

B.Sc.,
BIOTECHONOLOGY

SYLLABUS

FROM THE ACADEMIC YEAR
2026- 2027

A. University Vision

To provide quality education to reach the un-reached.

B. University Mission

- To conduct research, teaching and outreach programmes to improve conditions of human living.
- To create an academic environment that honours women and men of all races, caste, creed, cultures and an atmosphere that values intellectual curiosity, pursuit of knowledge, academic freedom and integrity.
- To offer a wide variety of off-campus educational and training programs, including the use of information technology, to individuals and groups.
- To develop partnership with industries and government so as to improve the quality of the workplace and to serve as catalyst for economic and cultural development.
- To provide quality/inclusive education, especially for the rural and un-reached segments of economically downtrodden students including women, socially oppressed and differently abled.

C. PREAMBLE

Biotechnology is a field of applied biology that makes use of living organisms or biological systems to make technological advances and use them in various field. It basically seems to improve the quality of human life and the health of the planet. The courses in Biotechnology Programme are mainly related to recent and emerging trends in Biology. In the B.Sc. Degree programme the most advanced and relevant courses such as nanotechnology, Bioprocess Technology, Bioinformatics, stem cell Biology, Nanotechnology have been incorporated. These will make the students ready for both industry as well as research-oriented endeavors.

D. PROGRAMME EDUCATIONAL OUTCOMES (PEO)

In alignment with the Vision and Mission of the University, the following have been defined as the PEO for the graduates.

PEO1: Developing strong positive attitude to learn independently the concepts in the field of study

PEO2: Ensuring confidence among the learners to apply the knowledge and skills gained to solve real life issues

PEO3: Habituating ethical values among the learners to succeed in personal and professional life

E. PROGRAMME OUTCOMES (PO)

Programme Outcomes for the Under Graduate Degree Programmes of the University are articulated as under.

After the successful completion of Undergraduate Programme from the University, the learner

should be able to

PO1: Comprehend the knowledge acquired and communicate the same to others

PO2: Analyze and compare the factual data / situation to comprehend and to critically evaluate to find solution to the problem ahead

PO3: Apply theories and philosophies learned in solving the problem in scientific manner

PO4: Think reflectively on the earlier activities and attempt for self-directed lifelong learning process

PO5: Understand multicultural existence and identify the means to prolong moral/ethical values in personal and professional life

PO6: Expose the learner to the digital technology to learn through multiple sources

PO7: Train the learner to be a responsible player in teams and impart leadership qualities in them.

F. PROGRAMME SPECIFIC OUTCOMES (PSO)

On completion of the programme, graduates will be able to:

PSO1: Disciplinary Knowledge

Apply fundamental and theoretical knowledge of biochemistry, microbiology, molecular biology, genetics, biostatistics, bioinformatics and immunology to support higher studies, research, and innovation.

PSO2: Critical Thinking

Analyze complex biological problems critically and evaluate appropriate biotechnological methods, bioethics, and safety solutions in academic, industrial, and healthcare contexts.

PSO3: Problem Solving

Solve biological, environmental, and health-related problems using logical reasoning, scientific experimental design, and computational tools like bioinformatics.

PSO4: Analytical Reasoning

Interpret experimental data, molecular structures, and biological pathways using quantitative and qualitative techniques to address scientific, agricultural, and sustainability-related challenges.

PSO5: Research Skills

Demonstrate basic research aptitude by formulating biological hypotheses, conducting laboratory experiments, analyzing data, and presenting scientific findings effectively.

PSO6: Self-directed Learning

Engage in lifelong learning and adapt to rapid advancements in biotechnology, genetic engineering, and life science technologies.

PSO7: Employability and Entrepreneurship

Develop practical laboratory skills and business acumen for employability, entrepreneurship, and career readiness in the pharmaceutical, food processing, agricultural, and tech-driven biosectors.

Each Course has to address a minimum of 4 PSOs

Level of contribution of the Course towards attaining PSOs

0 – No Contribution 1 – Low Level 2 – Medium Level 3 – High Level

F. COURSE OUTCOMES (CO)

Four Course Outcomes (COs) for each course that can be achieved by the learners on completion of that particular course are as follows:

Considering outcomes related to

- i. K1 and K2 level of evaluation in all the Units as CO1
- ii. K3 level of evaluation in all the Units as CO2
- iii. K4 level of evaluation in all the Units as CO3
- iv. K5 and K6 level of evaluation in all the Units as CO4.

All the COs proposed in each of the courses should be mapped with POs based on the relevance.

Level of Correlation between COs and POs

0 – No Correlation 1 – Low 2 – Medium 3 – High

G.PROGRAMME DETAILS

Eligibility Criteria

The Candidates who shall be admitted to the B.Sc Biotechnology course, should have passed plus two examinations of State or Central Board with Chemistry/Biology/Biochemistry as one of the subjects or any other science subject that may be considered as equivalent by Manonmaniam Sundaranar University.

Medium of Instruction: English

Duration of the Programme: 3 Years

H. EXAMINATION SCHEME

- A.** Each paper carries an internal component
- B.** There is a pass minimum of 40% for U.G. external and overall components

Theory External: Internal Assessment
= 75:25

Practical External: Internal
Assessment = 50:50

- C.** Internal Assessment

Internal marks for Theory shall be allocated in the following manner.

The average of the best two tests from three compulsory tests	20 Marks
Assignment/ Model Making /Quiz	05 Marks
Total	25 Marks

Note: Each test will be of one hour duration.

D. Practical

Internal marks for practical shall be allotted in the following manner.

Experimental work	20 Marks
Record	10Marks
Model Test	20 Marks
Total	50 Marks

E: Project work

Internal	External	Total
50 Marks	50 Marks	100 Marks

Distribution of Marks in Project Course

COMPONENTS	MARKS
Internal	50 Marks
External	
Project Report	25Marks
Presentation	15 Marks
Viva-voce	10 Marks
Total	100 Marks

Note:

- i) Group project
- ii) Maximum 5 students can be allotted in a group
- iii) Project shall be allotted at the beginning of the IV semester.
- iv) In house projects are encouraged.
- v) Students may be allowed to carry out the project work in other research institutes.
- vi) Faculty members of the respective colleges must serve as guides
- vii) Project report evaluation will be done and Viva-voce will be conducted by both the external examiner and the internal examiner at the end of the

SIXTH SEMESTER itself.

- viii) Project report in THREE copies has to be submitted at the time of the exam.
- ix) Evaluation of Project report has to be done by the examiner(s) appointed by the University for 50Marks.

I. QUESTION PAPER PATTERN

The question paper pattern for all theory papers shall be as follows.

Duration of Exam: 3Hours

Section	Type of questions	Mark
Part-A	Multiple choice question (Two question from each unit compulsory)	10×1=10 Marks
Part-B	Internal Choice questions (One question from each unit: either/or)	5×5=25 marks
Part-C	Internal Choice questions (One question from each unit: either/or)	5×8=40 marks
	Total	75 Marks

J. Model Question Paper

Subject: Cell and Molecular Developmental Biology

Part A- (10 x 1 = 10 marks)

Answer ALL questions

Choose the correct answer

- The term cell was coined in the year
 - (a) 1492
 - (b) 1665
 - (c) 1855
 - (d) 1900
- If ribosomes in a cell are destroyed, which process will stop first
 - (a) Respiration
 - (b) Protein synthesis
 - (c) Photosynthesis
 - (d) Diffusion
- Why are lysosomes called as 'suicidal bags'?
 - (a) They produce toxins
 - (b) They digest worn out cell parts
 - (c) They kill bacteria only
 - (d) They produce energy
- A scientist observes a cell with many mitochondria. The cell is most likely involved in:
 - (a) Low energy activity
 - (b) Active energy requiring processess
 - (c) Water storage only
 - (d) Cell wall formation only
- The enzyme used for unwinding DNA during replication is
 - (a) Ligase
 - (b) Polymerase

- (c) Helicase (d) Primase
6. If helicase enzyme is absent during DNA replication, what will happen?
- DNA strands cannot unwind
 - Ribosomes cannot form
 - Proteins cannot fold
 - Introns cannot be removed
7. Arrange the steps of signal transduction in the correct sequence
- Cellular response
 - Ligand binds receptor
 - Signal amplification
 - Activation of intracellular proteins
- a → d → c → b
 - b → d → c → a
 - c → b → d → a
 - a → b → d → c
8. Spot the incorrect statement about cell division
- Cell division produces new cells
 - Mitosis occurs in somatic cells
 - Meiosis produces diploid gametes
 - Cytokinesis divides the cytoplasm
9. A clinician suspects defective sperm maturation in a patient. Which supporting cells should be investigated first?
- Leydig cells
 - Oocytes
 - Sertoli cells
 - Polar bodies
10. Arrange the stages involved in neural organ formation during organogenesis
- Neural plate formation
 - Neural tube formation
 - Differentiation of nervous tissue
 - Gastrulation
- 1 → 2 → 4 → 3
 - 1 → 2 → 3 → 4
 - 3 → 2 → 1 → 4
 - 4 → 1 → 2 → 3

PART B – (5x5 = 25 marks)

Answer ALL questions choosing either (a) or (b).

Each answer should not exceed 250 words

11. (a) Explain the contribution of Robert Hook to Cell Biology
Or
(b) Describe the structure of plant cells with a neat labeled diagram
12. (a) Describe the fluid mosaic model of the plasma membrane
Or
(b) Analyze the importance of cell wall in maintaining plant cell rigidity
13. (a) Explain the central dogma of cells with a neat diagram
Or
(b) Describe the mechanism of DNA replication in prokaryotes
14. (a) Justify the role of extra cellular matrix in tissue organization

Or

- (b) Analyze the importance of crossing over during meiosis
15. (a) Justify the significance of cleavage in embryonic development

Or

- (c) Evaluate the role of mesoderm in organ development

PART C – (5x8 = 40 marks)

Answer ALL questions choosing either (a) or (b)

Each answer should not exceed 600 words

16. (a) Explain the structure of animal cells with neat labeled diagrams

Or

- (b) Draw and label a typical plant cell and explain the functions of each organelle

17. (a) Describe the structure and functions of Golgi apparatus

Or

- (b) Explain the structure and movement mechanism of cilia and flagella

18. (a) Compare prokaryotic and eukaryotic translation

Or

- (b) Describe the importance of post translational modification in proteins

19. (a) A researcher claims that cell cycle check points are more important than DNA repair enzymes –
Evaluate this statement

Or

- (b) Create a flowchart illustrating the complete cell cycle

20. (a) Examine the role of embryonic fields in tissue and organ development

Or

- (b) Design a schematic representation of cell movements during gastrulation

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Credit Distribution for UG Programmes

Sem I	Credit	H	Sem II	Credit	H	Sem III	Credit	H	Sem IV	Credit	H	Sem V	Credit	H	Sem VI	Credit	H
1.1. Part I Language – Tamil	3	6	2.1. Part I Language – Tamil	3	6	3.1. Part. I Language – Tamil	3	6	4.1. Part 1 Language – Tamil	3	6	5.1 Core Course – CC IX	4	5	6.1 Core Course – CC XIIIV	4	5
1.2. Part II English	3	6	2.2. Part II English	3	4	3.2 Part II English	3	6	4.2. Part II English	3	6	5.2 Core Course – CC X	4	5	6.2 Core Course – CC XV	4	5
1.3. Core Course – CC I	5	5	2.3 Core Course – CC III	5	5	3.3 Core Course – CC V	4	4	4.3 Core Course – CC VII	4	4	5.3 Core Course CC - XI	4	5	6.6 Core Course – CC XVI Project Viva Voce-	4	10
1.4 Core Course – CC II	4	5	2.4 Core Course – CC IV	4	5	3.4 Core Course – CC VI	4	4	4.4 Core Course – CC VIII	4	4	5.4 Core Course – Practical- CC -XII	4	5	6.4 Elective -VI Generic/ Discipline Specific	3	4
1.5 Elective I Generic/ Discipline Specific	4	4	2.5 Elective II Generic/ Discipline Specific	4	4	3.5 Elective III Generic/ Discipline Specific	4	4	4.5 Elective IV Generic/ Discipline Specific	4	4	5.5 Core Course – Practical- CC -XIII	3	4	6.5 Elective VII Generic/ Discipline Specific	3	4

[illegible]

K. ENTIRE PROGRAMME STRUCTURE

First Year – Semester-I

Part	List of Courses	Credit	No. of Hours
Part-1	Language – Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses& Allied Courses [in Total]	13	14
Part-4	Skill Enhancement Course SEC-1	2	2
	Foundation Course	2	2
		23	30

Semester-II

Part	List of Courses	Credit	No. of Hours
Part-1	Language – Tamil	3	6
Part-2	English	3	4
Part-3	Core Courses& Allied Courses including laboratory [in Total]	13	14
Part-4	Skill Enhancement Course -SEC-2	1	2
	Skill Enhancement Course -SEC-3 (Discipline / Subject Specific)	1	2
	Naan Mudhalavan	2	2
		23	30

Second Year – Semester-III

Part	List of Courses	Credit	No. of Hours
Part-1	Language - Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses& Allied Courses including laboratory [in Total]	12	12
Part-4	Skill Enhancement Course -SEC-4 (Entrepreneurial Based)	2	2
	E.V.S	2	2
	Naan Mudhalavan	2	2
		24	30

Semester-IV

Part	List of Courses	Credit	No. of Hours
Part-1	Language - Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses& Allied Courses including laboratory [in Total]	12	12
Part-4	Skill Enhancement Course -SEC-5 (Discipline / Subject Specific)	2	2

	Value Education	2	2
	Naan Mudhalvan	2	2
		24	30

Third Year**Semester-V**

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

Semester-VI

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

Consolidated Semester wise and Component wise Credit distribution

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

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

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

- Internal: 50 marks and External: 50 marks (Total: 100 marks)
- A report should be submitted at the end of 5th semester and evaluated by external examiners.
- Internship students should submit certificate of attendance from the industry along with report.

*****Extension Activity:**

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

L. Mapping of Course Outcomes (COs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs) can be carried out accordingly, assigning the appropriate level in the grids:

	POs							PSOs						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
CO1														
CO2														
CO3														
CO4														

FIRST YEAR- SEMESTER I

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

SEMESTER-II

CORE PAPER- I: CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	4	1			5	5	25	75	100
UNIT	Contents								No.of Hours
I	Discovery and diversity of cells - Cell theory - Structure of prokaryotic (bacteria) and eukaryotic cells (plant and animal cells).								10

II	Structure and Functions of Cell Organelles: Cell wall, Cell membrane, Cytoplasm, Nucleus, chromosomes, Endoplasmic reticulum, Ribosomes, Golgi bodies, Lysosomes, Mitochondria, Microbodies.	20
III	Structure and functions of DNA and RNA. Central Dogma of the cell - DNA Replication in prokaryotes and Eukaryotes, Transcription and Translation in Prokaryotes and Eukaryotes, Post Translational Modifications, Genetic code.	15
IV	Cell cycle - Cell division - Mitosis and Meiosis, Cell adhesion, Cellular differentiation, Cell junctions, Extra Cellular Matrix, Cell to cell communications.	15
V	Gametogenesis - Spermatogenesis and Oogenesis in mammals. Fertilization-Types of cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals. Organogenesis.	15
Total		75
Text Books		
1	T. Devasena (2012), Cell Biology, Oxford University Press.	
2	Gupta, Renu &Makhija, Seema &Toteja, Ravi. (2018). Cell Biology: Practical Manual.	
3	Gilbert, S.F. 2016. Developmental Biology, 11 th edition. Sinauer Associates Inc. Publishers, MA. USA.	
4	Bruce Alberts, 6 th Edition (2014). Molecular Biology of the cell, W. W. Norton & Company.	
5	James D. Watson (2001), The Double Helix: A personal account of the Discovery of the Structure of DNA, Touchstone Publishers.	
Reference Books		
1	Karp's Cell and Molecular Biology: Concepts and Experiments. 8 th Edition (2015). Wiley Publications.	
2	James D. Watson, 7 th Edition (2014), Molecular Biology of the Gene, Pearson Publications.	
3	Geoffrey M. Cooper, 7 th Edition (2015). The Cell: A Molecular Approach, Sinauer Associates, Qxford University Press.	
4	LodishHarwey, 6 th Edition (2016), Molecular Cell Biology, W. H. Freeman Publications.	
5	Wolpert L, Tickle C, 2015. Principles of Development, 5 th edition, Oxford University Press.	
Web Resources		
1	http://www.cellbiol.com/education.php	
2	https://global.oup.com/uk/orc/biosciences/cellbiology/wang/student/weblinks/ch16/	

3	https://dnalc.cshl.edu/websites/
4	https://www.cellsignal.com/contents/science/cst-pathways/science-pathways
5	https://nptel.ac.in/courses/102/106/102106025/11.

COURSE OUTCOMES (CO)

On completion of this course, the learners will be able to:

- **CO1 (K1 & K2 - Remember & Understand):** Describe the structural diversity of cells, primary biomolecules, cell organelles, the central dogma, mechanisms of cell division, and the fundamental stages of mammalian embryonic development.
- **CO2 (K3 - Apply):** Apply knowledge of cellular structures, replication/transcription mechanisms, and cell communication pathways to solve conceptual problems in cellular and molecular biology.
- **CO3 (K4 - Analyze):** Analyze the functional differences between prokaryotic and eukaryotic molecular processes, the distinct phases of cell cycles, and the complex regulation of gametogenesis and organogenesis.
- **CO4 (K5 & K6 - Evaluate & Create):** Evaluate experimental evidence supporting cell theories and cellular models, and synthesize comprehensive conceptual frameworks detailing how cells differentiate and develop into complex organisms.

MAPPING OF COURSE OUTCOMES (Cos) WITH PROGRAMME OUTCOMES(Pos) AND PROGRAMME SPECIFIC OUTCOME(PSOs)

	POs							PSOs						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
CO1	3	2	1	1	0	1	1	3	2	1	2	1	2	1
CO2	2	3	3	2	0	1	1	3	2	3	2	1	2	1
CO3	2	3	2	3	0	2	1	3	3	2	3	2	3	1
CO4	2	3	3	3	0	2	2	3	3	3	2	3	3	1

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			4	4	25	75	100
UNIT	Contents								No.of Hours
I	Atomic theory, formation of molecules. Types of chemical bonds. Classification of organic compounds with examples. Types of reactions with an example: addition, substitution, elimination, condensation reactions.								15
II	Acids & Bases- Concepts of acids and bases- Arrhenius, Lowry-Bronsted. Preparation of solutions, Concentration of Solutions– percent by weight, normality, molarity, molality, mole fraction. pH of solution, pH scale, measurement of pH. Buffer solutions-properties and functions of buffers, Henderson-Hasselbalch equation.								15
III	Biochemistry-the chemical foundation of life. Biomolecules- Carbohydrates: Properties and Classification- Ring structure of sugars and conformations of sugars. Metabolism of Carbohydrates – Glycogenesis, Glycogenolysis, Glycolysis, TCA cycle, bioenergetics of carbohydrate metabolism.								15
IV	Lipids: Classification, Characteristics, Properties and Biological importance. Triglycerides and phospholipids. Beta-oxidation of fatty acids. Nucleic acids: Structure and Classification-Purine and Pyrimidine bases. Classification of DNA & RNA. Metabolism of Nucleotides-Salvage pathway.								15
V	Amino acids: Classification and structure. Proteins: Structural conformation and Classification. Properties and biological importance of amino acids and proteins. Urea Cycle. Vitamins: Types, Structure and function. Electron transport chain and Oxidative phosphorylation. Photophosphorylation.								15
Total									75
Text Books									
1	P.L. Soni , A Text-book of Inorganic Chemistry, 11 th Edition, S. Chand & Sons publications								
2	Abhilasha Shourie, Shilpa S, Chapadgoankar& Anamika Singh (2020) Textbook of Biochemistry 1 st Edition								
3	J.L. Jain, 2016, Fundamentals of Biochemistry, S. Chand publication, 7th edition.								
4	A.C. Deb, 2016, Fundamentals of Biochemistry, New central book agencies, 7th edition.								

5	Satyanarayana .U, 2016, Biochemistry, MJ publishers 3 rd edition (2006).
Reference Books	
1	Lehninger (2013) Principles of Biochemistry 4 th edition WH Freeman and Company NY
2	Murray <i>et al.</i> , (2003) Harper's biochemistry 26 th edition Appleton and Lange Publishers
	Florida USA
3	Geoffrey L. Zubay, William W. Parson, Dennis E. Vance, 1995, Principles of Biochemistry, W.C. Brown Publishers, 1995, 3 rd edition.
4	Lubert Stryer (2007) Biochemistry –Stanford University 5 th Edition-W H Freemann and company San Francisco
5	Bahl Arun, Bahl B. S. (2016), A Textbook of Organic Chemistry, 22 nd Edition, S. Chand & Sons publications
Web Resources	
1	http://dwb4.unl.edu/chem869p/chem869plinks/s
2	www.longwood.edu/staff/buckalewdw/C3%20Biomolecules.pp
3	https://www.britannica.com/science/biochemistry
4	https://www.sciencedirect.com/topics/agricultural-and-biological-sciences
5	https://biochemistry.org/education/careers/becoming-a-bioscientist/w

Course Outcomes

On completion of this course, the learners will be able to:

CO1 (K1 & K2 - Remember & Understand): Define atomic structures, chemical bonding, and organic reaction types, while describing the structural classification and properties of biomolecules like carbohydrates, lipids, proteins, and nucleic acids.

CO2 (K3 - Apply): Apply concepts of acids, bases, and buffer systems to calculate solution concentrations (molarity, normality, pH) and demonstrate how chemical foundations support metabolic processes.

CO3 (K4 - Analyze): Analyze the intricate steps of metabolic pathways, including Glycolysis, the TCA cycle, Beta-oxidation, and the Urea cycle, to distinguish how the body handles different classes of nutrients.

CO4 (K5 & K6 - Evaluate & Create): Evaluate the bioenergetic efficiency of ATP production through the Electron Transport Chain and oxidative phosphorylation, and synthesize a comprehensive view of how molecular structures dictate biological function and energy flow.

MAPPING OF COURSE OUTCOMES (Cos) WITH PROGRAMME OUTCOMES(Pos) AND PROGRAMME SPECIFIC OUTCOME(PSOs)

	POs							PSOs						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
CO1	3	2	1	2	0	1	1	3	3	1	2	1	2	1
CO2	2	3	3	2	0	1	1	3	2	3	2	1	3	1
CO3	3	3	2	3	0	2	1	3	3	2	3	2	2	1
CO4	2	3	3	3	0	2	2	3	3	3	2	3	3	1

CORE II- PRACTICAL - I

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

i. CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY

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) Visit to a Biotechnology Laboratory	9
Total		45
Text Books		
1	K.V. Chaitanya, (2013), <i>Cell and molecular biology</i> : Lab manual, PHI publishers,. ISBN 978-81-203-800-4	

ii. BIOLOGICAL CHEMISTRY

UNIT	Contents	No. of Hours
I	Qualitative Analysis Qualitative analysis of carbohydrates - Glucose, Fructose, Lactose, maltose, sucrose, starch.	14

	Qualitative analysis of amino acids - Tyrosine, Tryptophan, Arginine	
II	Volumetric Analysis: . 1. Estimation of Glycine- Formal Titration. 2. Determination of Ascorbic acid – DCPIP method.	8
III	Colorimetric Analysis 1. Estimation of glucose 2. Estimation of Cholesterol- Zak's method 3. Estimation of proteins – Bradford's method	8
Total		30
Text Books		
1	J. Jayaraman, Laboratory Manual in Biochemistry, New Age International Pvt Ltd Publishers, 2011.	
2	S. K. Sawhney Randhir, Singh, Introductory Practical Biochemistry, Alpha Science International Ltd, 2 nd edition, 2005.	
3	Irwin H. Segel, Biochemical calculations, Liss, Newyork, 1991.	
Reference Books		
1	Dr. O P Panday, D N Bajpai, Dr. S Giri, PRACTICAL CHEMISTRY, S Chand, Revised edition 2016.	
2	Hands Thacher Clarke, A hand book of Oraganic:Qualitative and quantitative Analysis, 2007.	
3	N.S. Gnanapragasam and G. Ramamurthy, Organic chemistry Lab manual, S.Viswanathan Co. Pvt. Ltd., 1998.	

COURSE OUTCOMES (CO)

On completion of this practical course, the learners will be able to:

CO1 (K1 & K2 - Remember & Understand): Identify the optical components of a light microscope, understand the biochemical principles of qualitative tests for biomolecules, and describe the stages of chick embryo development and placental types.

CO2 (K3 - Apply): Apply specific staining and mounting techniques to prepare blood, buccal, and plant cell smears, and operate laboratory instrumentation like colorimeters and centrifuges for cell fractionation.

CO3 (K4 - Analyze): Analyze and differentiate different cell types, organelles, and developmental stages, while distinguishing various carbohydrates and amino acids through systematic qualitative testing.

CO4 (K5 & K6 - Evaluate & Create): Evaluate quantitative biological data obtained via volumetric titrations (glycine, ascorbic acid) and colorimetric assays (glucose, cholesterol, protein), and formulate standard operating protocols based on industrial laboratory exposures.

MAPPING OF COURSE OUTCOMES (Cos) WITH PROGRAMME OUTCOMES(Pos) AND PROGRAMME SPECIFIC OUTCOME(PSOs)

	POs							PSOs						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
CO1	3	3	1	2	0	1	1	3	2	1	2	2	2	2
CO2	2	3	3	2	0	1	1	3	2	3	2	2	2	2
CO3	3	3	2	3	0	2	1	3	3	2	3	2	2	2
CO4	2	3	3	3	0	2	2	3	3	3	2	3	3	3

SKILL ENHANCEMENT COURSE (SEC-1)

MUSHROOM CULTIVATION

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	2				2	2	25	75	100
UNIT	Contents								No. of

		Hours
I	Mushroom: Introduction, Morphology and Types, Identification of edible and poisonous mushroom, Nutritive values	6
II	Mushroom cultivation: prospects and scope of Mushroom cultivation in small scale Industry	5
III	Life cycle of Pleurotus spp and Agaricus spp	5
IV	Spawn production, growth media, spawn running and harvesting of mushrooms and marketing	6
V	Diseases and post harvest technology. Control of Insect pests, nematodes, mites, viruses, fungal competitors and other important diseases	8
Total		30
Text Books		
1	Handbook of Mushroom Cultivation. 1999. TNAU publication	
2	Marimuthu, T., Krishnamoorthy, A.S., Sivaprakasam, K. and Jayarajan. R. (1991). Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore	

3	Sing. 2005. Modern Mushroom Cultivation, International Book Distributors, Dehradun
4	Swaminathan, M. 1990. Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore – 560018
5	Suman. 2005. Mushroom Cultivation Processing and Uses, M/s. IBD Publishers and Distributors, New Delhi

COURSE OUTCOMES (CO)

On completion of this course, the learners will be able to:

- CO1** (K1 & K2 - Remember & Understand): Identify edible and poisonous mushrooms based on morphology, and describe their nutritive value, lifecycle stages (*Pleurotus* and *Agaricus*), and common pest diseases.
- CO2** (K3 - Apply): Apply specific standard procedures for spawn production, selection of growth media, cultivation setups, and optimized harvesting techniques for small-scale operations.
- CO3** (K4 - Analyze): Analyze the structural requirements, environmental parameters, and economic factors governing spawn running, disease management, and market channels.
- CO4** (K5 & K6 - Evaluate & Create): Evaluate post-harvest preservation technologies to maintain quality, and design a comprehensive commercial project plan for setting up a viable small-scale mushroom cultivation startup.

MAPPING OF COURSE OUTCOMES (Cos) WITH PROGRAMME OUTCOMES(Pos) AND PROGRAMME SPECIFIC OUTCOME(PSOs)

	POs							PSOs						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
CO1	3	2	1	2	0	1	2	3	2	1	2	1	2	3
CO2	2	3	3	2	0	1	2	3	2	3	2	1	2	3
CO3	2	3	2	3	0	2	2	3	3	2	3	2	2	3
CO4	2	3	3	3	0	2	2	3	3	3	2	3	3	3

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	2				2	2	25	75	100
UNIT	Contents								No. of Hours
1	Introduction to Biotechnology and Cell Biology: Cell theory, Isolation and growth of cells, Basic properties of cells, Different classes of cells – Prokaryotic and eukaryotic cells.								6
II	Molecular biology: Prokaryotic and Eukaryotic DNA replication, Prokaryotic & Eukaryotic Transcription & Translation.								5
III	Fundamentals of Microbiology: Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.								6
IV	Immunology: Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins, Humoral & Cellular immune responses, T lymphocytes & B lymphocytes								6
V	Recombinant DNA Technology: Molecular tools and applications- restriction enzymes, ligases, Cloning vectors (Natural Plasmid-F, R, Col, Artificial Plasmid), Microinjection and Electroporation.								7
Total									30
Text Books									
1	T. Devasena (2012), Cell Biology, Oxford University Press.								
2	Bruce Alberts, 6 th Edition (2014). Molecular Biology of the cell, W. W. Norton & Company.								
3	Dubey R.C. and Maheswari, S. (2003). A textbook of Microbiology, New Delhi: S. Chand & Co. Prescott, Harley, Klein, Microbiology, 10 th Edition, McGraw – Hill, 2016.								
4	NandiniShetty, 1996, Immunology : introductory textbook – I. New Age International, New Delhi.								

5	Brown T.A, 2015. Gene Cloning and DNA Analysis: An Introduction, 7th edition, Wiley - Blackwell.
Reference Books	
1	Karp's Cell and Molecular Biology: Concepts and Experiments. 8 th Edition (2015). Wiley Publications.
2	LodishHarvey, 6 th Edition (2016), Molecular Cell Biology, W. H. Freeman Publications.
3	Boyd, R.F. (1998). General Microbiology, 2 nd Edition., Times Mirror, Mosby College Publishing, St Louis.
4	Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, 2011. Roitt.s Essential Immunology, 12th edition, Wiley- Blackwell. USA.
5	Primrose.S.B (2014), <i>Principles of gene manipulation</i> , (7th edition), Blackwell Scientific limited, Germany. ISBN: 978-1-405-13544-3
Web Resources	
1	http://www.cellbiol.com/education.php
2	https://dnalc.cshl.edu/websites/
3	https://www.cliffsnotes.com/study guides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology
4	https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/
5	https://www.britannica.com/recombinant-DNA-technology

F. COURSE OUTCOMES (CO)

On completion of this course, the learners will be able to:

CO1 (K1 & K2 - Remember & Understand): Outline basic cell theories, the central dogma of molecular biology, structural features of major microbial groups, the mammalian immune system architecture, and fundamental tools of recombinant DNA technology.

CO2 (K3 - Apply): Apply core biological models to sketch DNA replication, transcription, and translation workflows, and demonstrate how physical vectors or methodologies (like microinjection or electroporation) deliver foreign genes into cells.

CO3 (K4 - Analyze): Analyze and contrast differences between prokaryotic and eukaryotic cellular structures, molecular processes, immune pathways (humoral vs. cellular), and structural specificities of enzymes and cloning vectors.

CO4 (K5 & K6 - Evaluate & Create): Evaluate the selection of specific molecular tools (restriction

enzymes, vectors) for diverse host systems, and design conceptual genetic recombination strategies to target basic biomedical or biotechnological scenarios.

MAPPING OF COURSE OUTCOMES (Cos) WITH PROGRAMME OUTCOMES(Pos) AND PROGRAMME SPECIFIC OUTCOME(PSOs)

	POs							PSOs						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
CO1	3	2	1	1	0	1	1	3	2	1	2	1	2	1
CO2	2	3	3	2	0	1	1	3	2	3	2	1	2	1
CO3	2	3	2	3	0	2	1	3	3	2	3	2	3	1
CO4	2	3	3	3	0	2	2	3	3	3	2	3	3	1

SEMESTER –II

CORE PAPER-III – GENETICS

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

UNIT	Contents	No.of Hours
I	Mendel's experiments, Monohybrid cross, Dihybrid cross, Backcross or Testcross, Mendel's laws. Incomplete dominance. Interaction of Genes- Epistasis -lethal genes. Multiple alleles – In Drosophila, Rabbit and Blood group inheritance in man.	15
II	Linkage - linkage in Drosophila- Morgan's experiments, factors affecting linkage. Crossing over- types, mechanism and significance of crossing over. Mapping of Chromosomes, interference and coincidence. Cytoplasmic inheritance -Carbon dioxide sensitivity in Drosophila and milk factor in mice. Sex –Linked Inheritance and Sex- Determination in Man.	15
III	Fine structure of the gene and gene concept, Operon Concept. Identification of the DNA as the genetic material- Griffith experiments, Avery, McLeod, McCarty and Hershey Chase experiment. Microbial Genetics- Bacterial recombination - Conjugation, Transformation, Transduction and sexduction.	15

IV	Mutation – types of mutation, mutagens, DNA damage and Repair Mechanism. Chromosomal aberrations- Numerical and Structural, Pedigree Analysis-Mendelian inheritance in human.	15
V	Population Genetics– Hardy Weinberg principle, gene frequency, genotype frequency and factors affecting gene frequency. Eugenics, Euphenics and Euthenics.	15
Total		75
Text Books		
1	Dr. Veer Bala Rastogi, 2020, Elements of Genetics, 11 th Revised & Enlarged Edition, Kedar Nath Ram	
2	NathPublications,Meerut,250001.www.knrnpublishations.com, ISBN-978-81-907011-2-9	
3	Verma, P.S. and Agarwal, V.K., 1995. Genetics, 8 th edition, S.Chand& Co., New Delhi – 10055.	
4	Verma, P.S., and Agarwal, V.K., 1995. Cell and Molecular Biology, 8 th edition, S.Chand and Co., New Delhi, 110055.	

Reference Books	
1	Gardener E.J. Simmons M.J. Slustad D. P. 2006. Principles of Genetics
2	Lewis, R.2001. Human Genetics- Concepts and application. 4 th edition. McGraw Hill.
3	Griffiths, Miller, J.H., An Introduction to Genetic Analysis W.H.Freeman. New York.
4	Winter, P.C., Hickey, G.J. and Fletcher, H.L.2000. Instant notes in Genetics. Viva books, Ltd
5	Good enough U. 1985. Genetics. Hold Saunders international.
Web Resources	
1	https://nptel.ac.in/courses/102/106/102106025/
2	http://www.ocw.mit.edu
3	http://enjoy.m.wikipedia.org
4	https://www.acpsd.net

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			4	4	25	75	100
UNIT	Contents								No. of Hours
I	History of Microbiology, Classification of bacteria, fungi, virus, protozoa and algae – classical and molecular approaches. Scope of microbiology, Role of microbes in biotechnology.								15

II	Structure of bacteria - Bacterial growth and measurement, Media – types and preparation- plating methods, staining methods (Gram's, capsule, spore, LCB mount), methods of preservation and storage of microbes. Culture of fungi, virus and algae.	15
III	Sterilization methods - physical and chemical methods- Mode of action. Antibiotic in clinical use, Resistance to antibacterial agents - MRSA, ESBL.	15
IV	Bioinsecticides - <i>Bacillus thuringiensis</i> , Baculoviruses. Biofertilizers - <i>Azospirillum</i> and blue green algae, single cell protein, prebiotics and probiotics, Dairy products (Cheese and Yoghurt).	15
V	Microbial Disease- host -pathogen interaction, clinical features, lab diagnosis and treatment of Airborne disease (Pneumonia, Chicken pox), food borne disease (Typhoid, Aspergillosis), Water borne disease (Cholera, Amoebiasis), Sexually transmitted disease (AIDS, Trichomoniasis), Vector borne disease (Dengue, Malaria).	15
Total		75
Text Books		
1	Pelczar.M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7th Edition., McGraw –Hill, New York.	
2	Dubey R.C. and Maheswari, S. (2003). A textbook of Microbiology, New Delhi: S. Chand & Co.	
3	Ananthanarayanan, Paniker, Kapil, Textbook book of Microbiology, 9th edition, Orient BlackSwan, 2013.	
4	Prescott, Harley, Klein, Microbiology, 10 th Edition, McGraw – Hill, 2016.	
5	Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (Editions) (1994) Methods for General and Molecular Bacteriology. ASM Press, Washington, DC	
Reference Books		
1	Madigan, Martinko, Bender, Buckley, Stahl, Brock Biology of Microorganisms, 14 th edition, 2017.	
2	Gillespie, Bamford, Medical Microbiology and Infection at a Glance, 4 th edition, 2012.	
3	Boyd, R.F. (1998). General Microbiology, 2 nd Edition., Times Mirror, Mosby CollegePublishing, St Louis.	

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

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

F. COURSE OUTCOMES (CO)

On completion of this course, the learners will be able to:

CO1 (K1 & K2 - Remember & Understand): Outline the historical milestones of microbiology, classify major microbial groups, explain bacterial growth mechanics, state the principles of sterilization, and describe key clinical features of prominent microbial diseases.

CO2 (K3 - Apply): Apply specific staining and plating techniques to culture and identify microbes, implement correct sterilization and preservation protocols, and execute laboratory diagnostic strategies for airborne, waterborne, and vector-borne pathogens.

CO3 (K4 - Analyze): Analyze bacterial growth curves, compare classical vs. molecular taxonomy models, distinguish structural cell variations across microbial groups, and analyze the specific modes of action behind chemical sterilants and antibiotic resistance mechanisms (e.g., MRSA, ESBL).

CO4 (K5 & K6 - Evaluate & Create): Evaluate the commercial efficacy of biofertilizers, bioinsecticides, and single-cell proteins, and synthesize tailored microbial processing workflows for producing functional dairy products, prebiotics, and probiotics for industrial biotechnology setups.

MAPPING OF COURSE OUTCOMES (Cos) WITH PROGRAMME OUTCOMES (Pos) AND

PROGRAMME SPECIFIC OUTCOME(PSOs)

	POs							PSOs						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
CO1	3	2	2	2	0	1	1	3	2	1	2	1	2	1
CO2	3	3	3	2	0	1	1	3	2	3	3	2	2	2
CO3	2	3	2	3	0	2	1	3	3	2	3	2	2	2
CO4	2	3	3	3	0	2	2	3	3	3	2	3	3	3

CORE PAPER IV- PRACTICAL II

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

i. GENETICS

UNIT	Contents	No. of Hours
1	Mitotic stages of onion (<i>Allium cepa</i>) root tip Meiotic stages of cockroach testes/ Flower bud/Grasshopper	9
II	Giant chromosomes from <i>Chironomus</i> larvae/ <i>Drosophila</i> salivary glands	9
III	Identification of Barr bodies from Buccal smear	9
IV	Preparations of culture medium and culture of <i>Drosophila</i> – methods of maintenance Identifications of mutants of <i>Drosophila</i>	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	

ii. FUNDAMENTALS OF MICROBIOLOGY

UNIT	Contents	No. of Hours
I	Sterilization techniques – Preparation of Media	6
II	Inoculation techniques- Pour plate, spread plate Isolation of bacteria from various sources and dilution techniques.	6
III	Staining techniques: Simple, Gram's, Capsule (Negative), Spores, Preparation of temporary mounts- Lacto phenol cotton blue staining.	6
IV	Motility tests: Hanging drop technique.	6
V	Biochemical characterization - catalase, oxidase, IMVIC test and TSI. Antibiotic sensitivity test (demonstration).	6
Total		30
Text Books		
1	James G Cappucino and N. Sherman MB(1996). A lab manual Benjamin Cummins, New York 1996.	
2	Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications.	
3	Sundararaj T (2005). Microbiology Lab Manual (1 st edition) publications.	
4	Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International 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, 2 nd Edition, Wm.C.Brown publishers.	
2	Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1 st Edition). Elsevier India.	
3	Talib VH (2019). Handbook Medical Laboratory Technology. (2 nd Edition). CBS.	
4	Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication.	
5	Lim D. (1998). Microbiology, 2 nd Edition, WCB McGraw Hill Publications.	
Web Resources		

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

COURSE OUTCOMES (CO)

On completion of this practical course, the learners will be able to:

CO1 (K1 & K2 - Remember & Understand): Explain the operational principles behind sterilization, pure culture inoculation, staining mechanisms, and the genetic features of chromosomal structures, Barr bodies, and *Drosophila* mutants.

CO2 (K3 - Apply): Apply specific cytogenetic and microbiological protocols to prepare mitotic/meiotic chromosome squashes, isolate pure bacterial cultures from environmental sources using serial dilutions, and perform complex staining procedures.

CO3 (K4 - Analyze): Analyze and differentiate cell division phases, identify phenotypic deviations in *Drosophila* mutants, interpret human karyotypes, and decode bacterial motility and antibiotic zones of inhibition.

CO4 (K5 & K6 - Evaluate & Create): Evaluate bacterial identities by synthesizing profiles from differential biochemical test arrays (IMViC, Catalase, Oxidase, TSI) and formulate systematic troubleshooting protocols for contaminated cultures or media preparation errors.

MAPPING OF COURSE OUTCOMES (Cos) WITH PROGRAMME OUTCOMES(Pos) AND PROGRAMME SPECIFIC OUTCOME(PSOs)

	POs							PSOs						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
CO1	3	2	1	2	0	1	1	3	2	1	3	2	2	1
CO2	2	3	3	2	0	1	1	3	2	3	3	2	2	2
CO3	2	3	2	3	0	2	1	3	3	2	3	3	2	2
CO4	2	3	3	3	0	2	2	3	3	3	2	3	3	2

SKILL ENHANCEMENT COURSE (SEC-2)

VERMITECHNOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	2				1	2	25	75	100
UNIT	Contents								No. of

		Hours
I	Types, Collection and Preservation of earthworms - Types and basic characteristics of species suitable for vermicomposting; Role of earth worms in soil fertility, Biology of <i>Lampitomarutti</i> , Collection and Preservation of Earthworm, Flow sheet for vermi technology	6
II	Culturing techniques of earthworms and composting materials - General method; Pot method; Wooden box method; Propagation. Factor affecting culturing of earthworm, Vermicomposting materials, Preliminary treatment of composting materials	6
III	Small scale techniques of Vermicomposting - Indoor dual bin method; Bed method; Pit method; Heap method; Expandable worm tower assembly method; Hanging basket method. Physical, chemical and biological properties of vermicompost	7
IV	Large scale techniques of Vermicomposting Outdoor dual bin; Raised cage; Dual pit; Commercial model; Trickling filter vermicomposting; Keep it simple and save plan	5
V	Vermiwash and Economics - Chemical composition of vermiwash, Techniques of vermiwash production. Advantages of Vermicomposting, Prospects of vermi-culture as self-employment venture.	6
Total		30
Text Books		
1	The Earthworm book, Ismail, S.A., other India Press, Goa	
2	Somani, L.L. 2008. Vermicomposting and vermiwash. Agrotech Publishing Academy, Udaipur	
3	Talashilkar and Dosani, 2005. Earthworm in Agriculture. Agrobios (India), Jodhpur.	
4	Ranganathan, L.S. 2006. Vermibiotechnology from soil health to human health – Agrobios, India	

COURSE OUTCOMES (CO)

On completion of this course, the learners will be able to:

CO1 (K1 & K2 - Remember & Understand): Identify suitable earthworm species (such as *Lampito mauritii*) for vermicomposting, describe their reproductive biology, outline the processing workflows, and state the nutrient profiles of vermicompost and vermiwash.

CO2 (K3 - Apply): Apply specific standard techniques to collect, preserve, and culture earthworms using diverse small-scale setups (pot, dual-bin, wooden box, or hanging basket methods), including the pre-treatment of organic feedstock waste.

CO3 (K4 - Analyze): Analyze critical operational parameters (such as temperature, moisture, and pH) that affect worm propagation, and compare the functional design layouts of small-scale vs. large-scale commercial composting modules.

CO4 (K5 & K6 - Evaluate & Create): Evaluate the chemical and biological quality of produced vermiwash, and design a scalable, cost-effective commercial vermiculture project model capable of operating as a self-employment venture.

MAPPING OF COURSE OUTCOMES (Cos) WITH PROGRAMME OUTCOMES(Pos) AND PROGRAMME SPECIFIC OUTCOME(PSOs)

	POs							PSOs						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
CO1	3	2	1	2	0	1	1	3	2	1	2	2	2	2
CO2	2	3	3	2	0	1	1	3	2	3	2	2	2	3
CO3	2	3	2	3	0	2	1	3	3	2	3	3	2	3
CO4	2	3	3	3	0	2	2	3	3	3	2	3	3	3

SKILL ENHANCEMENT COURSE (SEC-3)

ESSENTIAL OIL PREPARATIONS

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	2				1	2	25	75	100
UNIT	Contents								No. of

		Hours
1	Essential oils - Source, distribution and applications. Factors affecting the yield and quality. Aromatherapy uses.	5

II	Characterization- boiling point, volatility and solubility, physicochemical properties and Constituents of essential oils.	5
III	Extraction methods –Distillation-Steam distillation, Hydrodistillation, Maceration, Solvent extraction, distillation apparatus, Advantages, LC-MS.	7
IV	Plants yielding essential oil - Morphology, Method of extraction, Medicinal uses of Clove, Sandal, Lemongrass, Eucalyptus and Peppermint.	7
V	Registration, Packing, Storage and utilisation of essential oils. Quality & purity, Grade, Pricing and marketing, Economic benefits.	6
Total		30
Text Books		
1	Aromatic and Medicinal plants, yielding essential oil for pharmaceutical perfumery and cosmetic industry and Trade by Shiva M.P (2002)	
2	Aromatic and vital oil plants by Rajkumar Joshi. Agrotech press New Delhi.(2013).	

COURSE OUTCOMES (CO)

On completion of this course, the learners will be able to:

CO1 (K1 & K2 - Remember & Understand): Identify natural sources of essential oils, outline factors affecting their yield and quality, describe the botanical morphology of key aromatic plants (Clove, Sandal, Lemongrass, Eucalyptus, Peppermint), and list their applications in aromatherapy and medicine.

CO2 (K3 - Apply): Apply suitable extraction methodologies—such as steam distillation, hydrodistillation, maceration, or solvent extraction—using standard distillation apparatuses tailored to specific aromatic plant tissues.

CO3 (K4 - Analyze): Analyze the physicochemical traits (boiling point, volatility, solubility) and chemical constituents of complex essential oils, and interpret analytical fingerprinting data obtained via LC-MS instrumentation.

CO4 (K5 & K6 - Evaluate & Create): Evaluate product purity, grading standards, regulatory registration requirements, and packaging/storage models to design a comprehensive pricing and marketing strategy for a commercial essential oil enterprise.

MAPPING OF COURSE OUTCOMES (Cos) WITH PROGRAMME OUTCOMES(Pos) AND PROGRAMME SPECIFIC OUTCOME(PSOs)

	POs							PSOs						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
CO1	3	2	1	2	0	1	2	3	2	1	2	2	2	2
CO2	2	3	3	2	0	1	2	3	2	3	2	2	2	3
CO3	2	3	2	3	0	2	2	3	3	2	3	2	2	3
CO4	2	3	3	3	0	2	2	3	3	3	2	3	3	3

Course	ELECTIVE III
Title of the Course	(B) FOOD & NUTRITION
Credits	2
Hours/Week	4

Unit	Course Content	Teaching Hours
UNIT I	Definition and basis of food and nutrition, Different Food groups and classification, Nutritional significance and physiological role of food groups, Protein Energy Malnutrition (PEM), definition and types, Treatment and preventive measures of PEM.	5 hours
UNIT-II	Introduction to Vitamins., Fat soluble vitamins, Water soluble vitamins	5 hours
UNIT – III	Introduction to calorific value and nutritive value, Bomb calorimeter, Measurement of calorific value and nutritive of foods, RQ value, BMR and SDA of food stuffs. Nutritive value of proteins and amino acids, Balanced diet, composition of balanced diet for pregnant woman, infants, old age.	5 hours
UNIT – IV	Definitions of food adulterations and food poisoning, Sources of foods and types of adulterants, advantages and disadvantages of adulteration, Constituents of foods, carbohydrates, proteins, fats, oils, Flavours, colours and natural toxicants, Sources causes and remedies for acidity, gastritis, indigestion and constipation.	5 hours

UNIT-V	Introduction to food spoilage- Causes and types of food spoilage, types of food preservation and food processing.	5 hours
	Total Lecture hours	30

Text book:

1. Albanese, Anthony A Ed, Protein And Amino Acid Nutrition Academic Press New York 1959.
 2. Devlin T.M., Biochemistry by Stryer Text book of Biochemistry with clinical correlations.
 3. Lehninger, Principles of Biochemistry, by 4th Ed. By Nelson D.L. and Cox. M.M. 6
 4. Murray R.K., Grammer, D.K., Mayer P.A., Rodwell V.W., Harpers Biochemistry, alange medical book 26thEd. Mc. Graw Hill, Health Professions Division.
 5. West. E.S., Todal, W.R., Mason H.S. and Van Brygen J.T., Text Book of Biochemistry.
 6. Mayer, J., Human Nutrition, Charles, C. Thomas, spring field.
 7. Michael, J. Gibney, Barrie, M. Margetis, John, M. Kearney. Lenore Arab. PublicHealth Nutrition. Blackwellscience, Blackwell Publishing Company (2004).
 8. Frazier, We, Food Microbiology, Tata Mc Graw₄₆Hill 19789. Meyer, Lilian H. Ed. (1987), Food chemistry. Indian Ed. CBS Publishers and Distributors
 10. Barker, D.J. P (1998), Mothers, Babies and Health in later life. Edinburgh, Churchill livingstone.
 11. Ward, R.H.T; Smith, S.K. Donnai, D. (Eds.) (1994) Early fetal Growth and Development. London, & COG Press.
 12. Wallace, H.M. and Giri, K. (1990), Health care of women and children indevelopingcountries, third party publishing co.Oakland.
- Seema yadav: - Food Chemistry, anmol publishing (P) Ltd, New Delhi
- Car H.Synder: -the extraordinary chemistry for ordinary things, John Wiley & sonsinc, New York, 1992.
- B.Sivasankar – food processing and preservation – PHI learni9ng (P) LTD , New Delhi – 11001.

Course Material: website links, e-Books and e-journals

1. <https://chico-primo.hosted.exlibrisgroup.com>

COURSE OUTCOMES (CO)

On completion of this course, the learners will be able to:

CO1 (K1 & K2 - Remember & Understand): Define the fundamental concepts of food groups, vitamins, and metabolic metrics (BMR, SDA, RQ), and describe the causes, symptoms, and preventive measures for Protein Energy Malnutrition (PEM) and food spoilage.

CO2 (K3 - Apply): Apply nutritional principles to design balanced diets for specific demographic groups—including infants, pregnant women, and the elderly—and implement appropriate food preservation and processing methods to extend shelf life.

CO3 (K4 - Analyze): Analyze the calorific and nutritive value of food substances using tools like the Bomb calorimeter, and differentiate between various types of food adulterants, natural toxicants, and causes of gastrointestinal distress (gastritis, acidity).

CO4 (K5 & K6 - Evaluate & Create): Evaluate the safety and quality of food products by assessing adulteration risks and toxicological constituents, and synthesize therapeutic dietary remedies to address nutritional deficiencies and food-borne illnesses.

MAPPING OF COURSE OUTCOMES (Cos) WITH PROGRAMME OUTCOMES(Pos) AND PROGRAMME SPECIFIC OUTCOME(PSOs)

	POs							PSOs						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
CO1	3	2	1	2	0	1	1	3	2	1	2	1	2	1
CO2	2	3	3	2	0	1	2	3	2	3	2	1	2	2
CO3	2	3	2	3	0	2	1	3	3	2	3	2	2	2
CO4	2	3	3	3	0	2	2	3	3	3	2	3	3	3