biochemistry (6th ed) W.H. Freeman.

2. Voet.D & Voet. J.G (2010) Biochemistry , (4th ed), John Wiley & Sons, Inc.

3. Lubert Stryer (2010) Biochemistry,(7th ed), W.H.Freeman

Web sources

1.onlinecourses.swayam2.ac.in/cec20_bt12

2 onlinecourses.swayam2.ac.in/cec20_bt19

Mapping with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO1	PSO2	PSO3	PSO4
CO 1	3						3			3
CO 2	3						3			3
CO 3	3		3				3			3
CO 4	3			3			3			3
CO5	3						3	3		3

S - Strong (3) M - Medium (2) L -Low(1)

FIRST YEAR: SEMESTER II
ALLIED BIOCHEMISTRY : PRACTICAL II

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	AlliedBiochemistry Practical II	Allied Practical II	2	1	-	-	3	4	25	75	100

Learning objectives

The objectives of this course are to

- Identify amino acids by qualitative test
- Prepare biomolecules from its sources
- Estimate phosphorus quantitatively

I.**Qualitative analysis of amino acids**

a) Arginine b)Cysteine c) Tryptophan d)Tyrosine e) Histidine

II. **Biochemical preparations**

a) Preparation of casein from milk.

b)Preparation of starch from potato.

c)Preparation of albumin from egg.

IIIGroup Experiment

Determination of Iodine/ Saponification number of an edible oil(Demonstration) .

Course Outcome

CO	On completion of this course, students will be able to	Programme Outcome
CO1	Qualitatively analyze the amino acids and report the type of amino acids based on specific tests	PO1,PO2,PO3
CO2	Prepare the macronutrients from the rich sources.	PO1,PO2,PO3
CO3	Check the quality of edible oil	PO1,PO2,PO3

Text books

1.Laboratory manual in Biochemistry, J. Jayaraman, 2nd edition, NewAge International Publishers, 2011,

2. An Introduction to Practical Biochemistry, David T. Plummer, 3 rd edition, Tata McGraw-Hill Publishing Company Limited, 2001.

Reference books

1. Biochemical Methods, Sadasivam S and Manickam A, 4h edition, NewAge International Publishers, 2016

2. Essentials of Food and Nutrition, Vol. I & II, M.S. Swaminathan.

Mapping with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO1	PSO2	PSO3	PSO4
CO 1	2	3	3				3	3	3	3
CO 2	2	3	3				3	3	3	3
CO 3	2	3	3				3	3	3	3

S - Strong (3) M - Medium (2) L -Low

Credits	3	Hours/Week	4	Sub Code	TBTECA	Semester	III
Medium of Instruction : English					Elective course: 4		

ELECTIVECOURSE 4 -FUNDAMENTALS OF MICROBIOLOGY

Learning Objective	
LO1	Understand the classification of Microorganisms and structure of bacteria
LO2	Understand the various microbiological techniques, different types of media, and techniques involved in culturing microorganisms.
LO3	Categorize the methods of sterilization and identify the significance of culture media in the growth of different microbes.
LO4	Exhibit knowledge in analyzing the importance of Bio insecticides, Bio fertilizers prebiotics and probiotics.
LO5	Distinguish between normal flora and pathogens and describe the role of microbes in food intoxications.

UNIT	Contents	No. of Hours
I	History of Microbiology, Classification of bacteria, fungi, virus, protozoa and algae – classical and molecular approaches. Scope of microbiology – Role of microbes in biotechnology.	15
II	Structure of bacteria - Bacterial growth and measurement of growth, Media – types and preparation- plating methods - staining methods (Gram's, capsule, spore, LCB mount)- methods of preservation and storage of microbes. Culture of fungi, virus and algae.	15
III	Sterilization methods - physical and chemical methods- Mode of action – Antibiotic in clinical use - Resistance to antibacterial agents - MRSA, ESBL.	15

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IV	Bioinsecticides - *Bacillus thuringiensis*, Baculoviruses- Biofertilizers - *Azospirillum* and blue green algae - single cell protein – prebiotics and probiotics - Dairy products (Cheese and Yoghurt).	15
V	Microbial Disease- host -pathogen interaction, clinical features, lab diagnosis and treatment of Airborne disease (Pneumonia, Chicken pox), food borne disease (Typhoid, Aspergillosis), Water borne disease (Cholera, Amoebiasis), Sexually transmitted disease (AIDS, Trichomoniasis), Vector borne disease (Dengue, Malaria).	15
Total		75

Text Books

1	Pelczar.M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7th Edition.,McGraw –Hill, New York.
2	Dubey R.C. and Maheswari, S. (2003). A textbook of Microbiology, New Delhi: S. Chand & Co.
3	Ananthanarayanan, Paniker, Kapil, Textbook book of Microbiology, 9th edition, Orient BlackSwan, 2013.
4	Prescott, Harley, Klein, Microbiology, 10th Edition, McGraw – Hill, 2016.
5	Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (Editions) (1994) Methods for General and Molecular Bacteriology. ASM Press, Washington, DC

Reference Books

1	Madigan, Martinko, Bender, Buckley, Stahl, Brock Biology of Microorganisms, 14th edition, 2017.
2	Gillespie, Bamford, Medical Microbiology and Infection at a Glance, 4th edition, 2012.
3	Boyd, R.F. (1998). General Microbiology,2nd Edition., Times Mirror, Mosby CollegePublishing, St Louis.

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4	Tortora, G.J., Funke, B.R., Case,C.L. (2013). Microbiology. An Introduction 11th Edition., A La Carte Pearson.
5	Salle. A.J (1992). Fundamental Principles of Bacteriology. 7th Edition., McGraw Hill Inc.New York.

Web Resources

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

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MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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Credits	3	Hours/Week	2	Sub Code	TBTECB	Semester	III
Medium of Instruction : English						Elective Course :5	

ELECTIVE COURSE 5 -FUNDAMENTALS OF MICROBIOLOGY PRACTICAL

Learning Objective		
LO1	Describe the general Laboratory safety & Sterilization Techniques	
LO2	Develop Skills in Media Preparation, Isolation & Serial Dilution Techniques and Pure Culture Techniques	
LO3	Microscopically analyze the morphological features of Bacteria and fungi and define various Staining Techniques.	
LO4	Perform the Motility of organisms.	
LO5	Able to characterize and identify bacteria using Biochemical tests.	
UNIT	**Contents**	**No. of Hours**
I	Sterilization techniques – Preparation of Media	9
II	Inoculation techniques- Pour plate, spread plate Isolation of bacteria from various sources and dilution techniques.	9
III	Staining techniques: Simple, Gram's, Capsule (Negative), Spores, Preparation of temporary mounts- Lacto phenol cotton blue staining.	9
IV	Motility tests: Hanging drop technique.	9

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V	Biochemical characterization - catalase, oxidase, IMVIC test and TSI. Antibiotic sensitivity test (demonstration).	9
Total		**45**

Text Books

1	James G Cappucino and N. Sherman MB(1996). A lab manual Benjamin Cummins, New York 1996.
2	Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications.
3	Sundararaj T (2005). Microbiology Lab Manual (1st edition) publications.
4	Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ld., Publishers, New Delhi.
5	R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishing.

Reference Books

1	Atlas.R (1997). Principles of Microbiology, 2nd Edition, Wm.C.Brown publishers.
2	Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India.
3	Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS.
4	Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication.
5	Lim D. (1998). Microbiology, 2nd Edition, WCB McGraw Hill Publications.

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Web Resources	
1	http://www.biologydiscussion.com/micro-biology/sterilisation-and-disinfection-methods-and-principles-microbiology/24403.
2	https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635
3	https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf
4	https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology

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MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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Credits	4	Hours/Week	4	Sub Code	TBTECC	Semester	IV
Medium of Instruction : English					Elective course: 5		

ELECTIVECOURSE 4 -FUNDAMENTALS OF MICROBIOLOGY

Learning Objective	
LO1	Understand the types of Microscopes
LO2	Understand the importance of water purification
LO3	Categorize the significance of soil microbes in agriculture
LO4	Exhibit knowledge in analyzing the importance of air sanitation
LO5	gain the knowledge about intestinal parasites

UNIT	Contents	No. of Hours
I	Microscopy – Simple and Compound Microscopy – Darkfield –Phase contrast – Fluorescence and Electron Microscopy.Stain and Staining techniques – Simple, differential, and specialstaining (Endospore, capsular & Granular).	15
II	Water microbiology- bacteriological examination of water, purification of drinking water, Sewage and its treatment- water-borne diseases	15
III	Soil microbiology- physical and chemical properties of soil, classification of soils, soil profile, soilmicroflora, and soil as a natural habitat for microbes.Microorganisms in the rhizosphere, root surfaces, and phylloplane. Biological Nitrogen fixation is symbiotic and Asymbiotic.	15
IV	Microbiology of Air: Composition of air.Number and kinds of microorganisms in air (indoor, outdoor)Distribution and sources of airborne microorganisms.Air is a carrier of microorganisms.Droplet, droplet nuclei, Dispersal of Microorganisms in air. Techniques for microbiological analysis	15

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	of air. Significance of air flora in human health, hospitals, and industries. Airborne diseases - list of diseases caused by bacteria, fungi, viruses. Air pollution. Air sanitation – dust control, UV radiation, bactericidal vapors, filtration, aminar airflow system (HEPA filters)	
V	Medical parasitology: Entamoeba histolytica, Giardia & Trichomonas,Leishmania, Plasmodium, Filaria,	15
Total		75

Text Books

1	Pelczar.M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7th Edition..McGraw –Hill, New York.
2	Dubey R.C. and Maheswari, S. (2003). A textbook of Microbiology, New Delhi: S. Chand & Co.
3	Ananthanarayanan, Paniker, Kapil, Textbook book of Microbiology, 9th edition, Orient BlackSwan, 2013.
4	Prescott, Harley, Klein, Microbiology, 10th Edition, McGraw – Hill, 2016.
5	TEXTBOOK – PARASITOLOGY A Conceptual Approach by Loker and Hofkin 2015.

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.

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5	Salle. A.J (1992). Fundamental Principles of Bacteriology. 7th Edition., McGraw Hill Inc.New York.
Web Resources	
1	Horst W. Doelle (2004). Microbial Metabolism and Biotechnology. Proceedings of an E-seminar organized by the International organization for Biotechnology and Bioengineering (IOBB)
2	http://www ejb.org/content.
3	www. Biotech.kth.se Electronic Journal of biotechnology
4	https://www.cliffsnotes.com/study guides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology
5	https://bio.libretexts.org/@go/page/9188

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MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOME

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

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Skill enhancement courses

Credits	2	Hours/Week	2	Sub Code	T1BTSE1	Semester	I
Medium of Instruction : English					Skill enhancement Course : 1		

SEC1- 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.

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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

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Credits	2	Hours/Week	2	Sub Code	T1BTSE2	Semester	II
Medium of Instruction : English					Skill enhancementCourse : 2		

SEC2- 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

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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.

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Credits	2	Hours/Week	2	Sub Code	T1BTSE3	Semester	II
Medium of Instruction : English					Skill enhancementCourse : 3		

SEC 3: 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.

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

4. Nita Bahl. 2002. Handbook on Mushroom 4th edition Vijayprimlani for oxford & IBH publishing co., Pvt., Ltd., New Delhi. 5. Dr.C. Sebastian Rajesekaran Reader in Botany Bishop Heber College, Trichy – 17.

5. 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.

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Credits	1	Hours/Week	1	Sub Code	T1BTSE4	Semester	III
Medium of Instruction : English					Skill enhancementCourse : 4		

SEC4- 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.

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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 editions
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).

https://explorable.com/quantitative-research-design

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Credits	2	Hours/Week	2	Sub Code	T1BTSE5	Semester	III
Medium of Instruction : English					Skill enhancement Course : 5		

SEC5- 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.

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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.

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Credits	2	Hours/Week	2	Sub Code	T1BTSE6	Semester	IV
Medium of Instruction : English					Skill enhancement Course : 6		

SEC6- 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. Gnaànamani M.R., 1998 Modern aspects of commercial poultry keeping, Giri.
3. Banarjee G.C., 1992 Poultry, Oxford and IBH, New Delhi.

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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.

Credits	2	Hours/Week	2	Sub Code	T1BTSE6	Semester	IV
Medium of Instruction : English					Skill enhancement Course : 7		

SEC7- 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.

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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

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Foundation Course

Credits	2	Hours/Week	2	Sub Code	BTFC	Semester	I
Medium of Instruction : English					Foundation course : 7		

Introduction to Biotechnology

Unit-I

History & Introduction to Biotechnology What is Biotechnology? Definition of Biotechnology,

Traditional and Modern Biotechnology, Overview of Branches of Biotechnology.

Unit –II

Overview of Applications of Biotechnology in Agriculture, Medicine, Bioprocess Technology, Food Biotechnology, Environmental Biotechnology, Molecular forensic and Molecular diagnostics

Unit –III

Molecular biology of life processes, genes, and gene expression.

Unit –IV

Recombinant DNA technology, animal cell culture, transgenic plants and animals

UNIT V

Overview of Biotechnology Institutions in India (Public and Private Sector) Biotech Success Stories.careers and employment in biotechnology.

Reference Books

1. McGregor, C.W.; Membrane separation in Biotechnology; Marcel Dekker, Inc, New York.
2. Frieferder, S.; Physical Biochemistry; Freeman and Co., New York.
3. Biotol Series (I - IV); Techniques used in Bioproduct Analysis; Buterworth Heineman,U.K.
4. Work, T.S.; Lab. Techniques in Biochemistry and Molecular Biology, Elsevier, New York.
5. Microbiology: Michael J. Pelczar Jr., E. C. S Chan, Noel R. Krieg

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