MOTHER TERESA WOMEN'S UNIVERSITY

KODAIKANAL - 624 101
Tamil Nadu.

DEPARTMENT OF BIOTECHNOLOGY

Curriculum Framework and Syllabus for

B.Sc. BIOTECHNOLOGY

(For the candidates to be admitted from the academic year 2021-2022 onwards)

(UNDER CHOICE BASED CREDIT SYSTEM- CBCS)

Mother Teresa Women's University, Kodaikanal
Department of Biotechnology
Choice Based Credit System (CBCS)
(2021-2022 onwards)
B.Sc. Biotechnology

1. About the Programme

B.Sc., Biotechnology is a 3 year Undergraduate Programme and the Programme is offered through six semesters providing a strong foundation of biotechnological concepts. This Programme is rationalized to bestow students with an improved knowledge of the basic cellular and molecular level and acquire an indepth knowledge of biotechniques. The meticulously structured Programme has a strong interdisciplinary research base in biological sciences which prepares the student for the industry as well as research programmes. Graduates in this discipline significantly will contribute to research and development for society's welfare in terms of Environment, Agriculture and Medicine.

2. Programme Educational Objectives (PEOs)

PEO1	To disseminate knowledge to the students to shape a successful career in Biotechnology.
PEO2	To equip the students with fundamental concepts to handle scientific challenges.
PEO3	To emphasize the need for skilled biotechnologists in the modern scientific society.
PEO4	To create awareness regarding the professional demands and opportunities in the field of biotechnology.
PEO5	To persuade the students to move for higher studies and research to contribute scientifically to the society.

3. Eligibility

i. Candidate should have passed the Higher Secondary Examination conducted by the Board of Higher Secondary Examination, Govt. of Tamilnadu or any other Examination accepted by the syndicate as equivalent there to with at least one of the following subject Biology/Botany/Zoology.

ii. Candidate should have secured atleast 55% in the above subject and above in the aggregate.

iii. A relaxation of 10% in the total percentage will be given to SC, ST candidates.

4. General Guidelines for UG Programme

i. **Duration:** The programme shall extend through a period of 6 consecutive semesters and the duration of a semester shall normally be 90 days or 450 hours. Examinations shall be conducted at the end of each semester for the respective subjects.

ii. **Medium of Instruction:** English

iii. **Evaluation:** Evaluation of the candidates shall be through Internal Assessment and External Examination.

- **Evaluation Pattern**

Evaluation Pattern	Theory		Practical	
	Min	Max	Min	Max
Internal	**10**	**25**	**10**	**25**
External	**30**	**75**	**30**	**75**

- **Internal (Theory): Test (15) + Assignment (5) + Seminar/Quiz(5) = 25**
- **External Theory: 75**

- **Question Paper Pattern for External examination for all course papers.**

Max. Marks: 75 **Time: 3 Hrs.**

S.No.	Part	Type	Marks
1	**A**	**10*1 Marks=10** Multiple Choice Questions(MCQs): 2 questions from each Unit	**10**
2	**B**	**5*4=20** Two questions from each Unit with Internal Choice (either / or)	**20**
3	**C**	**3*15=45** Open Choice: Any three questions out of 5 : one question from each unit	**45**
Total Marks			**75**

*** Minimum credits required to pass: 156**

- **Project Report**

A student should select a topic for the Project Work at the end of the third semester itself and submit the Project Report at the end of the fourth semester. The Project Report shall not exceed 75 typed pages in Times New Roman font with 1.5 line space.

- **Project Evaluation**

There is a Viva Voce Examination for Project Work. The Guide and an External Examiner shall evaluate and conduct the Viva Voce Examination. The Project Work carries 100 marks (Internal: 25 Marks; External (Viva): 75 Marks).

5. Conversion of Marks to Grade Points and Letter Grade

(Performance in a Course/ Paper)

Range of Marks	Grade Points	Letter Grade	Description
90 – 100	9.0 – 10.0	O	Outstanding
80-89	8.0 – 8.9	D+	Excellent
75-79	7.5 – 7.9	D	Distinction
70-74	7.0 – 7.4	A+	Very Good
60-69	6.0 – 6.9	A	Good
50-59	5.0 – 5.9	B	Average
40-49	4.0 – 4.9	C	Satisfactory
00-39	0.0	U	Re-appear
ABSENT	0.0	AAA	ABSENT

6. Attendance

Students must have earned 75% of attendance in each course for appearing for the examination. Students with 71% to 74% of attendance must apply for condonation in the Prescribed Form with prescribed fee. Students with 65% to 70% of attendance must apply for condonation in the Prescribed Form with the prescribed fee along with the Medical Certificate. Students with attendance lesser than 65% are not eligible to appear for the examination and they shall re-do the course with the prior permission of the Head of the Department, Principal and the Registrar of the University.

7. Maternity Leave

The student who avails maternity leave may be considered to appear for the examination with the approval of Staff i/c, Head of the Department, Controller of Examination and the Registrar.

8. Any Other Information

In addition to the above mentioned regulations, any other common regulations pertaining to the UG Programmes are also applicable for this Programme.

Program Outcomes (POs)

Upon completion of the B. Sc Biotechnology programme, the students will be able to

PO1	elucidate the key concepts and principles of Biotechnology.
PO2	employ the knowledge of biotechnology to make scientific queries and understand recent advancements in biotechnology.
PO3	exhibit proficient skills in handling sophisticated and advanced scientific instruments.
PO4	achieve expertise in different aspects of basic biotechnology.
PO5	apply the concepts of biotechnology to study the fundamentals of different bio-techniques
PO6	utilize the theoretical and practical knowledge in their higher studies and careers.
PO7	apply the scientific skills acquired to develop a sustainable environment for the society.
PO8	use the scientific knowledge obtained to develop and support the Indian economy.

9. Program Specific Outcomes (PSOs)

On completion of B. Sc. BiotechnologyProgramme, the students will be able to

PSO1	enrich the knowledge in the basic concepts and principles of Biotechnology.
PSO2	apply the theoretical and practical knowledge of Biotechnology in gaining a successful career.
PSO3	work as entrepreneurs and techno managers with strong ethics and communication skills.
PSO4	interact effectively with people in the field of Biotechnology and allied industries in designing, developing, and providing solutions for product/ processes/ Technology/ Development.
PSO5	be proficient with basic laboratory skills and hands on training reuired for higher studies and research.

MOTHER TERESA WOMEN'S UNIVERSITY, KODAIKANAL

Framework of the Syllabus to be implemented from the Academic Year 2021-2022
Curriculum Framework and Syllabus for

B.Sc. BIOTECHNOLOGY

(For the candidates to be admitted from the academic year 2021-2022 onwards)

Paper No.	Paper Code	Course Title	Credits	Hours		(CIA)	(ESE)	Total
				T	P			
Semester I								
1	U21LTA11	Tamil I- Part – I	3	6		25	75	100
2	U21LEN11	English I-Part- II	3	6		25	75	100
3	U21BTT11	Core I- Cell and Molecular Biology	4	6		25	75	100
4	U21BTT12	Core II- Genetics	4	5		25	75	100
5	U21BTA11	Allied I- Taxonomy and Plant Physiology	4	5		25	75	100
6	U21EVS11	Environmental Studies	2	2		25	75	100
7	U21PELS11	Professional English - I	4	6		25	75	100
		Total	**24**	**36**				**700**
Semester II								
8	U21LTA22	Tamil II -Part- I	3	6		25	75	100
9	U21LEN22	English II-Part- II	3	6		25	75	100
10	U21BTT21	Core III- Biochemistry	4	5		25	75	100
11	U21BTP21	Core IV – Practical - Biochemistry	4		5	25	75	100
12	U21BTA22	Allied II - Animal Physiology	4	5		25	75	100
13	U21VAE21	Value Education	3	3		25	75	100
14	U21PELS22	Professional English - II	4	6		25	75	100
		Total	**25**	**36**				**700**
Semester III								
15	U21LTA33	Tamil III- Part I	3	6		25	75	100
16	U21LEN33	English III -Part -II	3	6		25	75	100
17	U21BTT31	Core V- Developmental Biology	4	5		25	75	100
18	U21CHA33	Allied - Chemistry	4	5		25	75	100
19	U21BTE311/ U21BTE312	Elective I- Endocrinology/Nutrional Biochemistry	3	4		25	75	100
20	U21MSS31	Skill Based Elective I - Managerial Skills	2	2		25	75	100

21		Non Major Elective I	2	2		25	75	100
		Total	**21**	**30**				**700**
Semester IV								
22	U21LTA44	Tamil IV-Part –I	3	6		25	75	100
23	U21LEN44	English IV-Part –II	3	6		25	75	100
24	U21BTT41	Core VI- Microbiology	4	4		25	75	100
25	U21BTP42	CoreVII- Practical - Microbiology	4		4	25	75	100
26	U21CHA43	Allied IV- Practical - Chemistry	4	4		25	75	100
27	U21BTE421/ U21BTE422	Elective II-Seed Technology/Biofertilizer	3	3		25	75	100
28	U21CSS42	Skill Based Elective II- Computer Skills for Office Management	2	2		25	75	100
29		Non Major Elective II	2	2		25	75	100
		Total	**25**	**31**				**800**
Semester V								
30	U21BTT51	Core VIII- Immunology	4	5		25	75	100
31	U21BTT52	Core IX - Principles of Animal Biotechnology	4	5		25	75	100
32	U21BTT53	Core X- Basics of Plant Biotechnology	4	5		25	75	100
33	U21BTP53	Core XI - Bioinstrumentation	4	5		25	75	100
34	U21BTP54	Core XII-Practical - Immunology, Principles of Animal Biotechnology and Basics of Plant Biotechnology	4		5	25	75	100
35	U21BTE531/ U21BTE532	Elective III - Forestry/ Biodiversity Conservation	3	3		25	75	100
36	U21BTS531/ U21BTS532	Skill Based Elective – III – Medical Lab Technology / Food Processing Technology	2	2		25	75	100
		Total	**25**	**30**				**700**
Semester VI								
37	U21BTT61	Core XIII – Environmental	4	5		25	75	100

		Biotechnology						
38	U21BTT62	Core XIV – Fermentation Technology	4	5		25	75	100
39	U21BTT63	Core XV - Bioinformatics	4	5		25	75	100
40	U21BTT64	Core XVI- Biostatistics	4	5		25	75	100
41	U21BTP65	Core XVII- Practical- Environmental Biotechnology, Fermentation Technology & Bioinformatics	4		5	25	75	100
42	U21BTE641/ U21BTE642	Elective IV - Biosafety and IPR/ Food Biotechnology	3	3		25	75	100
43	U21BTS641/ U21BTS642	Skill Based Elective –IV- Mushroom Cultivation/ Single Cell Protein	2	2		25	75	100
44	U21EAS61	Extension Activity (NSS/NCC/YRC/Physical Education)	3			100		100
		Total	**28**	**30**				**800**
Grand Total			**148**	**193**				**4400**

Extra Credit Course:
U21BTO31 - Online Course – III Semester
U21BTI41 - Internship – IV Semester
U21BTV51 - Value added course – V Semester (Dairy Technology)
Each carries 2 Credits to be included as additional credit courses.

Non Major Elective

NME - I	U21BTN31	Vermitechnology
NME - II	U21BTN42	Intellectual Property Right

SEMESTER – I

Course Code	U21BTT11	CELL AND MOLECULAR BIOLOGY	L	T	P	C
CORE - I			6	-	-	4

Cognitive Level	**K2: Understand** **K3: Apply** **K4: Analyze**
Learning Objective	• To make the students exposed to the structure of cells • To make the students understand the function of cell organells • To understand the concepts of cell cycle • To learn the process of replication, transcription and translation
Unit I	**The plant cell**
Structure and function of cell wall, membrane, chloroplast,mitochondria, ribosomes, peroxisomes, Golgi apparatus, nucleus, Nucleolar organizer and ER.	
Unit II	**Cell cycle**
Mitosis and meiosis, pairing, crossing over and cytokinesis.Transposons and Plasmids.	
Unit III	**Chromosomes**
Morphology and chemistry, Chromatin organization – C- valueparadox. Mechanism of DNA: Enzymes and Proteins involved in DNA replication – DNA polymerases, DNA Ligase, Primase and telomerase.	
Unit IV	**Transcription**
Transcription, RNA splicing – post transcriptional modification. Enzymes involved in transcription.	
Unit V	**Translation**
Translation – mechanisms of initiation, elongation and termination of polypeptides. Post translational modifications – targeting of proteins to different cellular components	
Text Books	1. S. C. Rastogi, Cell Biology, New Age International Publishers, 2019. 2. P. S. Verma, V. K. Agarwal, Cell Biology, S. Chand Publishing, 2016. 3. N. Arumugam, Cell Biology and Molecular Biology, Saras Publication, 2014. 4. Gerald Karp, Cell Biology 7 th Edition, Wiley, 2013. 5. Ajoy Paul, Textbook of Cell and Molecular Biology, Books & Allied Ltd. , 2011

References Books	1. SP Vyas, A.Mehta Cell and molecular biology- by CBS Publishes 2019. 2. Gerald Karp, Cell Biology, One buy Publisher,2014. 3. Donald E. Bianchi Philip Sheeler, Cell and molecular biology , 3RD Edition, Wiley India Pvt.Ltd , 2011. 4. S.C.Rastogi, Cell and Molecular Biology,New Age international publishers, 2012.		
E-reference links:	1. https://microbenotes.com/cell-organelles/ 2. https://www2.le.ac.uk/projects/vgec/highereducation/topics/cellcycle-mitosis-meiosis 3. https://medlineplus.gov/genetics/understanding/basics/chromosome/ 4. https://biologydictionary.net/transcription/		
Course Outcomes	At the end of the course, the student will be able to		
	CO1	comprehend the structure and function of the plant cell.	**K2**
	CO2	understandthe importance of cell cycle.	**K2**
	CO3	gain knowledge in the organization of chromosomes and replication of DNA	**K2**
	CO4	illustrate the mechanisms in the process of transcription.	**K3**
	CO5	analyse the factors required for the translation and post translational modifications	**K4**

Mapping of COs with POs & PSOs:

CO	**PO**								**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	M	S	S	S	S	S	S	M	S	M	S
CO2	S	M	S	S	M	M	M	M	S	S	S	M	M
CO3	M	S	S	S	M	S	S	S	M	S	M	S	S
CO4	M	S	M	M	S	S	M	M	S	S	S	S	S
CO5	S	M	S	M	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

CODE	U21BTT12	THEORY - GENETICS	L	T	P	C
CORE II			5	-	-	4

Cognitive Level	**K2: Understand** **K3: Apply** **K4: Analyze**
Learning Objective	• To acquaint with the concepts in genetics. • To understand the concepts in mendalian genetics • To learn the concepts in gene interaction • To learn the human genetic traits, chromosomal abnormalities and population genetics
Unit I	**Classical genetics:**
Mendelian laws – monohybrid, dihybrid inheritance –complete, incomplete and co-dominance – lethal factor – allelic and non-allelic gene interaction – complementary and supplementary genes – epistasis – Pleotrophism.	
Unit II	**Inheritance:**
Multiple alleles and blood groups antigens. Quantitative inheritance Sex determination and sex linked inherited disorders – X – linked, Y – linked inheritance.	
Unit III	**Chromosome and Pedigree:**
Chromosome organization – linkage and crossing over-theories and types. Maternal inheritance. Pedigree studies: Symbols used in pedigree analysis.	
Unit IV	**Chromosomal abnormalities:**
Structural and numerical- deletion, duplication, translocation, inversion – number: Autosomal disorder-Down's syndrome, Edward's syndrome-sex chromosomal-turner's syndrome, klenefelters syndrome. Mutation – gene mutation – molecular basis of mutation	
Unit V	**Population genetics**:
Hardy Weinberg equilibrium, gene pool, Eugenics, Prevention of disease: Prenatal diagnosis; Genetic counseling	
Text Books	1. BenjaminA.pierce ,Genetics A conceptual Approach,W.H Freeman, 2016. 2. ProfessorBrooker R.G ,Genetics,McGraw Hill Education, 2014. 3. Hartwell,L.H.etal,Genetics From Genes to Genome, McGraw Hill Education 2014.
Reference Books	1. B.D.Singh, Fundamentals of Genetics, kalyaniPublishers , 2014. 2. Veer BalaRastogi ,Genetics,MEDTECK , 2019 . 3. Klug,Cummings, Spencer ,Concepts of Genetics, Pearson, 2019. S.S. Randhawa, A text book of Genetics, PeeVee ,2017.
E-reference links:	1. https://courses.lumenlearning.com/boundless-biology/chapter/laws-of-inheritance/

<table>
<tr><td></td><td colspan="3">2. https://www.ncbi.nlm.nih.gov/books/NBK21850/
3. https://biologydictionary.net/multiple-alleles/#:~:text=Multiple%20alleles%20exist%20in%20a,is%20called%20a%20homozygous%20genotype.
4. https://nptel.ac.in/content/storage2/courses/102103012/pdf/mod2.pdf
5. https://www.ncbi.nlm.nih.gov/books/NBK21578/
6. https://plato.stanford.edu/entries/population-genetics/</td></tr>
<tr><td rowspan="6">Course Outcomes</td><td colspan="3">Upon completion of this course, the students will be able to</td></tr>
<tr><td>CO1</td><td>describe the classical concepts of Mendelian genetics across life-forms.</td><td>K2</td></tr>
<tr><td>CO2</td><td>understand the concepts of multiple alleles and sex linkeddisorders.</td><td>K2</td></tr>
<tr><td>CO3</td><td>illustrate the chromosome organization and pedigree analysis.</td><td>K3</td></tr>
<tr><td>CO4</td><td>compare and contrast the chromosomal traits in different chromosomal disorders.</td><td>K4</td></tr>
<tr><td>CO5</td><td>know about population genetics and learn the ways to prevent chromosome disorders.</td><td>K2</td></tr>
</table>

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	M	S	S	S	S	M	S	M	M	S
CO2	M	M	M	M	S	M	M	M	M	M	S	M	M
CO3	S	S	M	S	S	S	S	M	S	M	M	M	S
CO4	M	M	S	S	M	S	S	S	S	S	S	S	M
CO5	M	S	S	S	M	S	M	S	S	S	S	S	M

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Code	U21BOA11	TAXONOMY AND PLANT PHYSIOLOGY	L	T	P	C
Allied - I			5	-	-	4
Cognitive Level		**K2: Understand K3: Apply K4:Analyse**				
Learning Objective		• To know the Kingdom andclassification of plants • To learn the structure and morphology of plants. • To gain knowledge on the physiological functioning of plants.				
Unit I		**Terminology of flower and floral parts:**				
Morphology – Inflorescence – types- racemose, cymose, mixed and special types. Descriptive Fruit-classification. Details of simple, fleshy, dry dehiscent and dry indehiscent, aggregate and multiple fruits.						
Unit II		**Taxonomy:**				
Binomial nomenclature. Systems of classification-Bentham &Hooker.A detailed study of the following families and their Economic Importance - Annonaceae, Leguminosae, Asclepiadaceae, Caesalpinoideae, (Caesalpiniaceae) &Mimosoideae (Mimosaceae), Cucurbitaceae, Apiaceae, Gramineae (Poaceae).						
Unit III		**Water relation:**				
Significance, - osmotic and non-osmotic uptake of water. Ascent of sap-cohesion theory: root pressure, transpiration, physiology of stomatal Action, Translocation of solutes and assimilates. Mineral uptake: Passive and active. Role of major and minor elements, mineral deficiency symptoms.						
Unit IV		**Photosynthesis:**				
Role of pigments enhancement effect, photosystems I & II Photosynthetic electron transport, Photophosphorylation, Carbon Assimilation: Calvin cycle Hatch &Salck pathway, CAM pathway.						
Unit V		**Plant Growth:**				
Regulatory substances; auxin, kinins, gibberellins, abscissic acid and their function. Photoperiodism, phytochrome-vernalization.						
Text Books		1. Annie Ragland, V. Kumaresan, A Text Book of Botany-Volume – I, Saras Publication,2015. 2. Annie Ragland, V. Kumaresan, A Text Book of Botany Volume – II, Saras Publication,2015. 3. Annie Ragland, V. Kumaresan, A Text Book of Botany Volume– III, Saras Publication,2015. 4. Annie Ragland, V. Kumaresan, A Text Book of Botany Volume – IV, Saras Publication,2015. 5. V. Kumaresan, Annie Ragland, Taxonomy of Angiosperms, Saras Publication, 2014.				

Reference Books	1. S. L. Kochhar, SukhbirKaurGujrat ,Plant Physiology: Theory and Applications, Cambridge University Press, 2021. 2. Dr. R P. Singh, Plant Anatomy, Physiology and Taxonomy ,KK Publication, 2014. 3. V. K. Jain, Fundamentals of Plant Physiology ,S Chand Publishing, 2017. 4. Lincoln Taiz, Eduardo Zeiger, Plant Physiology ,Sinauer Associates, 2016. 5. Dr. P. C. Vashishta, Dr. A. K. Sinha, Dr Anil Kumar, Botany for Degree Gymnosperms , S. Chand & Company, 2011.		
E-reference Links	1. https://forestrypedia.com/floral-terminology-illustrated/ 2. https://www.biologydiscussion.com/plants/families-of-flowering-plants-and-their-economic-importance/6580 3. https://ssec.si.edu/stemvisions-blog/what-photosynthesis 4. https://biologydictionary.net/c3-c4-cam-plants/ 5. http://www.omafra.gov.on.ca/english/crops/hort/plantgrowthregulators.htm		
Course Outcomes	Upon completion of this course, the students will be able to		
	CO1	list the terminologies in taxonomy.	**K2**
	CO2	illustrate the key concepts in Bentham and Hooker classification.	**K3**
	CO3	understand the different types of water, solute and mineral uptake in plants.	**K2**
	CO4	understand and demonstrate the process of photosynthesis.	**K3**
	CO5	compare the role of different regulatory substances in plant growth.	**K4**

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	S	S	S	M	S	S	S	S	S
CO2	S	S	S	S	M	S	S	S	S	S	S	M	S
CO3	M	M	S	M	S	M	S	S	S	M	S	S	S
CO4	S	S	M	M	S	S	M	S	S	S	S	M	M
CO5	S	M	S	S	S	S	S	M	S	S	S	M	S

Strongly Correlating (S) - 3 marks ;Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ;No Correlation (N) - 0 mark

SEMESTER – II

CODE	U21BTT21	BIOCHEMISTRY	L	T	P	C
CORE III			5	-	-	4

Cognitive Level	**K2: Understand K3: Apply**
Learning Objective	▪ To gain knowledge about biomolecules and their influence in day to day life ▪ To learn the nomenclature of different carbohydrates, lipids and amino acids. ▪ To learn about function, structure and various concepts of biomolecules
Unit I	**Carbohydrates**
Classification of Carbohydrates .structural elucidation of glucose and fructose. Properties, structure and biological functions of mono, di, oligo and polysaccharides. Homoglycans and Heteroglycans. Carbohydrate metabolism: Glycolysis and TCA cycle; Glycogenesis; Glycogenolysis; Gluconeogenesis	
Unit II	**Amino acids**
Structure, classification, physical and chemical properties. Peptides, peptide bond, biologically important peptides. **Proteins**: classification and Biological importance. Primary structure, Secondary, tertiary and quaternary structure. Ramchandranplot	
Unit III	**Nucleic acids**
DNA and RNA, Components of mono nucleotides, Purines and pyrimidine's: Physical properties and structure of double stranded DNA (A, B and Z DNA). The biological significance of double strandedness. Types of RNAs and their biological significance.	
Unit IV	**Lipids**
Nomenclature, classification and Biological significance. Simple lipids: types of fatty acids, triglycerides, waxes, steroids. Compound lipids: Phospholipids, sphingolipids and glycolipids, Lipoproteins; Structure and functions of lipoproteins; Role of lipids in bio membrane	
Unit V	**Vitamins**
Source, structure, biological role, daily requirement and deficiency manifestation of the fat soluble vitamins A,D,E & K. Water soluble vitamins-Ascorbic acid, thiamine, riboflavin, pyridoxine, niacin, pantothenic acid, lipoicacid, biotin, folic acid and vitamin B12.	
Text Books	1. T. Devasena ,Biomolecules , MJP Publishers, 2011. 2. Mohan P Arora ,Biomolecules , Himalaya publishing House ,Ist edition, 2012. 3. S. AzhaguMadhavan, P. Vinotha, V. Uma, Chemistry of Biomolecules, Notion Press , 2020.

Reference Books	1. P.K.Gupta ,Biomolecules and cell Biology, Rastogi Publication, 2017-2018. 2. Arihant Experts, Handbook of Chemistry , ArihantPubklications,

	2020. 3. Voet and Voet, Biochemistry ,John Wiley, 4 th edition, 2011. 4. Keith Wilson and John Walker, Principle and Techniques of Biochemistry and Molecular Biology ,Cambridge university Press, 2013. 5. Lehninger,Principles of Biochemistry,W H Freeman &co ,2017.
E-reference links:	1. https://microbenotes.com/carbohydrates-structure-properties-classification-and-functions/ 2. https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3A_Biochemistry_Free_For_All_(Ahern_Rajagopal_and_Tan)/02%3A_Structure_and_Function/202%3A_Structure_Function_-_Amino_Acids 3. https://www.thoughtco.com/protein-function-373550 4. https://www.healthline.com/nutrition/micronutrients#definition 5. https://courses.lumenlearning.com/boundless-biology/chapter/nucleic-acids/ 6. https://www.verywellhealth.com/what-is-a-lipid-5084584
Course Outcomes	At the end of the course, the student will be able to
	CO1 understand about the classification of carbohydrates - Properties, structure and biological functions
	CO2 knowamino acids-structure, classification, physical and chemical properties.
	CO3 illustrate the structure and functions of nucleic acids
	CO4 gain knowledge on lipids- classification and biological
	CO5 know the importance of vitamins and their deficiency problems

Mapping of COs with POs & PSOs:

CO	**PO**								**PSO**				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	S	S	S	S	M	M	S	S	S	S	S	S
CO2	S	S	S	S	M	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	M
CO4	S	S	M	S	S	S	S	S	M	S	S	M	M
CO5	S	S	S	S	S	S	S	S	M	M	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

<table>
<tr><td colspan="2">Course Code U21BTP21</td><td colspan="3" rowspan="2">PRACTICAL - BIOCHEMISTRY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">CORE IV</td><td>-</td><td>-</td><td>5</td><td>4</td></tr>
<tr><td colspan="2">Cognitive Level</td><td colspan="6">K2: Understand K3: Apply K4: Analyse K5: Evaluate</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="6">• To know the fundamental aspects in biological phenomenon.
• To develop the skills in identifying the various biomolecules
• To develop the skills of quantifying the various biomolecules</td></tr>
<tr><td colspan="2">Experiments in Biochemistry</td><td colspan="6">1. Estimation of Protein – Lowry’s method.
2. Estimation of DNA by DPA Method
3. Estimation of RNA by Orcinol method
4. Estimation of Sugars by Benedict method
5. Estimation of Lipids
6. Analysis of Oils- Iodine Number- Saponification Value –Acid Number.
7. Estimation of Vitamin C.
8. Paper Chromatography.
9. Preparation of Buffer- Phosphate, Acetate, Tris.
10. Principles of Colorimeter, Spectrophotometer and pH.
11. Determination of Normality, Molarity, Molality, Percent Solution</td></tr>
<tr><td colspan="2">References</td><td colspan="6">1. David T. Plummer, An introduction to practical bio-chemistry. Tata McGraw publication 2008
2. Pattabiraman, Laboratory manual in bio-chemistry. Pineapple research ststion 2015
3. J. Jayaraman, Practical bio-chemistry. Jaypee brothers medical 2013
4. Keith Wilson & John Walker, Principle and Techniques of Biochemistry and Molecular Biology Cambridge university Press, 2010</td></tr>
<tr><td colspan="2">E- references Links</td><td colspan="6">1. https://www.thoughtco.com/protein-function-373550
2. https://www.healthline.com/nutrition/micronutrients#definition
3. https://courses.lumenlearning.com/boundless-biology/chapter/nucleic-acids/
4. https://www.verywellhealth.com/what-is-a-lipid-5084584</td></tr>
<tr><td colspan="2">Course Outcomes</td><td colspan="6">Upon completion of this course, the students will be able to</td></tr>
<tr><td colspan="2" rowspan="5"></td><td>CO1</td><td colspan="3">analyse the role of chemical constituents required for the estimation of biomolecules.</td><td>K4</td></tr>
<tr><td>CO2</td><td colspan="3">illustrate the principle behind the estimation ofprotein, DNA and RNA.</td><td>K3</td></tr>
<tr><td>CO3</td><td colspan="3">organize the laboratory setup for oil analysis using iodine and acid number.</td><td>K5</td></tr>
<tr><td>CO4</td><td colspan="3">learn about the basic procedureof paper chromatography.</td><td>K5</td></tr>
<tr><td>CO5</td><td colspan="3">learn about the basic preparation of buffers and the principles of basic instruments.</td><td>K3</td></tr>
</table>

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	M	S	M	M	S	S	M	M	S	S
CO2	S	S	S	M	M	S	M	M	S	M	M	S	S
CO3	M	M	S	M	S	S	M	S	S	S	S	S	M
CO4	M	M	M	S	S	S	S	S	M	S	S	M	M
CO5	S	S	S	S	S	S	S	S	M	M	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Code	U21ZOA22	ANIMAL PHYSIOLOGY	L	T	P	C
ALLIED II			5	-	-	4
Cognitive Level		**K2: Understand K3: Apply K5:Evalute**				
Learning Objective		• To get knowledge about different Systems In the Body • To get basic Knowledge on Functioning of Different organs. • To make the students Know about Reproductive system in humans.				
UNIT I		**Introduction to Organs of Digestion:**				
Role of enzymes in carbohydrate, Protein and Fat Digestion ,absorption of digested food materials in man						
Unit II		**Respiration:**				
Respiratory pigments – Distribution – composition – properties –Functions-Transport and exchange of oxygen and carbon-di-oxide - Anaerobiosis - Respiratory Quotient						
Unit III		**Circulation:**				
Origin and conduction of heat beat – cardiac cycle – ECG – Blood pressure -. Excretion – kinds of excretory products – structure of kidney – Nephron – Mechanism of urine formation in man – composition of urine.						
Unit IV		**Nerve Physiology:**				
Structure, types and functions of neuron. Nerve impulse – Definition – Conduction of nerve impulse through nerve– Synapse – Synaptic transmission of impulses – Neurotransmitters – Neuromuscular Junction.						
Unit V		**Reproductive Physiology:**				
Ovary, Graafian follicles, menstrual cycle, pregnancy, lactation, menopause - the role of hormones.						
References		**Text Books** 1.S C Rastogi , Essentials of animal physiology, New age International (P) Ltd., Publishers, 2019. 2.Wesley Mills, A Text book of Animal physiology, Alpha editions, 2019. 3.MohanP.Arora, Animal physiology, Himalaya Publishing House, 2014. 4.Richard W. Hills, Gordon A. Wyse, Margaret Anderson, Animal Physiology, Oxford university press , 2017.				
		Reference Books 1.BansiDhar Singh, Animal Physiology and Biochemistry, Ram Prasad Publication, 2020. 2.Bhatia Jain Patni Singh Kohli, Animal Physiology and Biochemistry,RBD Publication,2016. 3.Vernon. L. Kellogg, The animal and man, Alpha Editions, 2020				

E-Reference Links	1. https://healthyeating.sfgate.com/enzymes-used-break-down-carbohydrates-2211.html 2. https://opentextbc.ca/biology/chapter/11-3-circulatory-and-respiratory-systems/ 3. https://www.khanacademy.org/science/biology/human-biology/neuron-nervous-system/a/overview-of-neuron-structure-and-function 4. http://www.lamission.edu/lifesciences/lecturenote/AliPhysio1/Reproduction.pdf		
Course Outcomes	Upon completion of this course the students will be abte to		
	CO1	know about the role of enzymes in digestion	**K2**
	CO2	acquire knowledge on respirarionand functions of respiratory pigments	**K2**
	CO3	differentiate the blood components and apply them to find each component	**K3**
	CO4	gain knowledge on nervous system and functions of neurotransmitters	**K2**
	CO5	evaluate the concepts of reproductive system and understand its functioning	**K5, K2**

Mapping of COs with POs & PSOs:

CO	**PO**								**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	M	S	S	S	S	S	S	S
CO2	M	M	S	S	S	S	M	S	S	S	M	M	S
CO3	S	M	S	S	S	M	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	S	S
CO5	S	M	S	S	S	M	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

SEMESTER – III

Course Code	U21BTT31	DEVELOPMENTAL BIOLOGY	L	T	P	C
CORE V			5	-	-	4
Cognitive Level		K1: Recall K2: Understand K3: Apply				
Learning Objective		• To study about gametogenesis, origin of sperm and egg, cleavages. • To learn about gastrulation, metabolism and molecular changes and gene activities during gastrulation. • To study about the organogenesis and regeneration.				
Unit I		**Gametogenesis**				
Definition-primordial germ cells-origin-spermatogenesis-physiological ripening of sperm-oogenisis-previtellogenesis-vitellogenesis						
Unit II		**The egg**				
Size-shape-egg membranes,tertiarymembranes,organization of the egg yolk, pigments, egg cortex, polarity, oriin of polarity, types of eggs. Cleavage-Definition, morula, blastula, types of blastula, molecular changes, planes of cleavages, types of cleavage, factors affecting cleavage, cleavage laws, adhesion of blastomeres during cleavage, nuclei of cleaving cells, cytoplasm of cleaving cells.						
Unit III		**Gastrulation:**				
Definition, exogastrulation, metabolism and molecular changes during gastrulation, gene activities during gastrulation. Morphogenic movements- Definition, types epiboly, emboly mechanism of morphogenic movements						
Unit IV		**Organogenesis**				
Definition, tabulation, neurogenesis, spermatogenesis, growth and differentiation derivatives of ectoderm and mesoderm.						
Unit V		**Regeneration:**				
Definition – Types, Human Reproduction puberty, Menstrual cycle. Menopause, Pregnancy and related problems parturition and lactation.						
Textbook		1. Leon. W. Browder, Developmental Biology; Springer, 2012Sastry and 2. Shukla, Developmental Biology, Rastogt Publication, 2017				
References		1. Michael J. Barresh, Developmental Biology, Oxford, 2020 2. Scott F. Gilbert, Developmental Biology, OUP, publisher, 2017 3. A.K.Rathoure, Developmental Biology, Brillion Publishing, 2017				

E-References Link	1. https://www.e-libraryme.com/2019/12/developmental-biology.html 2. https://plato.stanford.edu/entries/biology-developmental/ 3. https://www.ncbi.nlm.nih.gov/books/NBK9983/		
Course outcomes	Upon completion of this course, the students will be able to		
	CO1	gather knowledge on gametogenesis	K1, K2
	CO2	acquire information on egg and cleavage	K1, K2, K3
	CO3	recognize the importance of gastrulation	K1, K2, K3
	CO4	explain the process of oogenesis	K1, K2, K3
	CO5	describe regeneration and human reproduction	K1, K2, K3

Mapping of CO with PO & PSO:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	S	S	M	S	S	S	M	M	S
CO2	S	S	M	M	S	S	S	S	S	S	S	S	S
CO3	S	S	M	S	M	S	S	M	S	S	M	S	M
CO4	S	M	S	M	S	S	M	S	S	S	S	S	S
CO5	S	S	M	S	S	S	S	S	S	S	M	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Code	U21CHA33	CHEMISTRY	L	T	P	C
ALLIED	III		5	-	-	4

Cognitive Level	**K1: Recall K2: Understand K3: Apply**
Learning Objective	• To understand the handling of chemicals and errors in chemical analysis • To get knowledge in chemical bonding and hybridization • To acquire knowledge in volumetric analysis • To understand the basic concept of Biomolecules
Unit I	**Handling of chemicals and Data analysis :**

a) Storage and handling of chemicals: Handling of acids, ethers, toxic and poisonous chemicals. Antidotes, threshold vapour concentration and first aid procedure.

b)Errors in chemical analysis: Accuracy, precision. Types of error-absolute and relative errors. Methods of eliminating and minimizing errors.

c) Separation techniques–Solvent extraction. Principle of adsorption and partition chromatography, column chromatography, thin layer chromatography (TLC), paper chromatography and their applications.

Unit II	**Chemical bonding :**

a) Ionic Bond: Nature of Ionic bond. Structure of NaCl, KCl and CsCl. Factors influencing the formation of ionic bond.

b) Covalent Bond: Nature of covalent bond. Structure of CH_4, NH_3, H_2O based on hybridisation.

c) Coordinate Bond: Nature of coordinate bond. Coordination complexes. Werner's theory. Geometrical and optical isomerism in square planar and octahedral complexes. Mention of structure and functions of chlorophyll and hemoglobin

d) Hydrogen Bond: Theory and importance of hydrogen bonding. Types of hydrogen bonding. Hydrogen bonding in carboxylic acids, alcohol, amides, polyamides, DNA and RNA.

e) vander Waal's forces: Dipole – dipole and dipole - induced dipole interactions.

Unit III	**Volumetric analysis :**

a) Methods of expressing concentration: normality, molarity, molality, ppm.

b)Primary and secondary standards: preparation of standard solutions

c) Principle of volumetric analysis: end point and equivalence points.

d) Strong and weak acids and bases - Ionic product of water , pH, pKa, pKb. Buffer solutions - pH of buffer solutions. Mention of Henderson equation & its significance.

Unit IV	**Chemical Kinetics:**
a) Chemical Kinetics: Rate, rate law, order and molecularity. Derivation of rate expressions for I and II order reactions. b) Catalysis-Homogeneous and heterogeneous catalysis. Enzyme catalysis, enzymes in biological system and in industry.	
Unit V	**Chemistry of biomolecules :**
a) Fats – Occurrence and composition. Hydrolysis of fats. b) Vitamins – Source, provitamin, properties and classification. Structure and function of vitamin A, C, D, K and E c) Hormones – Thyroxin, adrenaline and sex hormones (structure and functions only)	
Text Books	1. R. Gopalan, S. Sundaram, Allied Chemistry, Sultan Chand and Sons, 1995.
Reference Books	1. U. Sathyanarayana, Biochemistry, Books and allied (p) Ltd, 1999. 2. B.R.Puri and L.R.Sharma, Principles of physical chemistry, ShobanLalNagin Chand and Co., 1992.
Course Outcomes	Upon completion of this course, the students will be able to

	CO1	gain the knowledge on the handling of chemicals and errors in chemical analysis	**K1, K2**
	CO2	learn about chemical bonding and hybridization	**K1, K2**
	CO3	acquire knowledge on calculations for preparing standard solutions	**K1,K2**
	CO4	understand the advanced concepts and rate equations in chemical kinetics.	**K1, K2, K3**
	CO5	learn the importance of chemistry inBiomolecules	**K1, K2, K3**

Mapping of COs with POs & PSO:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	S	S	S	S	M	S	S	S	S	S	S	S
CO3	S	S	S	S	M	S	S	S	S	S	S	S	M
CO4	S	M	S	S	S	S	S	S	S	S	S	S	S
CO5	M	S	S	S	S	S	S		S	S	M	S	S

Strongly Correlating (S) - 3 marks ;Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ;No Correlation (N) - 0 mark

Course Code	U21BTE311	ENDOCRINOLOGY	L	T	P	C
ELECTIVE - I			4	-	-	3

Cognitive Level	K1:Recall K2:Understand
Learning Objectives	• To have a knowledge on the functions of neuroendocrine systems • To get a thorough knowledge on various glands and related hormones • To know the role of hormones in metabolism • To understand the hormonal regulation in reproduction
Unit I	**Hormones**
Nature, function and classification of hormones – Feedback control of hormone secretion – Organisation and functions of neuroendocrine systems- Hypothalamo– hypophyseal interactions- Bioactive peptides.	
Unit II	**Pituitary gland**
Pituitary gland – Structure and functions, role of hormone secretions - Thyroid gland – Structure, function and biosynthesis of thyroid hormone – Parathyroid –Structure and PTH – Calcitonin – Role of hormones in calcium and phosphate metabolism.	
Unit III	**Gastrointestinal system**
Gastrointestinal hormones - their secretion, control and function – Insulin and glucagons – Adrenal hormones and Stress management – Catecholamines as emergency hormones- their role in the regulation of carbohydrate, protein and lipid metabolisms.	
Unit IV	**Human gland**
Adrenal gland – Structure and role played its hormones in glucose metabolism – Aldosterone and the rennin- angiotensin system – Pineal gland- structure and its influence on reproduction and pigmentation – Thymus gland – Structure and thymic hormones – their functions in brief	
Unit V	**Hormone Biosynthesis**
Steroid hormone biosynthesis in the ovary and testis – Hormonal regulation of ovarian cycles in mammals – Folliculogenesis, ovulation, corpus luteum formation and regression – Hormones in pregnancy and lactation. Gonadal steroid action on spermatogenesis and spermiogenesis – Role of hormones in sex accessory gland growth and functions.	
Text Books	1. Shlomo Melmed,Endocrinology, Publisher Saunders,2011 2. John Wass , Katharine Owen, Endocrinology and Diabetes, Publisher OUP UK,2014 3. Dharmalingam, Endocrinology, Publisher Jaypee Brothers

	Medical Publishers, 2010		
Reference Books	1. M.P. Goswami, Endocrinology and Molecular Cell Biology, Gaurav book centre Pvt Ltd, Delhi .2013 2. George Griffing, Endocrinology,Stat Pearls Publishing, USA. 2015		
E-Reference	1. https://www.classcentral.com/course/swayam-endocrinology-19855 2. https://www.webmd.com/diabetes/endocrine-system-facts 3. https://www.livescience.com/26496-endocrine-system.html 4. https://www.healthline.com/health/the-endocrine-system		
Course	Upon completion of this course, the students will be able to		
	CO1	understand the hormone classification and function of hormones	**K1**
	CO2	know the structure of Pituitary glands and its hormone function	**K2**
	CO3	comprehend the gastrointestinal hormones functions on the regulation of macromolecules metabolism	**K2**
	CO4	learn the importance of adrenalin and thymic hormones	**K2**
	CO5	get deep knowledge on ovarian cycles and sex hormones	**K2**

Mapping of COs with POs & PSOs:

CO	**Pos**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	M	M	S	S	M	S	M	S
CO2	S	S	M	M	M	S	S	S	S	S	M	S	S
CO3	S	S	M	S	S	S	M	S	S	M	M	M	S
CO4	M	S	S	S	M	S	M	S	S	M	S	M	M
CO5	S	S	S	M	S	S	S	S	S	M	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Code	U21BTE312	NUTRITIONAL BIOCHEMISTRY	L	T	P	C
ELECTIVE - II			4	-	-	3

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objective	• To explain mechanisms of digestion and absorption. • To learn the factors influencing bioavailability of nutrients • To describe the biochemical and physiological functions of the nutrient • To explain the mechanisms of nutrient homeostasis in the body. • To attain knowledge in Physiological role and nutritional significance ofcarbohydrates, lipids, vitamins
Unit I	**Food and its nutrition**:
Introduction and definition of food and nutrition. Basic food groups; Basic concepts of energy expenditure, unit of energy, measurements of food Stuffs by bomb calorimeter	
Unit II	**Value of Nutrition:**
Nutritive value of proteins; essential amino scids. Single cell proteins. Protein malnutrition and under nutrition, their preventive and curative measures.	
Unit III	**Hyperglycemia & hypoglycemia**
Diabetes mellitus - definition, types, features, gestation diabetes mellitus , glucose tolerance test, glycosurias, Hypoglycemia & its causes	
Unit IV	**Balanced diet:**
Composition of balanced diet and RDA for infants, children, adolescent, adult male and female, pregnant lactating woman and old age.	
Unit V	**Significance of nutrients:**
Physiological role and nutritional significance of carbohydrates, lipids, vitamins (water and fat soluble) and minerals.	
Textbook	1. Victor Rodwell, David Bender, & Kathleen Botham. Harper's Illustrated Biochemistry. 31st Edition. McGraw-Hill Education; 2018. 2. Dr. M Swaminathan. Text Book On Food & Nutrition. The Bangalore Press.
References	1. B. R. Mackenna & Robin Callander. Illustrated Physiology. 6th Edition. Churchill Livingstone; 1996. 2. White, Abraham; Handler, Philip; Smith, Emil L. Principles of biochemistry. 3rd Edition McGraw - Hill; 1964. 3. John E. Hall . Guyton and Hall Textbook of Medical Physiology. 13th Edition. Saunders; 2015.

E-references	1. https://www.otsuka.co.jp/en/nutraceutical/about/nutrition/functions/ 2. https://www.ncbi.nlm.nih.gov/books/NBK279510/ 3. https://www.contemporaryclinic.com/view/treatment-strategies-for-hypoglycemia-and-hyperglycemia 4. https://www.nutrition.org.uk/healthyliving/healthydiet/healthybalanceddiet.html 5. https://oneyouleeds.co.uk/the-five-food-groups/		
Course outcome	Upon completion of this course, the students will be able to		
	CO1	gather information on food and its nutrition.	K1
	CO2	know the nutrients value and its importance in prevention of disease.	K1
	CO3	acquire knowledge on diabetes mellitus and its effect in our body.	K2
	CO4	recognise the importance of balanced diet.	K2
	CO5	realise the facts behind the significance of nutrients.	K2

Mapping of COs with POs & PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	M	M	M	S	S	S	S	S	M	M	S
CO2	S	S	S	S	S	M	S	S	S	S	M	M	S
CO3	S	S	M	S	M	S	S	S	S	M	S	S	M
CO4	S	M	S	M	S	S	S	S	S	S	M	S	S
CO5	S	S	S	M	S	S	S	S	S	M	S	S	S

Strongly Correlating (S) - 3 marks ;Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ; No Correlation (N) - 0 mark

CODE U21BTN311	VERMI TECHNOLOGY	L	T	P	C
NME I		2	-	-	2
Cognitive Level	**K2: Understand K3: Apply K6: Create**				
Learning Objective	• To learn about the types of earthworms • To learn the tchniques of bed preperations • To acquire knowledge on vermicast collection and packaging of vermicompost • To acquire the knowledge on applications and uses of vermicompost				
Unit I	**Vermi compost**				
History and scope of Vermi composting - Ecological classification: Humus feeders, Humus formers leaf, mold, top soil and sub soil types.					
Unit II	**Earthworm:**				
Physical, chemical and biological changes brought by earthworm in soil burrows- drilosphere - earthworm casts. Economic importance of vermicompost.					
Unit III	**Soil fertility:**				
Role of Earthworms in soil fertility– Types of Earthworm – Epigeics, Anecic and Endogeics –Use of Vermicompost for crop production					
Unit IV	**Earthworm Applications**:				
Use of earthworms in land improvement and land reclamation					
Unit V	**Vermiwash:**				
Economics of Vermicompost and Vermi wash production.					
Text Books	1. Vermiculture and vermitechnology ,Peter Davis Fresh Organic Gardening ,2014. 2. Jason Johns ,Worm Farming Creating compost at home with Vermiculture , Create space Independent, 2015.				
Reference Books	1. AvinashChauhan ,Vermitechnology, Vermiculture, vermicompost and earthworm , Lambert Pubishers ,2014. 2. Abdullah Adil Ansari, ,Vermitechnology- Permutaion and combination of organic waste, Lambert Pubishers, 2014.				
E-reference links:	1. https://www.ecomena.org/vermicomposting/ 2. https://www.trees.com/gardening-and-landscaping/types-of-earthworms 3. https://extension.psu.edu/six-steps-to-mushroom-farming 4. https://agritech.tnau.ac.in/farm_enterprises/Farm%20enterprises_%20Mushroom_Mother%20spawn.html				

Course Outcome	Upon completion of this course, the students will be able to		
	CO1	gain basic knowledge about Vermi composting.	**K2**
	CO2	illustrate the economic importance of vermi compost	**K3**
	CO3	evaluate the role of earthworms in soil fertility	**K6**
	CO4	appraise the role of earthworms in land improvement.	**K6**
	CO5	get the knowledge of vermiwash and its applications	**K6**

Mapping of COs with POs & PSOs:

CO	**PO**								**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	M	S	S	S	S	M	S	M	S	M	S
CO2	S	M	M	S	M	S	M	S	S	M	S	S	S
CO3	M	S	S	M	M	M	M	S	M	S	S	S	M
CO4	M	S	S	M	S	M	S	S	S	S	M	M	S
CO5	S	M	M	S	S	S	S	S	S	S	S	M	M

Strongly Correlating (S) - 3 marks ; Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ; No Correlation (N) - 0 mark

SEMESTER – IV

CODE	U21BTT41	MICROBIOLOGY	L	T	P	C
CORE VI			4	-	-	4

Cognitive level	K2 : Understand K3 : Apply K4: Analyse
Learning Objective	• To learn the concepts of microbiology and the contribution by different scientist • To enable the students to learn the structure, function and diversity of microorganisms • To identify the microorganism and analyse their classification. • To learn the genetic make up of the microorganisms, methods of reproduction and the factors affecting their growth
Unit I	**Concepts in Microbiology:**
Spontaneous generation vs. biogenesis. Contributions of Anton von Leuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Basic Principles in microscopy, Types of Microscopes – Light, Compound, Phase contrast and Electron microscope (TEM and SEM).	
Unit II	**Classification of microorganisms:**
Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems. Difference betweenProkaryotic and Eukaryotic microorganisms.General structure, growth and reproduction of Bacteria, Fungi, Algae, Virus and Protozoa.	
Unit III	**Nutritional requirements of Microorganisms:**
Autotrophs, Heterotrophs, Photoautotrophs, Chemotrophs. Culture media -Solid and Liquid -Types of media-Semisynthetic, synthetic, Enriched, Enrichment, Selective and Differential media.Macro nutrients growth factors	
Unit IV	**Microbial growth:**
Factors influencing and affecting microbial growth, Growth and death kinetics, Sterilization and Disinfection -Methods of sterilization- Physical methods- Dry heat- Moist heat, Radiation-Chemical sterilization -antimicrobial chemo therapy.	
Unit V	**Gene transfer in microbes**:
Conjugation, Transformation, Transduction.	
Text Books	1. C. P. Baveja, Textbook of Microbiology 6 th Edition, Arya Publications, 2021. 2. N. Arumugam, A. Mani, A. M. Selvaraj, L. M. Narayanan, Microbiology, Saras 3. Publication, 2014. 4. R. C. Dubey, D. K. Maheshwari, A Text book of Microbiology, S. Chand, 2013.
Reference Books	1. Ananthanarayan and Paniker's, Textbook of Microbiology, Eleventh Edition ,University press, 2020. 2. Harsh Mohan , Textbook of Pathology with Pathology Quick Review and MCQs-English,jaypeebrothers,medical publishers 2018 .

	3. SubhashChandraParija ,Textbook of Microbiology and Immunology ,Elsiever India Publication1 , 2016 . 4. Jeffrey C PommervilleFundamentals of Microbiology Jones and Bartlett publisher, 2017. 5. D.K.Sharma, Microbiology, Alpha science international limited,2013.
E-reference links	1.https://blog.addgene.org/plasmids-101-transformation-transduction-bacterial-conjugation-and-transfection 2.https://www.ncbi.nlm.nih.gov/books/NBK21399/ 3.http://www2.hawaii.edu/~johnb/micro/medmicro/medmicro.5.html 4.https://www.austincc.edu/rohde/CHP7a.htm 5.http://ecoursesonline.iasri.res.in/mod/page/view.php?id=5207
Course Outcomes	Upon completion of this course, the students will be able to

CO1	define the concepts in microbiology and list the eminent scientists in the field of microbiology.	**K2**
CO2	identify the major categories of microorganisms and analyse their classification, diversity, and ubiquity**.**	**K2**
CO3	gain knowledge on the nutritional requirements of microbes and the factors influencing nutrition uptake.	**K2**
CO4	illustrate the factors influencing the microbial growth.	**K3,K5**
CO5	compare the techniques of gene transfer in microbes.	**K4**

Mapping of COs with POs & PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	M	M	M	S	S	S	M	S	S	S	M	S	S
CO2	S	S	M	M	M	S	M	S	S	S	S	M	M
CO3	S	S	M	M	M	S	S	S	M	M	S	S	S
CO4	S	S	M	M	M	M	M	S	S	M	M	S	S
CO5	M	S	S	S	S	M	S	S	S	M	M	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

<table>
<tr><td colspan="2">CODE U21BTP42</td><td colspan="3" rowspan="2">PRACTICAL - MICROBIOLOGY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">COREV II</td><td>-</td><td>-</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Cognitive Level</td><td colspan="6">K2: Understand K3: Apply K4: Analyze</td></tr>
<tr><td colspan="2">Learning Objective</td><td colspan="6">• To learn the concepts of Microcsope
• To know about media preparation and sterilization techniques
• Learn the techniques of staining and plating methods</td></tr>
<tr><td colspan="2">Experiments in microbiology</td><td colspan="6">1. Maintenance of hygienic conditions in the laboratory-rules and regulations.
2. Microscope and its functions,
3. Preparation of different culture media and sterilization methods.
4. Simple staining
5. Gram’s staining
6. Capsule staining
7. Negative Staining
8. Endospore staining
9. Isolation of pure cultures of bacteria by streaking method.
10. Estimation of CFU count by Spread plate method / Pour plate method.
11. Motility by hanging drop method.
12. IMVIC test.</td></tr>
<tr><td colspan="2">Text Books</td><td colspan="6">1. C. P. Baveja, V. Baveja, Text and Practical of Microbiology for MLT 3 rdEdition,Arya Publications, 2019.
2. S. Rajan, R. Selvi Christy, Experimental Procedures in Life Sciences, CBS, 2019.</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="6">1.Wilson& Walker ,Biochemical Methods , Cambridge ,2018.</td></tr>
<tr><td colspan="2">E-reference links</td><td colspan="6">1. https://www.youtube.com/watch?v=icRQE73AUII
2. https://www.youtube.com/watch?v=AZS2wb7pMo4
3. https://www.youtube.com/watch?v=bRadiLXkqoU
4. https://www.youtube.com/watch?v=BY1scdexKIw</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="6">Upon completion of this course, the students will be able to</td></tr>
<tr><td colspan="2" rowspan="5"></td><td>CO1</td><td colspan="3">know about the safe practices in a microbiology laboratory.</td><td>K2</td></tr>
<tr><td>CO2</td><td colspan="3">understand the functions of microscope.</td><td>K2</td></tr>
<tr><td>CO3</td><td colspan="3">experiment the methods of simple, gram,capsule and endospore staining.</td><td>K4</td></tr>
<tr><td>CO4</td><td colspan="3">apply and know about different techiquesfor isolation of organisms and staining techniques.</td><td>K3</td></tr>
<tr><td>CO5</td><td colspan="3">learn the principles of biochemical tests</td><td>K2</td></tr>
</table>

Mapping of COs with POs & PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	M	S	S	S	S	M	S	M	S	M	S
CO2	S	S	M	M	M	S	S	M	S	S	S	S	M
CO3	M	S	S	S	S	M	S	S	M	M	S	S	S
CO4	S	S	S	S	S	M	S	S	S	S	M	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks ;Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ;No Correlation (N) - 0 mark

<table>
<tr><td colspan="2">Course Code U21CHA43</td><td colspan="2" rowspan="2">PRACTICAL - CHEMISTRY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">ALLIED IV</td><td>-</td><td>-</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Cognitive Level</td><td colspan="6">K1: Recall K2: Understand K3: Apply</td></tr>
<tr><td colspan="2">Learning objective</td><td colspan="6">• To understand basics and gain knowledge on laboratory reagents and their uses in volumetric analysis.
• To acquire knowledge in he preparation of standard solutions.
• To be able to perform titratons for different solutions</td></tr>
<tr><td colspan="2">Experiments inChemistry</td><td colspan="6">Acidimetry and alkalimetry:
Titration acids used: hydrochloric acid, sulphuric Standard solutions prepared: sodium carbonate, sodiumbicarbonate, oxalic acid.

Oxidation and reduction titration:
Oxidising agents: Potassium permanganate (permanganimetry) Reducing agents: Ferrous sulphate, ferrous ammonium Sulphate, oxalic acid

Standard solutions prepared:
Ferrous Sulphate, ferrous ammonium Sulphate and oxalic acid.

Iodometry titrations:
titrations of liberated iodine against sodium thiosulphate using acidified potassium permanganate, potassium dichromate and copper Sulphate solutions.
Standard solutions: potassium dichromate, copper sulphate.</td></tr>
<tr><td colspan="2">Text Books</td><td colspan="6">1. Sundaram, Krishnan, Raghavan, Practical Chemistry (Part II), S. Viswanathan Co. Pvt., 1996.
2. B.S. Furniss, A.J. Hannaford, P.W. G. Smith, A.R. Tatchell, Vogel’s Text Book of Practical Organic Chemistry. 5th Edn., Pearson Education, 2005.</td></tr>
<tr><td colspan="2">References Books</td><td colspan="6">1. N.S. Gnanapragasam and G. Ramamurthy, Organic Chemistry – Lab manual, S. Viswanathan Co. Pvt., 1998.
2. Practical Chemistry by A.O. Thomas, Scientific Book Centre, Cannanore, 2003.
3. Basic Principles of Practical Chemistry, V. Venkateswaran, R. Veeraswamy, A. R. Kulandaivelu, Sultan Chand & Sons, New Delhi, 2nd Edn., 2004.</td></tr>
<tr><td colspan="2">Course outcome</td><td colspan="6">Upon completion of this course, the students will be able to</td></tr>
<tr><td colspan="2" rowspan="2"></td><td>CO1</td><td colspan="3">know the procedure for titration of acid and bases.</td><td colspan="2">K1, K2</td></tr>
<tr><td>CO2</td><td colspan="3">gain knowledge in the oxidation and reduction agents and perform titrations.</td><td colspan="2">K1, K2, K3</td></tr>
</table>

	CO3	illustrate the methods to prepare standard solutions	**K1, K2, K3**
	CO4	learn and illustrate the concepts in iodometry titrations	**K1, K2, K3**
	CO5	explain and compare the principle behind different titration reactions	**K1, K2, K3**

Mapping of COs with POs & PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	S	S	S	S	M	S	S	S	S	S	S	S
CO3	S	S	S	S	M	S	S	S	S	S	S	S	M
CO4	S	M	S	S	S	S	S	S	S	S	S	S	S
CO5	M	S	S	S	S	S	S		S	S	M	S	S

Strongly Correlating (S) - 3 marks ;Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ;No Correlation (N) - 0 mark

CODE	U21BTE421	SEED TECHNOLOGY	L	T	P	C
ELECTIVE II			3	-	-	3

Cognitive Level	K2: Understand K3: Apply K4: Analyze
Learning Objective	• To understand the structures of seed, formation and seed development. • To have knowledge about the production of high quality seeds • To know about the various metabolic changes at germination • To acquire a basic knowledge on seed treatment
Unit I	**Seed processing:**
Importance of seed processing in the pathway of seed improvement, physical characteristics used to separate seeds. Preparing seeds for processing. licensing of machines.	
Unit II	**Seed drying :**
Importance and advantages of seed drying ,moisture content and methods of seed moisture measurements, Theory of seed drying (wet dry seeds),advantages of mechanical drying equipments dehumidification and drying of heat sensitive seeds, relative humidity and equilibrium, moisture content of seeds.	
Unit III	**Seed processing machines :**
Principle, construction, working, adjustments, cleaning and uses of seed processing machines viz. i) Air screen cleaner cum grader ii) Specific gravity separator, aspirators, pneumatic aspirators, stoner iii)Roll mill iv) Magnetic separators v) Spiral separators, dropper best separator, electrostatic separators	
Unit IV	**Seed Treatment:**
Principle, construction, working, adjustments and uses of slurry seed treater mist -o- matic seed treated, storage and labeling of treated seeds, seed users safety. Seed conveyors and elevators	
Unit V	**Seed storage:**
structures and their management: Packing and marketing of seeds, bagger weigher, bag closing, portable and conveyor type of bag closer, labeling and maintaining lot identify, lot numbers, seed pellets, handling and stacking, maintenance of seed processing record.	
Text Books	1.Phundan Singh, Principles of seed technology, Kalyani Publisheres,2020. 2.Rahul Singh Rajput, Instant Plant Breeding and seed technology, Jain Brothers, 2019. 3.Rakesh singhNegi, NavneetiChamoli, DeeptiPrabha, Treasure of seed science and technology, Jain Brothers publishers, 2020. 4.K. Vanangamudi, Seed Science and technology, New India Publishing agency, 2020 .
Reference books	1.SR.Reddy, Farming system and sustainable agriculture, Kalyani publishers, 2017. 2.Mukesh Kumar, Compendum of seed technology, Write and print Publication, 2019.

E-reference links	1. https://agriallis.com/wp-content/uploads/2021/01/SEED-PROCESSING-AND-ITS-IMPORTANCE.pdf 2. https://www.biotecharticles.com/Agriculture-Article/Seed-Drying-Principle-Methods-and-their-Advantages-4077.html 3. https://agritech.tnau.ac.in/seed_certification/seed_processing_equipments.html 4. https://forestrypedia.com/seed-storage-its-importance-and-storage-methods/		
Course Objectives	Upon completion of this course the students will be able to		
	CO1	understand the basics of seed processing	**K2**
	CO2	learn the techniques of seed drying	**K4**
	CO3	illustrate the process of seed processing machines.	**K3**
	CO4	learn the seed tratement techniques	**K3**
	CO5	gain knowledge on the techniques of Seed storage	**K3**

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	M	M	S	M	M	S	M	S	S	M	S
CO2	S	M	S	S	S	M	M	M	S	S	M	M	S
CO3	S	M	M	S	M	S	M	M	S	M	S	M	S
CO4	M	S	M	S	S	S	S	S	S	S	S	S	M
CO5	S	M	S	S	M	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Code	U21BTE422	BIOFERTILIZER	L	T	P	C
Elective	II		3	-	-	3
Cognitive Level		**K2:Understand K3:Apply K4:Analyze**				
Learning Objective		• To understand the basic concepts of Biofertiliser • To learn the techniques of manufacture of Biofertiliser • To impart knowledge on Enterpreunership skill development				
Unit I		**Introduction:**				
History, importance of different types of fertilizers and their application to crop plants. Effect of chemical fertilizers on environment.						
Unit II		**Biofertilizer:**				
Algal and fungal (Mycorrhizal) biofertilizers, Bacterial biofertilizersRhizobial, free living N2 fixers and phosphate solubilizing bacteria, their significance and practice.						
Unit III		**Manures:**				
A general account of manures such as leaf moulds, composts form Yard Manure and a study of the following oilseed cakes: Castro and Neem as Biopesticides.						
Unit IV		**Application of biofertilizers and manures:**				
A combination of biofertilizer and manure application. Organic farming-compost and Vermi compost.						
Unit V		**Mass production of Cyanobacterial Biofertilizers:**				
Nostoc, Anabaena Azolla. Blue green algae.						
Text Books		1. ReetaKhosla, Biofertilizers and Biocontrol agents for organic Farming, KojoPress, 2017. 2. S.R. Reddy, Principles of Organic Farming, Kalyani, 2017. 3. V. Kumaresan, Biotechnology, Saras Publication, 2015.				
Reference Books		1. N.S. SubbaoRao, soil microorganisms and plant growth, Science publishers, 2011. 2. N. S. SubbaoRao, Biofertilizer, cbcs publishers, 2020. 3. Ronald M. Atlas & Richard Bertha, Microbial Ecology, Fundamentals & application, addidion Wesley, 2011 . 4. Surjitsen, Krisnenduacharya, Munjularai, Biofertilisers and Biopesticides Techno world publishers, 2019.				
E-reference links:		1. https://www.fertilizer-machine.net/solution_and_market/types-of-fertilizer.html 2. https://www.hunker.com/12401292/harmful-effects-of-chemical-fertilizers 3. https://www.nature.com/scitable/knowledge/library/biological-nitrogen-fixation-23570419/ 4. http://lnmuacin.in/studentnotice/2020/mass%20inoculation.pdf				
Course Outcomes		On Successful completion of the course, the students will be able to				

	CO1	know about the basics and history of biofertilizers.	**K2**
	CO2	illustrate the preparation of biofertilizers.	**K3**
	CO3	gain knowledge on the preparation of different types of manures.	**K2**
	CO4	gain knowledge on the types of manures accordingly to the plant type.	**K2,K3**
	CO5	learn and compare the statergies for mass production of biofertilizers.	**K4**

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	M	S	S	S	S	S	S	M	S
CO2	S	S	S	M	S	S	M	S	S	S	M	S	S
CO3	M	M	S	S	S	S	S	M	S	S	S	M	S
CO4	M	S	S	M	S	S	S	S	S	S	S	S	S
CO5	S	M	S	S	S	S	M	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Code	U21BTN421	INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
NME II			2	-	-	2

Cognitive Level	**K2:Understand K4:Analyze**
Learning Objective	• To introduce fundamental aspects of Intellectual property Rights • To disseminate knowledge on patents, patent regime in India and abroad and registration aspects • To gain knowledge on copyrights and its related rights and registration aspects • To disseminate knowledge on trademarks and registration aspects • To disseminate knowledge on Design, Geographical Indication (GI).
Unit I	**IPR**
Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design- Trade Secret - IPR in India : Genesis and development – IPR in abroad	
Unit II	**Patents**
Elements of Patentability: Novelty , Non Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and licence , Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties - Patent office and Appellate Board	
Unit III	**Copyright**
Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of protection, Ownership of copyright, Assignment and license of copyright - Infringement, Remedies & Penalties.	
Unit IV	**Trademarks**
Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademarks registry and appellate board	
Unit V	**Other forms of IP**
Design: meaning and concept of novel and original - Procedure for registration, effect of registration and term of protection. Geographical Indication (GI) :Geographical indication: meaning, and difference between GI and trademarks - Procedure for registration, effect of registration and term of protection	
Text Books	1. Nithyananda, K V. Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited. 2019

	2. Neeraj, P., & Khusdeep, D. Intellectual Property Rights. India, IN: PHI learning Private Limited. 2014 3. Ahuja, V K. Law relating to Intellectual Property Rights. India, IN: Lexis Nexi 2017		
Reference Books	1. P.Narayanan,Intellectual Property Law,Eastern Law House,2017 2. J.P.Mishra,An Introduction to intellectual property rights,Central law Publications,2012 3. Professionals ,Intellectual Property Laws,Professional book publisher,2020		
E-reference links:	1. http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf 2. http://www.ipindia.nic.in/ 3. https://www.wipo.int/about-ip/en/		
Course Outcomes	On Successful completion of the course, the students will be able to		
	CO1	know the importance of IPR and IPR in India	**K2**
	CO2	know about patent and its importance	**K2,K3**
	CO3	acquire the knowledge on copyrights and its procedure	**K2**
	CO4	understand about Trademarks and Registration of Trademarks	**K3**
	CO5	know about the procedure for registration of Novel Products	**K2**

Mapping of COs with POs & PSOs:

CO	**PO**								**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	M	M	M	S	S	S	M	S	S	S	M	S	S
CO2	S	S	M	M	M	S	M	S	S	S	S	M	M
CO3	S	S	M	M	M	S	S	S	M	M	S	S	S
CO4	S	S	M	M	M	M	M	S	S	M	M	S	S
CO5	M	S	S	S	S	M	S	S	S	M	M	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

SEMESTER – V

CODE	U21BTT51	IMMUNOLOGY	L	T	P	C
CORE VIII			5	-	-	4

Cognitive Level	**K2: Understand K3: Apply K4:Analyse**
Learning Objective	• To know about the basic concepts of Immunology • To learn about the immune organs and types of immunity • To understand the organization and function of immunoglobulins
Unit I	**Immunity:**
Introduction, History and Scope of immunology. Types of immunity, Antigen, Antibody-cells involved in immunity.	
Unit II	**Immunoglobulins:**
Immunoglobulins – Structure, types,distribution and functions. Single domain antibodies. Lymphoid tissues – Primary and secondary lymphoid organs – thymus, bone marrow; spleen, lymphnode, MALT. T & B Cells – receptors – activation and function. Humoral responses.	
Unit III	**MHC:**
MajorHistoCompatability – structure and functions. Typesof MHC. Antigen processing and presentation. T- Cell Activation. Cell mediated immunity	
Unit IV	**Hypersensitivity:**
Hypersensitivity reactions**,** Transplantation, HLA Typing; Mechanism of Graft rejection. Tumour immunology, Auto immune disorders, immuno deficiency and tolerance.	
Unit V	**Antigen-antibody interactions:**
precipitation – diffusion –radial and double diffusion – agglutination – Haemagglutination, Passive agglutination. Immunoelectrophoresis-definition and types Immuno diagnostics, ELISA, FISH, RIA and Western blotting. Monoclonal antibodies and vaccines	
Text Books	1. Jenny Punt, Sharon stranford, Patrica jones, Judith A Owen, Immunology, WH Freeman publisher , 2010. 2. Abul Abbas and Andrew H Lichtman and Shiv Pillai, Basic immunology Elsevier Publication , 2019.
Reference Books	1. S. K. Gupta ,Essentials of Immunology ,Publisher APC Books,2011. 2. Peter J Delves ,Roitts Essential Immunology , John Wiley publishers, 13 Edition, 2017. C. V. Rao ,Immunology: A Textbook , Good reads ,2020.
E-reference links	1. https://www.news-medical.net/life-sciences/What-is-an-Antigen.aspx 2. https://courses.lumenlearning.com/boundless-biology/chapter/antibodies/

	3. https://www.nursingtimes.net/clinical-archive/immunology/the-lymphatic-system-2-structure-and-function-of-the-lymphoid-organs-26-10-2020/ 4. https://www.lecturio.com/magazine/hypersensitivity-and-its-types/ 5. https://www.narayanahealth.org/organ-transplant/		
Course Outcomes	At the end of the course, the student will be able to		
	CO1	know about types of immunity and antigen and antibodies involved in immune reaction	**K2**
	CO2	describe the functions of Lymphoid organs	**K2**
	CO3	illustrate the structure and function of MHC	**K3**
	CO4	understand hypersensitivity reactions and learn about auto immune disorders and immuno deficiency	**K4**
	CO5	understand the mechanism of antigen and antibody reaction and alsoknow the immunotechniques for diagnosis of diseases.	**K2**

Mapping of COs with POs & PSOs:

CO	**PO**								**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	M	S	S	S	S	M	S	M	S
CO2	M	M	S	S	S	S	S	M	S	S	S	S	S
CO3	S	S	M	S	S	M	S	S	S	M	S	S	M
CO4	S	M	S	S	S	S	M	M	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	M	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Code	U21BTT52	PRINCIPLES OF ANIMAL BIOTECHNOLOGY	L	T	P	C
CORE	IX		5	-	-	4
Cognitive Level	**K2: Understand K3: Apply K4: Analyze K5: Evaluate**					
Learning Objective	• To learn animal cell culture techniques • To gain knowledge on invitro fertilization techniques • To know thebasic principles and techniques in genetic manipulation and genetic engineering.					
Unit 1	**Animal cell culture:**					
Fundamentals. Facilities and Applications. Media for Animal cells. Types of cell culture: Primary cell culture, secondary culture, cell transformation, cell lines, Insect cell lines, stem cell cultures, cell viability and cytotoxicity.Senescence and apoptosis, Organ culture.						
Unit II	**In Vitro Fertilization and Embryo Transfer:**					
Composition of IVF media, Steps involved in IVF, Fertilization by means of micro insemination, Stem cell culture,embryonic stem cell and their applications. Ethical issues in animal biotechnology.						
Unit III	**Genetic engineering in animals**:					
Methods of DNA transfer into animal cells- calcium phosphate co precipitation, micro-injection, electroporation, Liposome encapsulation, Biological vectors..						
Unit IV	**Gene therapy:**					
Gene therapy, mapping of human genome. RFLP and applications.DNA finger printing and Forensic Science. Cryopreservation- Need of Cryopreservation,						
Unit V	**Transgenics:**					
Transgenic animals. Transgenic animals: Mouse, Fish, Goat, Pig, Cattle, Sheep, Rabbit, Birds, Silkworm and Mosquitoes. Production and recovery of products from animal tissue cultures: cytokines, Plasminogen activators, Blood clotting factors, Growth hormones – Merits and demerits of transgenic animals						
References	**Text Books:** 1.B.Singh, S.K.Gautham, A text book of Animal Biotechnology, The energy and Resource Institute ,2015. 2. M. M. Ranga ,Animal Biotechnology, 3 rd edition .Agrobios publishers, 2019. 3. BhaskarGanguly& SohiniDey, Animal Biotechnology ,Stadium press publishers, 2014. 4. S. K. Jindal and M. C. Sharma, Biotechnology in animal health and Production , New India publishing Agency ,2015.					
	Reference Books 1.BhaskarGanguly&SohiniDey ,Animal Biotechnology, Stadium press					

<table>
<tr><td></td><td colspan="3">publishers,2014.
2.SarahLombard,AnimalBiotechnology,Callisto ,Reference publishers,2018.
3.S. K. Jindal and M. C. Sharma ,Biotechnology in animal health and Production, New India publishing Agency,2015.
4.SinghBirbal ,Advances in Animal Biotechnology , Springer publishers ,2019.</td></tr>
<tr><td>E-reference links</td><td colspan="3">1. https://www.sigmaaldrich.com/technical-documents/protocols/biology/cell-types-culture.html
2. https://www.healthline.com/health/in-vitro-fertilization-ivf#purpose
3. https://www.mybiosource.com/learn/gene-transfer-technique/
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5823056/
5. https://people.ucalgary.ca/~browder/transgenic.html
6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7112688/</td></tr>
<tr><td rowspan="6">Course Outcomes</td><td colspan="3">Upon completion of this course the students will be able to</td></tr>
<tr><td>CO1</td><td>explain the fundamentals of animal cell and tissue culture.</td><td>K2</td></tr>
<tr><td>CO2</td><td>get knowledge about various IVF Techniques</td><td>K3</td></tr>
<tr><td>CO3</td><td>develop basic skills for the transfer of DNA into host cells</td><td>K5</td></tr>
<tr><td>CO4</td><td>understand the gene therapy and its application in medicine</td><td>K3</td></tr>
<tr><td>CO5</td><td>acquire knowledge in transgenic animals and its applications</td><td>K3</td></tr>
</table>

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	M	S	S	M	M	S	S	S	S	M	S
CO2	S	M	S	S	S	M	S	S	S	S	S	M	S
CO3	S	S	S	M	M	S	M	S	S	S	S	S	S
CO4	S	M	S	M	S	S	S	M	S	S	S	M	M
CO5	S	M	S	M	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks ;Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ;No Correlation (N) - 0 mark

Course Code	U21BTT53	BASICS OF PLANT BIOTECHNOLOGY	L	T	P	C
CORE	X		5	-	-	4
Cognitive Level	K2: Understand K3: Apply K4: Analyze					
Learning Objective	• To understand the genome organization of plants • To aquire knowledge on plant vectors • To learn the techniques of plant tisuue culture					
Unit I	Plant genome organization					
Structure of representative plant genes and gene families in plant – organization of chloroplast genome – organization of mitochondrial genome. Micropropagation on large scale, somatic embryogenesis, protoplast culture and somatic hybridization, Anther, pollen and ovary culture for production of haploid plants.						
Unit II	Molecular biology and gene rearrangement					
Agrobacterium and crown gall tumours – mechanism of T-DNA transfer to plant – Ti plasmid vectors and its utility – plant viral vectors – symbiotic nitrogen fixation in Rhizobia						
Unit III	Genetic engineering of plants					
Construction of genome libraries and cDNA libraries Molecular breeding - probe construction – recombinant DNA – Transgenic plant and applications .						
Unit IV	Plant hormones					
Auxin, IAA. GA, Cytokinin and Absicisic acid (ABA) - molecular basis of action – phytochrome – role in photo – morphogenesis – regulation of gene expression - stress induced promoter switches in the control of gene expression – ethylene and fruit ripening.						
Unit V	Plant tissue culture					
Cells suspension cultures– haploid plants – cloning of hosts – micro propagation – somatic embryogenesis – protoplast isolation and applications.						
References	**Textbooks** 1.Trivedi, P.C.,Applied Biotechnology and plant genetics, Dominant publishers and distribution,2011. 2.H.S.Chawla ,Introduction to plant Biotechnology ,Oxford and IBH Publishers , 2020. 3.B.D.Singh ,Plant Biotechnology, Kalayani Publishers , January 2015.					
	Reference books 1.Abdin, M.Z.Kiran, U.Kamaluddin, Ali ,Plant biotechnology principles and applications, Springer publications, 2017. 2.R.Keshavachandran, V. Peter K, Plant Biotechnology methods in tissue culture and gene transfer , Universities press publishers,2018. 3. N.K.Gupta and Sunita Gupta Fundamental of plant biochemistry and biotechnology ,Kalyani publishers, 2018.					

E-reference links:	1. https://www.microscopemaster.com/micropropagation.html 2. https://www.apsnet.org/edcenter/disandpath/prokaryote/pdlessons/Pages/CrownGall.aspx 3. https://www.intechopen.com/books/symbiosis/potential-of-rhizobia-in-improving-nitrogen-fixation-and-yields-of-legumes 4. https://www.nature.com/scitable/topicpage/genetically-modified-organisms-gmos-transgenic-crops-and-732/ 5. https://www2.estrellamountain.edu/faculty/farabee/biobk/BioBookPLANTHORM.html		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1	know the organisation of genome in plants	**K2**
	CO2	learn the mechanism of T-DNA transfer into a plant cell and to know about different plant viral vectors for gene transfer	**K3**
	CO3	acquire knowledge on construction of libraries, genetically modified plants with novel traits	**K2**
	CO4	compareplant growth hormones and gene expression in different plants.	**K4**
	CO5	illustrate the techniques of culturing tissues and protoplast isolation	**K3**

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	M	M	M	M	S	S	M	M	S	S	S	M	M
CO2	M	M	S	S	S	M	M	M	S	S	S	M	M
CO3	S	S	M	M	S	M	M	S	S	S	S	S	M
CO4	S	S	M	S	M	S	S	S	S	S	S	S	M
CO5	S	S	S	S	S	S	M	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks ;Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ;No Correlation (N) - 0 mark

Course Code	U21BTP54	BIOINSTRUMENTATION	L	T	P	C
CORE	XI		5	-	-	4
Cognitive Level	K2: Understand K3: Apply K4: Analyze					
Learning Objective	• To know the fundamental principles and applications of basic instruments in biology • To learn the types of electrophoresis and spectroscopy • To understand, design and evaluate systems and devices that can measure, test and/or acquire biological information					
Unit I	**Microscopy**: Parts and their function, resolving power, aperture – simple, compound, light and dark field, electron and phase contrast microscopes, fluorescent– their applications.					
Unit II	**Colorimetry**: parts and their functions - Beer Lambert's Law. pH metry, Spectroscopy -NMR, IR, UV. Centrifugation techniques – principle, centrifuges and their uses, separation methods. Ultracentrifugation – applications					
Unit III	**Chromatography techniques** – Principles and types – paper, TLC, Column, HPLC and GC. Electrophoretic techniques – principle, electrophoresis of proteins and nucleic acids. Capillary electrophoresis**,** Pulse field electrophoresis and 2 D gel electrophoresis					
Unit IV	**Biochemical Techniques**: • Estimation of carbohydrates • Estimation of Proteins • Preparation of Buffers • Qualitative identification of Nucleic Acids					
Unit V	**1. Lipid analysis** a) Determination of Saponification number b) Determination of Acid number c) Determination of Iodine number **2. Separation of lipids by TLC** Separation of Amino acids by Paper chromatography.					
Text Books	1. M. J. Reilly, Bioinstrumentation , CBS Publishers & Distributers, 2016. 2. John G. Webster ,Bioinstrumentation, Wiley,2018. 3. M.H. Fulekar & Bhawana Pandey, I. K. Bioinstrumentation,International Publishing House Pvt. Ltd., 2014					
References	1. L. Veerakumari, Bioinstrumentation, MJP Publisher, 2019. 2. M. J. Reilly, Bioinstrumentation, CBS Publishers & Distributers, 2016. 3. John G. Webster,Bioinstrumentation, Wiley,2018.					

	4. Keith Wilson and John Wilson,Practical Biochemistry,Fifth edition Cambridge University Press ,2018. 5. M.H. Fulekar & Bhawana Pandey ,Bioinstrumentation , I. K. International Publishing House Pvt. Ltd., 2014.
E-Rreferences Link	1. https://application.wiley-vch.de/books/sample/3527338802_c01.pdf 2. https://bioeng.berkeley.edu/research/bioinstrumentation 3. https://worldwidescience.org/topicpages/b/bioinstrumentation.html
Course outcomes	Upon completion of this course, the students will be able to

CO	**Course Outcomes**	**Knowledge Level**
CO1	understand the fundamentals of microscope and its working principle.	K1, K2
CO2	realize the use of Colorimetry and spectroscopy. Acquire knowledge on centrifuge and its types	K1, K2, K3
CO3	recognize the importance of chromatographic techniques and Empathize on electrophoretic techniques	K1, K2, K3
CO4	explain the fundamentals of Biochemical techniques	K1, K2, K3
CO5	estimate and separate the lipid molecules	K1, K2, K3

Mapping of CO with PO & PSO:

CO	**PO**								**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	M	S	S	S	S	S	S	S	M	S	M
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	M	M	S	M	S	S	M	S	S	M	S	M
CO4	M	S	S	S	S	M	S	S	S	S	S	S	S
CO5	S	M	M	M	S	S	S	S	S	M	S	M	S

Strongly Correlating (S) - 3 marks ; Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark; No Correlation (N) - 0 mark

Course Code	U21BTP55	IMMUNOLOGY,PRINCIPLES OF ANIMAL BIOTECHNOLOGY AND BASICS OF PLANT BIOTECHNOLOGY	L	T	P	C
CORE	XII		-	-	5	4
Cognitive Level	**K2: Understand K3: Apply**					
Learning Objective	• To learn about the techniques in immunology • To acquire knowledge on Animal Biotechnology • To gain knowledge in the field of Environmental Biotechnology					
Experiments	**Immunology practicals** 1. Antigen-anti body reactions 1. Immuno diffusion (Single radial, double Diffusion) 2. Blood grouping 3. Preparation of serum from blood **Practicals In Animal Biotechnology** 1. Designing and safety measures in animal cell culture lab 2. Cleaning and sterilisationofglasswares and plastic tissue culture flasks 3. Preperation of Animal Tissue culture Media 4. Ehidium Bromide staining **Experiments in Plant Biotechnology** 1. Sterilization procedures In Plant Tissue culture 2. Media preparation, different media combination used in plant tissue culture. 3. Explant preparation for plant tissue culture. 4. Isolation of protoplast from leaves (mechanical method)					
References	**Text Books** 1. V. Kumaresan, Animal Biotechnology, Publisher Saras Publication, 2019 2. Birbal Singh, Gorakh Mal , Sanjeev K. Gautam, Manishi Mukesh, Advances in Animal Biotechnology, Publisher Springer, 2019 3. Hrudayanth Thatoi, Supriya Dash, Swagat Kumar Das, Practical Biotechnology Principles and Protocols, Fream tech press, 2020 4. K. R. Aneja, Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology, New Age International Publishers, 2017. 5. Quak,F., Plant Tissue Culture: Methods and Applications in Agriculture, Academic Press, New York, 2018.					
	Reference Books 1. Weir., Hand book of experimental Immunology. Vol I & II. Blackwell scientific publishing. 2011 2. Hudson L & Hay H.C, Techniques in clinical immunology, Blackwell scientific publishing, 2015. 3. Srivastava A K, Animal Biotechnology, Oxford& IBH Publishing, 2013					

E- reference links	1. https://www.lecturio.com/magazine/hypersensitivity-and-its-types/ 2. https://www.narayanahealth.org/organ-transplant/ 3. https://www.dacollege.org/smat/zoo-sem4-ANTIGEN-ANTIBODY-INTERACTION.pdf 4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5823056/ 5. https://people.ucalgary.ca/~browder/transgenic.html 6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7112688/		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1	explain the procedure of immuno- assays and blood grouping.	**K2**
	CO2	understand the different types of media used animal cell culture	**K2**
	CO3	illustrate the staining techniques in animal tissue culture.	**K3**
	CO4	learn and understand the basic techniques of microbial isolation From soil	**K2**
	CO5	gain knowledge on isolation of azobacter and phosphate solubilizing bacteria	**K2**

Mapping of COs with POs & PSOs:

CO	**PO**								**PSO**				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	M	M	S	S	M	M	S	S
CO2	S	S	S	M	M	S	M	M	S	M	M	S	S
CO3	M	M	S	M	S	S	M	S	S	S	S	S	M
CO4	M	M	S	S	S	S	S	S	M	S	S	M	M
CO5	S	S	S	S	S	S	S	S	M	S	S	M	S

Strongly Correlating (S) - 3 marks ;Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ;No Correlation (N) - 0 mark

Course Code	U21BTE511	FORESTRY	L	T	P	C
Elective	III		3	-	-	3
Cognitive Level	**K2: Understand K3: Apply**					
Learning Objective	• To know the scope and importance of forestry • To understand the methods in siviculture • To learn the scope and necessity of agroforestry • To acquire knowledge on forest soils, forest conservation and wildlife biology • To know about the forest economics and forest laws in India					
Unit I	**Siviculture:**					
Introduction to siviculture, Ecological and physiological factors influencing vegetation, natural and artificial regeneration of forests, Silviculture systems and their management. Mangrove and cold deserts- Characteristics, identification and management of species.Traditional and recent advances in tropical silvicultural research and practices.						
Unit II	**Agroforestry:**					
Scope and necessity; role in the life of people and domestic animals and in integrated land use. Agro forestry systems under different agroecological zones; selection of species and role of multipurpose trees and NTFPs, techniques, food, fodder and fuel security.						
Unit III	**Forests Soils:**					
Classification, factors affecting soil formation; physical, chemical and biological properties.Soil conservation – definition, causes for erosion.Role of forests in conserving soils. Maintenance and build up of soil organic matter, provision of loppings for green leaf manuring; forest leaf litter and composting; Role of micro-organisms in ameliorating soils; N and C cycles, VAM.						
Unit IV	**Forest Protection & wildlife Biology:**					
Susceptibility of forests to damage, nature of damage, cause, prevention, protective measures and benefits due to chemical and biological control. General forest protection against fire, equipment and methods, controlled use of fire, economic and environmental costs; timber salvage operations after natural disasters.Rotational and controlled grazing, human impacts; encroachment, poaching, grazing, live fencing, theft, shifting cultivation and control.						
Unit V	**Forest Economics and Legislation:**					
Socio-economic analysis of forest productivity and attitudes; valuation of forest goods and service.History of forest development;Indian Forest Policy of 1894, 1952 and 1990. National Forest Policy, 1988 of People's involvement, Joint Forest Management, Involvement of women. Indian Forest Act 1927; Forest Conservation Act, 1980; Wildlife Protection Act 1972 and their amendments; Application of Indian Penal Code to Forestry.						

References	**Text books** 1. Parmeshwar S. Concepts in Forestry, Publisher Anmol Publications Pvt. Ltd. 2013 2. De Vere Burton L. Introduction to forestry science, Delmar Publishers, New York. 2000 3. Manikandan K. and PrabhuS. Indian Forestry A Breakthrough Approach to Forest Service - 8th Edition, Jain brothers publication, India,2021		
	Reference Books 1. Roger S,2013, 2nd edition, Forestry in global context, CABI publishers,United States. 2. Donald L. Grebner , Pete Bettinger, Jacek P. Siry , 2013. Introduction to forestry and natural resource. 1 st Edition, Academic press		
E-reference links:	• http://www.jnkvv.org/PDF/11042020094651R.K.Bajpai.pdf • http://apps.worldagroforestry.org/Units/Library/Books/PDFs/32_An_introduction_to_agroforestry.pdf?n=161 • https://ucanr.edu/sites/SFIT/files/190066.pdf • https://www.cbd.int/idb/doc/2011/idb-2011-booklet-en.pdf • https://www.ubcpress.ca/asset/9068/1/9780774821520.pdf • http://ifs.nic.in/Dynamic/book/page3.pdf		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1	learn about silviculture and the characteristics of different types of forests	**K2**
	CO2	understand the multipurpose of trees in different industries and the scope of agroforestry	**K3**
	CO3	acquire knowledge on forests soils and learn the importance of forests in soil conservation	**K2**
	CO4	learn the damages that occur in forests and ways to prevent the damages	**K3**
	CO5	attain knowledge on the forest economics and the forest laws in India	**K2**

Mapping of COs with POs & PSOs:

CO	**PO**								**PSO**				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	M	S	S	M	M	S	M	M	M	S	S
CO2	S	M	S	M	M	S	M	M	S	M	M	S	S
CO3	M	M	M	M	S	M	M	S	S	S	S	S	M
CO4	M	M	S	S	S	S	S	S	M	S	M	M	M
CO5	S	M	M	S	S	M	S	M	M	S	M	M	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	U21BTE512	BIODIVERSITY CONSERVATION	L	T	P	C
Elective	III		3	-	-	3
Cognitive Level	**K2: Understand K3: Apply K4:Analyse**					
Learning Objective	• To provide students with opportunities for goal oriented research in biodiversity conservation and management for ecotourism and wildlife development. • To identify the variety of our enormous biological resources in relation to their various ecological settings. • To understand the functioning of the ecological systems and their driving force.					
Unit I	**Biodiversity and Conservation**					
Catergories of biodiversity – species concepts: keystone, flagship, dominant and co-dominant species – Biogeography: Major terrestrial biomes – theory of island biogeography – Biogeographical zones of India – Principles and approaches of conservation – In-situ conservation: National parks, Wildlife Sanctuaries, Biosphere reserves – Ex-situ conservation: Botanical and herbal gardens, zoological parks, seed orchards and gene banks.						
Unit II	**Values of biodiversity**					
Ecosystem services- screening plants for medicines- New agricultural and industrial products from the tropics- identifying and protecting the origin of food crops. Speciation- species area relationship: productivity- diversity relationship – Biodiversity hot spot.						
Unit III	**Biosafety**					
The effect of global climatic change on natural communities- IUCN categories of extinction- red data book – causes for species extinction – impact of exotic species on native species – GMOs and biosafety – Intellectual property rights- GATT,WTO, farmers and breeders rights- Bodiversity act -2002.						
Unit IV	**Remote sensing**					
Introduction-Analysis techniques-Digital image processing Role of remote sensing in biodiversity management-GIS and biodiversity, landscape elements Oceans colour and fishery, water security. Environment assessment and monitoring.						
Unit V	**Conservation**					
In situ and Ex situ conservation methods- conservation of biological diversity in Botaniocal gardens- Information management for the conservation of biodiversity. Cryobiology-Agro ecology and in situ conservation of native crop diversity- International development and the protection of biodiversity						
References	**Text books** 1. B.B.Hosetti and S.Ramakrishna, Biodiversity concepts and conservations, Aavishkar publishers, 2016. 2.MahendraChaturvedi, Biodiversity and conservation, D.P.S. Publsihing House, 2011.					

	3.KV.Krishnamurthy, An Advanced textbook on Biodiversity, Oxford and IBH Publishing House, 2013. 4.PraveenGarg, Biodiversity and its conservation, BR Publishers, 2018.
	Reference Books 1.P.D.Sharma , Ecology and environment, Rastogi Publishers, 2017. 2. Ravi Biruduand P.Padmavathi, Ecology and Biodiversity, Notion Press, 2017.
E-reference links:	1. https://www.toppr.com/guides/biology/biodiversity-and-conservation/types-of-biodiversity/ 2. https://www.safeworldhse.com/2020/04/biodiversity-types-importance-loss-conservation.html 3. http://www.bsienvis.nic.in/Database/Biodiversity-Hotspots-in-India_20500.aspx 4. https://www.environmentbuddy.com/endangered-wildlife/list-of-biodiversity-hotspots-examples/ 5. file:///C:/Users/machs/Downloads/sensors-10-09647.pdf 6. https://www.scimagojr.com/journalsearch.php?q=21482&tip=sid
Course Outcomes	Upon completion of this course the students will be able to

	CO1	learn the fundamentals of Biodiversity -In-situ and Ex-situ conservation	**K2**
	CO2	know the value of Biodiversity and importance of ecosystem service	**K3**
	CO3	explain the global climate changes and biodiversity acts.	**K2**
	CO4	illustrate remote sensing and its techniques.	**K3**
	CO5	compare in-situ and ex-situ conservation techniques.	**K4**

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	M	S	M	S	S	S	S	S
CO2	M	S	S	S	S	S	M	S	S	M	S	S	S
CO3	S	S	M	S	S	S	S	S	S	M	S	S	S
CO4	S	S	S	M	S	S	M	S	S	S	S	S	S
CO5	M	S	S	S	S	S	S	S	M	S	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Code	U21BTS531	MEDICAL LAB TECHNOLOGY	L	T	P	C
SBE	III		2	-	-	2

Learning Objective	• To understand the basic concepts of medical laboratory techniques • To learn the techniques required for clinical diagnosis • To perform basic biochemical tests and histopathology tests • To gain knowledge on the principles of diagnosis
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze K5: Evaluate
Unit I	**Basic Hematology**:

Specimen collection and handling, transportation of specimens, disposal of specimen after laboratory use. Specimen preservation. Composition of blood. Methods of estimation of Haemoglobin, PCV, total and differential count of WBC, platelet count, clotting, bleeding and prothrombin time. Blood Group - methods of grouping and Rh factor.

Unit II	**Biochemical test:**

Tests for specific amino acids, determination of proteins in serum and plasma. Determination of glucose, glucose tolerance test, ketone bodies, glycated hemoglobin, triglycerides, cholesterol, lipoproteins. Examination of body fluids - ascitic fluid, pleural fluid, synovial fluid, pericardial fluid, CSF and amniotic fluid. Urine analysis, abnormal constituents. Faecal specimen - Macroscopic and microscopic examinations - detection of occult blood, Semen analysis. Laboratory analysis of throat swab, sputum specimens, purulent exudates – Tuberculosis

Unit III	**Histopathology :**

Tissue reception, labeling, fixation and section cutting, Preparation of paraffin blocks (Dehydration, clearing, embedding, blocking).Handling and care of microtome, types of microtome, sharpening of knives, and section cutting. Frozen section techniques - CO2 freezing, cryostat. Preparation of common stains. H & E, Congo red, methyl violet, Leishman stain, Giesma and staining techniques. Mounting of specimens, record keeping, indexing of slides. Molecular analysis of chromosomal aberrations in leukemias and lymphomas. Molecular diagnosis of genetic diseases.

Unit IV	**Principles of Diagnosis:**

History, Physical Examination, Treatment, Differential Diagnosis, Tests and procedure (Clinical laboratory test, Tests using Radioisotopes, Endoscopy, Ultrasound, X-Ray, MRI, CT scan, PET scans, cytologic and Histologic examination of cells and tissue from patients).

Unit V	**Molecular Diagnosis:**

Nucleic acid amplification methods and types of PCR: Reverse Transcriptase-PCR, Real-Time PCR, Inverse PCR, Multiplex PCR, Nested PCR, Alu-PCR, Hot-start, In situ PCR, Long-PCR, PCR-ELISA, Arbitrarily primed PCR, Ligase Chain Reaction. Proteins and Amino acids, Qualitative and quantitative techniques: Protein stability, denaturation; amino acid sequence analysis. Viral diagnostics: immunodiagnosis, molecular diagnosis. SNP-based diagnosis. DNA chips, automation, gene therapy; applications in diagnosis of genetic disorders, Diagnosis of Prenatal & neonatal genetic disorders.

Text Books	1. GP Pal,Textbook of Histology, Publisher: Paras Medical Books,2015 2. B.S.Shah, Short Textbook Of Hematology,Publisher : CBS Publishers & Distributors,2014 3. Nader Rifai, A. Rita Horvath, Carl T. Wittwer, Clinical Chemistry and Molecular Diagnostics, Publisher Elsevier India,2018
References	1. Praful. B. Godkar, Darshan. P. Godkar, Text Book of Medical Laboratory Technology. Bhalani Publishing House. 2014. 2. F.J. Baker, R.E. Silverton, Butterworth - Heinemann. Introduction to Medical Laboratory Technology. Butterworth- Heinemann, Saunders Publisher, 2014. 3. Todd & Stanford. Clinical Diagnosis and Management by Laboratory Methods. 16th ed. 2016.
E-reference links:	1. https://www.thebalancecareers.com/what-is-a-medical-laboratory-technologist-526029 2. https://www.leicabiosystems.com/knowledge-pathway/an-introduction-to-specimen-processing/ 3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1214554/ 4. https://www.justintimemedicine.com/CurriculumContent/p/387 5. https://www.bloodworksnw.org/medical-services/introduction-to-hematology
Course outcome	Upon completion of this course, the students will be able to

CO1	know the methods of sample collection, specimen preservation and estimation methods	**K2**
CO2	estimate biomolecules and body fluids using several biochemical tests	**K5**
CO3	understand the methods in histopathology and sample freezing techniques	**K2**
CO4	learn the principles of diagnosis and apply the techniques to perform tests	**K2**
CO5	develop skills in handling different types of PCR for molecular diagnosis	**K1,K2,K3**

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	M	S	S	S	M	M	S	S	S	M	S
CO2	S	M	S	S	S	S	S	S	M	S	S	M	S
CO3	M	S	M	M	S	S	S	S	S	M	S	S	S
CO4	S	S	S	S	S	M	S	S	S	S	M	S	S
CO5	S	M	M	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks ;Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ;No Correlation (N) - 0 mark

Course Code	U21BTS532	FOOD PROCESSING TECHNOLOGY	L	T	P	C
SBE	III		2	-	-	2

Cognitive Level	**K1: Recall K2: Understand K3: Apply**
Learning Objective	• To learn the functional groups of food • To acquire knowledge on Food processing • To learn the principle of food spoilage and food preservation. • To learn the techniques of food packaging
Unit I	**Nutrient rich Foods:**
Carbohydrate, fat and protein rich foods, vitamins, minerals and fiber. Milk and milk Products – Fluid milk & some of its derivatives, Ice cream & related products, cheese, Yoghurt milk powder, paneer, Indian dairy products – kheer, khoa / mawa, khurchan, Rabri, kulfi / Dahi, Ghee, Lassi, Makkhan.	
Unit II	**Food preservation:**
Food Irradiation, microwave heating & cosmic heating preparation of cakes-methods. Assessment of Quality Factors in foods: - Appearance factors, Textural factors, flavor factors, quality standards.	
Unit III	**Food detoriation and its control:**
Shelf life & dating of foods, principles of food preservation, control of microorganisms. Beverages: Carbonated non-alcoholic beverages, beer, wine, coffee, tea. Causes of spoiling and their control methods.	
Unit IV	**Processing of food Materials Hands on training:**
Picklemaking, jamsjellies, squash.	
Unit V	**Food Safety, Risks Hazards:**
Food processing & the environment, principles of food packaging. Governmental regulation of food & nutrition labelling for jam, jelly, squash, pickle. General characteristic of milk, milk products.	
References	**Text Books** 1.Sukumar De ,Outlines of Dairy technology , Oxford university press ,2011. 2.W.Hartel ,Principles of Food Processing,Springer,2019. 3.Shubhangini A.Joshi ,Nutrition & Dietetics , McGraw hill, 2017
	Reference Books 1.NormalN.Potter, Joseph H. Hotchkiss ,Food science , Fifth Edition ,Shafifur, 2017. 2.P.J Fellows, Food processing technology ,wood head pulishing, 2017.
E-reference	1. https://academic.oup.com/advances/article/5/2/131/4557960 2. https://www.highspeedtraining.co.uk/hub/food-preservation-methods/

links	3. https://www.acsedu.co.uk/Info/Alternative-Living/Preventative-Healthcare/Food-Spoilage.aspx 4. https://onlinelibrary.wiley.com/doi/full/10.1111/j.1750-3841.2007.00301.x		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1	gain knowledge and understanding on different foods and milk products	**K1**
	CO2	understand the food preservation techniques and quality factors	**K3**
	CO3	understand the factors responsible for food detoriation and ways to prevent food spoilage.	**K2**
	CO4	understand the preparation of pickle, jam, jellies and squash.	**K4**
	CO5	gain knowledge on food safety and regulations of government.	**K2**

Mapping of COs with POs & PSOs:

CO	**PO**								**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	M	S	S	S	M	M	S	S	S	M	S
CO2	S	M	S	S	M	M	M	S	M	S	S	M	S
CO3	M	S	M	M	S	S	M	S	S	M	S	S	S
CO4	S	S	S	S	S	M	M	S	S	M	M	S	S
CO5	S	M	M	M	S	S	S	S	S	S	M	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

SEMESTER - VI

Course Code	U21BTT61	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
CORE	XIII		5	-	-	4
Cognitive Level	**K2:Understand K3:Apply K4: Analyze K6: Create**					
Learning Objective	• To provide students with knowledge of environmental biotechnology. • To develop an knowledgeon pollution. • To gain working knowledge on bioremediation • To gain knowledge on genetically modified organisms.					
Unit I	**Natural resources:** Classification of Natural resources, Renewable and non-renewable, conservation of natural resources-water and soil resources. Environmental impact- production of biofuel and biogas.					
Unit II	**Bioremediation**: Concepts of bioremediation (in-situ and ex-situ), Bioremediation of toxic metal ions – bio sorption and bioaccumulation principles. Environmental impact of pollution and measurement methods – Composting of organic wastes, microbial bioremediation of oil spills; Bio-leaching: Microbial leaching of ores – direct and indirect mechanisms. Waste water treatment – sewage treatment and common industrial effluent treatment; Concepts of phytoremediation; Microbial biotransformation of pesticides and xenobiotic.					
Unit III	**Biofertilizers:** Biofertilizers and their importance in crop productivity; Algal and fungal (Mycorrhizal) biofertilizers Bacterial biofertilizers (Rhizobial, free living Nitrogen fixers and phosphate solubilizing bacteria, their significance and practice.					
Unit IV	**Biopesticides:** Bacterial (BT pesticides), fungal (Trichoderma); Viral biopesticides – Baculovirus, NPV insecticides; Production of biofertilizers and biopesticides for large scale application.					
Unit V	**Genetically Engineered Microorganisms:** Genetically Engineered Microorganisms in treatment of wastes, genetically engineered plants and microorganisms in agriculture and productivity. Hazards of genetically engineered microorganisms, plants and animals-Policies of genetic engineering research.					
References	**Text Books**. 1.U. Sathyanarayana, U. Chakrapani, Biotechnology, Books & Allied Ltd. , 2020. 2. N. Arumugam, M. G. Ragunathan, Environmental Studies, Saras Publication, 2019. 3. V. Kumaresan, Biotechnology, Saras Publication, 2015. 4. V. Kumaresan, N. Arumugam, Environmental Biotechnology, Saras Publication,2014. 5. R. C. Dubey, Advanced Biotechnology, S. Chand & Company, 2014.					
	Reference Books 1. Bruce E. Rittman Perry L. McCarty, Environmental Biotechnology:					

<table>
<tr><td></td><td colspan="3">Principles and Applications , McGraw-Hill Education, 2011.
2. Jogdand ,Environmental Biotechnology , S.N.. Himalaya Publishing House, Bombay, 2011.
3. De, K.K, Wiley ,Environmental Chemistry Eastern Ltd. NewDelhi, 2014.
4. Mackenzie Davis ,Waste Water Engineering , McGraw-Hill Education, 2012.
IndhuShekhar Thakur, Environmental Biotechnology Concepts and Applications 2nd Edition ,Dreamtech Press, 2019.</td></tr>
<tr><td>E-reference links</td><td colspan="3">1. https://www.environmentalpollution.in/natural-resources/natural-resources-meaning-and-classification-of-natural-resources/278
2. https://www.intechopen.com/books/frontiers-in-bioenergy-and-biofuels/biogas-biodiesel-and-bioethanol-as-multifunctional-renewable-fuels-and-raw-materials
3. https://www.intechopen.com/books/trace-metals-in-the-environment-new-approaches-and-recent-advances/bioremediation-techniques-for-polluted-environment-concept-advantages-limitations-and-prospects
4. http://wiki.biomine.skelleftea.se/wiki/index.php/Bioleaching
5. https://www.nap.edu/read/2131/chapter/4#19
6. https://investuttarakhand.com/themes/backend/investible/IP%20UK%20Manufacturing-of-Biofertilizers-and-Biopesticides.pdf</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon completion of this course the students will be able to</td></tr>
<tr><td></td><td>CO1</td><td>illustrate the classification and conservation of natural resources</td><td>K3</td></tr>
<tr><td></td><td>CO2</td><td>compare the eco-friendly bioremediation techniques that can solve environmental problems.</td><td>K4</td></tr>
<tr><td></td><td>CO3</td><td>gain knowledge on biofertilizers and crop productivity.</td><td>K2</td></tr>
<tr><td></td><td>CO4</td><td>compare the potential use of different biopesticides on plants against pests and know production of biofertilizers and biopesticides</td><td>K4</td></tr>
<tr><td></td><td>CO5</td><td>evaluate the role of genetically engineered organisms for treatment of waste.</td><td>K6</td></tr>
</table>

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	M	S	S	S	S	S	S	M
CO2	S	S	M	S	M	S	M	S	M	S	M	S	S
CO3	S	S	M	M	S	S	S	S	S	S	S	S	M
CO4	S	S	S	S	S	S	M	S	S	S	S	S	S
CO5	S	S	M	S	S	S	S	S	S	S	S	S	M

Strongly Correlating (S) - 3 marks ;Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ;No Correlation (N) - 0 mark

Course Code	U21BTT62	FERMENTATION TECHNOLOGY	L	T	P	C
CORE	XIV		5	-	-	4
Cognitive Level	**K2:Understand K3:Apply**					
Learning Objective	• To learn about importance of microorganisms in industries • To understand the techniques of fermentation. • To learn the production of industrial products using micro organisms.					
Unit I	**Introduction to industrial microorganisms**: Isolation, Preservation and Maintenance of Industrial Microorganisms. Kinetics of microbial growth and death. Media for industrial fermentation. Air and Media Sterilization.					
Unit II	**Types of fermentation processes:** Solid state and liquid state fermentations; batch, fed-batch and continuous fermentations. Components of bioreactor, Types of bioreactor, Measurement and control of bioprocess parameters- pH, temperature, dissolved oxygen, foaming and aeration.					
Unit III	**Downstream Processing:** Introduction, Removal of microbial cells and solid matter, foam removal, precipitation, filtration, centrifugation, cell disruption, liquid-liquid extraction chromatography, Membrane process, Drying and Crystallization.					
Unit-IV	**Microbial production of Industrial Products:** Alcohol (Ethanol), Acids (Citric), Antibiotics (Penicillin), Amino acids (lysine), Single Cell Protein (algae/fungi).					
Unit-V	**Enzyme immobilization:** Methods of immobilization, advantages and application of immobilization, large scale application of immobilized enzymes.					
References	**Textbooks** 1. U. Sathyanarayana, U. Chakrapani, Biotechnology, Books & Allied Ltd. , 2020. 2. S.M. Reddy, Basic Fermentation Technology, New Age International Publishers, 2017. 3. H. K. Das, Textbook of Biotechnology ,5th Edition, Wiley, 2017. 4. WulfCrueger, AnnelieseCrueger, ATextbook of Industrial Microbiology,Wiley,2017 5. Dr. R. C. Dubey, A Textbook of Biotechnology, S. Chand, 2014. 6. N. Arumugam, Microbial Biotechnology, Saras Publication, 2007.					
	ReferenceBooks 1.DoraiswamiRamkrishna, SubhabrataSengupta, SudiptaDeyBandyopadhyay, AvijitGhosh, Advances in Bioprocess Engineering and Technology , Springer, 2020. 2. Michael l. Shuler, FikretKargi ,Bioprocess Engineering: Basic Concepts, Pearson Education India, 2015. 3.Casida, L. E, Industrial Microbiology, New Age International (P) Ltd., New Delhi, 2013.					

	4.Michael Shuler and FikretKargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ. 2020.		
E-reference links:	1. http://microbio.du.ac.in/web3/uploads/Microbiology%20Uploads/Reading%20material/MBOE-201%2002.%20strain%20improvement.pdf 2. https://www.mpgmahavidyalaya.org/userfiles/Fermentation%20Types.pdf 3.https://theconstructor.org/environmental-engg/difference-chemical-oxygen-demand-cod-biological-oxygen-demand-bod/34792/ 4. https://microbiologynotes.org/downstream-processing-and-its-steps/ 5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5385174/ 6. https://www.britannica.com/topic/food-preservation/Fungi 7. https://www.news-medical.net/health/What-are-Biosensors.aspx		
Course Outcomes	On Successful completion of the course, the students will be able to		
	CO1	describe the media formulations, microbial growth kinetics and isolation techniques.	**K2**
	CO2	acquire knowledge on bioreactor selection, upstream & fermentation processes, and its role in manufacturing bio-products	**K3**
	CO3	learn and describe the down-stream process in fermentation.	**K2,K3**
	CO4	gain knowledge about production of commercial products using microbes.	**K3**
	CO5	learn the techniques in enzyme immobilization.	**K3**

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	M	S	M	S
CO2	S	M	M	M	M	S	M	M	M	S	S	S	M
CO3	S	S	M	S	S	S	M	S	S	S	M	S	M
CO4	M	S	M	M	S	S	M	S	S	S	M	S	S
CO5	S	M	M	M	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks ;Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ;No Correlation (N) - 0 mark

Course Code	U21BTT63	BIOINFORMATICS	L	T	P	C
CORE	XV		5	-	-	4
Cognitive Level	K2: Understand K3: Apply K4: Analyze					
Learning Objective	• To gain knowledge in the concepts of bioinformatics. • To learn about programming languages, internet nd search engines. • To acquire knowledgeon database searching tools					
Unit I	**Introduction and history of bioinformatics:**					
History, development and types of computers. General awareness of computer systems – hardware and software (CPU and other peripheral devices, computer arithmetic, computer logic.						
Unit II	**DataBases:**					
Programming languages – Internet, World Wide Web, Web browser,EMB net, NCBI. File transfer protocol. Search engines						
Unit III	**Sequence analysis :**					
Sequence analysis – need and importance – pair wise alignment – dynamic programming – Global (Needle man – Wunsch) and local (Smith Waterman) Alignment Concepts –Multiple sequence alignment – RFLP, SNP, RAPD, Human Genome Project.						
Unit IV	**DataBanks:**					
Use of nucleic acid and protein databanks.Database searching tools Definition, Entrez, BLAST, FASTA, Genbank. 3D structural analysis of biomolecules – molecular visualization tools Rasmol, chemsketch and SPDBV – Protein Docking.						
Unit V	**Evolutionary analysis:**					
Phylogeentic tree- Distance – clustering methods – Rooted and unrooted tree representation. Neutral Networks. Bootstrapping stratergies.						
References	**Text books** 1. S.C.Rastogi, N.Meniratta, Bioinformatics Methods and Applications, Prentice Hall India Learning Private Limited, 2013. 2. Harsha ,Fundamentals of bioinformatics, S. Wiley Publishers ,2019. 3. Jeremy Ramdass, Bioinformatics An Introduction,Springer publishers ,2015. 4. T.K.Atwood ,Introduction to Bioinformatics , Pearson Publishers, 2017.					
	Reference books 1.ZhumurGhosh&BibekanandMallick ,Bioinformatics Principles and applications , OUP Publishers ,2018. 2.Ruchi Singh, Bioinformatics Preoteomics and genomics ,Vikas publishing House ,2014.					

E-reference links	1. https://www.cs.cmu.edu/~fgandon/lecture/uk1999/computers_types/ 2. https://www.wikilectures.eu/w/Computer_hardware_and_software 3. https://webfoundation.org/about/vision/history-of-the-web/ 4. https://www.ncbi.nlm.nih.gov/books/NBK20261/ 5. https://www.mrc-lmb.cam.ac.uk/genomes/madanm/pdfs/biodbseq.pdf 6. https://www.intechopen.com/books/computational-biology-and-chemistry/bioinformatics-as-a-tool-for-the-structural-and-evolutionary-analysis-of-proteins		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1	learn about history of bioinformatics and computerhardwares and softwares	**K2**
	CO2	gain knowledge to use internetand the search engines	**K3**
	CO3	gain the knowledge about gene sequences analysis,Multiple sequence alignment	**K3**
	CO4	gain knowledge in using various biological databases tools	**K3**
	CO5	know and analyze about evolution and construction of the Phylogenetic tree	**K4**

Mapping of COs with POs & PSOs:

CO	**PO**								**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	M	S	S	S	S	M	M	S
CO2	S	S	S	S	S	S	M	M	S	S	S	M	S
CO3	M	M	S	M	M	S	S	M	M	S	S	S	S
CO4	M	M	M	S	M	S	M	S	S	M	S	S	M
CO5	S	M	M	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Code	U21BTT64	BIOSTATISTICS	L	T	P	C
CORE	XVI		5	-	-	4
Cognitive Level	**K2: Understand K3: Apply K4:Analyse**					
Learning Objective	• To recognize the definition of statistics, its subject and its relation with the other sciences. • To identify data relating to variables and suitable sampling theories • To create awareness on various calculation methodologies used in life science					
Unit I	**Introduction to Basis of statistics**					
Definition – Statistical methods – kinds of Biological Data. Classification of Data, Meaning and definition, objectives of Classification of Data.						
Unit II	**Collection, Organization and Representation of Data**					
Collection of Data, Types of Data- Primary Data and Secondary Data, methods of collecting Data. Sampling and sampling Designs – Meaning and Definition – Random and Non – Random sampling. Tabulation and representation of data – diagrammatic and graphical.						
Unit III	**Measures of central Tendency**					
Definition, Types of averages- Arithmetic mean,Median, Mode, Problems related to ungrouped data, simple grouped data – Continuous and discrete series.						
Unit IV	**Measures of Dispersion**					
Definition, Types of dispersion – Range, Mean deviation,Standard deviation and variance, problems related to measures of dispersion.						
Unit V	**Correlation and Regression analysis**					
Correlation analysis (Karl Pearson's and Spearman's Rank), Regression analysis – simple, linear. Analysis of variance (ANOVA): One-way & Two-way. Concept of probability – Addition and multiplication theorem of probability, conditional probability.						
References	**Text books** 1. Veer Balarastogi ,Biostatistics , Medtech publishers, 2015. 2. B. Annadurai ,A textbook of Biostatistics ,New age international publishers , 2017. 3. BelavendraAntonisamy, Prasanna S Preamkumar, Principles and practices of Biostatistics,Elseviar Publishers ,2017. 4. K.L.A.P Sarma, B,Ravindra Reddy, Biostatistics, Daya Publishing House, 2013					
	Reference Books 1.APKulkarni ,Basics of Biostatistics ,CBS publishers ,2020. 2.K. Balaji, A.V.S. Raghavaiah& K. N. Jayaveera ,Biostatistics, Wiley Publishers ,					

	2020. 3. VeerBalarastogi ,Biostatistics , Medtech publishers , 2015. 4. Wayne W. Daniel & Chad L. Cross ,Biostatistics , Wiley Publishers, 2014. 5. B.Annadurai,A textbook of Biostatistics,New age international publishers,2017.		
E-reference links:	1. https://www.easybiologyclass.com/statistical-data-variables-types-and-classification-biostatistics-short-notes/ 2. https://www.toppr.com/guides/business-economics-cs/descriptive-statistics/diagrammatic-presentation-of-data/ 3. https://www.kluniversity.in/arp/uploads/2096.pdf 4. https://www.statisticshowto.com/probability-and-statistics/hypothesis-testing/anova/ 5. https://www.investopedia.com/terms/s/standarddeviation.asp 6. https://www.graphpad.com/support/faq/what-is-the-difference-between-correlation-and-linear-regression/ 7. https://data36.com/statistical-averages-mean-median-mode/		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1	understandthe fundamentals of statistics, methodology and classification of data.	**K2**
	CO2	know themethods of collecting data and the different typres of sampling and sampling designs	**K3**
	CO3	understand and analyze the mesures of central tendency	**K4**
	CO4	classify variables and meaures of dispersion.	**K3**
	CO5	learn to use correlation analysis, regression analysis and analysis of variance.	**K2**

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	M	S	M	S	S	S	S	S
CO2	S	S	M	S	S	S	M	S	S	S	S	S	S
CO3	S	S	M	S	S	S	S	S	S	M	S	S	S
CO4	S	S	S	M	S	S	M	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks ;Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ;No Correlation (N) - 0 mark

Course Title & Code	U21BTP65	ENVIRONMENTAL BIOTECHNOLOGY, FERMENTATION TECHNOLOGY AND BIOINFORMATICS	L	T	P	C
CORE	XVII		-	-	5	4
Cognitive Level	K2: Understand K3: Apply K4: Analyze					
Learning Objective	• To learn about fermentation and bioreactors • To acquire knowledge on industrial application of microorganisms • To learn the techniques plant tissue culture • To know about BLASTA and FASTA					
Experiments	**Experiments in Environmetnal Biotechnology** 1.Enumeration of Microbial population in soil-Bacteria,fungi.actinomycetes 2.Isolation of Azotobacter from the soil 3.Isolation of Phosphate solublising bacteria 4.Isolation and charaterization ofbacteria from crude oil contaminated soil **Experiments in BioprocessTechnology** 1.Isolation and characterization of Microorganisms involved in Biodegradation (Cellulolytic) 2.Isolation and characterization of microorganisms involved in biodegradation (amylolytic) 3.Production of wine from grapes using baker's yeast 4.Production of alcohol by S. cerevisiae 5.Isolation of Rhizobial colonies involved in biofertilization **Experiments in Bioinformatics** 1.Evolutionary analysis/Phylogenetic analysis-Analysis of parametersaffectinc trees 2.PDB structure retrival and visualization analysis of Homologous structures 3.Sequence (FASTA and BLAST) searches 4.Bibliographic search from PUBMED					
References	**Text Books** 1.S.V.S. Rana, Environmental Biotechnology, Publisher Rastogi,2014 2.S.C.Rastogi, N.Meniratta, Bioinformatics Methods and Applications, Prentice Hall India Learning Private Limited, 2013.					
	Reference Books 1.Abunayeem Book , Microbiology laboratory, Research gate,2016. 2.DasSurajitHirakRanjan, Microbial Biotechnology,springer, 2015. 3.Marchan, D.J.,Handbook of Cell and Organ Culture,BurgessPub.Co., Minneapolis, USA,2011. 4.Shanmugam, Laboratory Manual of Cell Biology,Macmillan, India. 2012. 5.Ruchi Singh ,Bioinformatics Preoteomics and genomics , Vikas publishing House ,2014. 7.T.K.Atwood ,Introduction to Bioinformatics , Pearson Publishers ,2017.					
E-Links	1.http://www.unice.fr/EB/USTH%202013/BP04_practical_2_protoplast_boncompagni.pdf 2.https://www.plantcelltechnology.com/blog/meristem-and-shoot-tip-culture/					

	3.https://www.grin.com/document/265322 4.https://www.cs.cmu.edu/~fgandon/lecture/uk1999/computers_types/ 5.https://www.wikilectures.eu/w/Computer_hardware_and_software 6.https://webfoundation.org/about/vision/history-of-the-web/		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1	acquire basic techniques in plant biotechnology.	**K2**
	CO2	understand the different types of media used in microbial isolation	**K2**
	CO3	demonstrate the production of wine and alcohol.	**K3**
	CO4	know the basics of phylogenetic analysis	**K2**
	CO5	analyze sequences using BLAST and FASTA	**K4**

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	M	M	S	M	S	M	S	M	S
CO2	S	S	M	M	M	S	S	S	S	S	S	M	S
CO3	S	S	S	S	S	S	M	S	S	S	S	M	S
CO4	S	M	S	M	M	S	S	M	S	S	M	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks ;Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ;No Correlation (N) - 0 mark

Course Code	U21BTE641	BIOSAFETY AND IPR	L	T	P	C
ELECTIVE	IV		3	-	-	3
Cognitive Level	K2: Understand K3: Apply K4: Analyze					
Learning Objective	• To gain knowledge on various aspects of biosafety regulations and IPR • To analyse the concerns arising from the commercialization of biotech products • To gain knowledge on process of applying for patent					
Unit I	**Biosafety**					
Introduction; biosafety issues in biotechnology. Introduction to Biological Safety Cabinets; Biosafety Levels. Containment levels and their impact on Environment- Containment-definition, types of containment,						
Unit II	**Biosafety Guidelines:**					
Biosafety guidelines and regulations (National and International) – operation of biosafety. Guidelines and regulations of Government of India; Roles of Institutional Biosafety Committee. Biotechnology and bio piracy.						
Unit III	**Risk management:**					
Definition of GMOs & LMOs; RCGM, GEAC etc.GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication.						
Unit IV	**Types of Intellectual Property:**					
Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications. Importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – world intellectual property rights organization (WIPO).						
Unit V	**Patent Filing Procedures:**					
National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting, financial assistance for patenting.						
References	**Text Books** 1. V.K. Ahuja ,Intellectual property rights in India , Lexisnexis publishers, 2015 2. M.K.Satheesh, Bioethics and Biosafety, Wiley Publishers, 2020. 3. DeepaGoel ,IPR, Biosaftey and Bioethics ,Pearson publishers ,2013.					
	Reference Books					

	1.M.M.S.Karki, Intelleutal property rights , Basic concept, 2011. 2.Rae Scott B Willam B, Bioethics , Eerdmans publishing house,2013.		
E-reference links:	1. https://www.mobt3ath.com/uplode/books/book-7844.pdf 2. https://microbenotes.com/biosafety-cabinets/ 3. https://consteril.com/biosafety-levels-difference/ 4. https://genesandnutrition.biomedcentral.com/articles/10.1007/s12263-012-0316-4 5. https://www.dubaicustoms.gov.ae/en/IPR/Pages/WhatIsIPR.aspx 6. https://cleartax.in/s/patent-regsitration 7. https://www.mondaq.com/india/patent/783950/international-patent-filing-via-patent-co-operation-treaty-pct		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1	gain awareness about biosafety and its levels	**K2**
	CO2	analyse the guidelines of biosafety.	**K4**
	CO3	acquire adequate knowledge in the use of genetically modified organisms and its effect on human health.	**K2**
	CO4	illustrate the concepts of IPR	**K3**
	CO5	learn the process for applying patent	**K3**

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	M	S	M	M	S	M	S	S	M	S
CO2	S	M	S	S	S	M	M	M	S	S	M	M	S
CO3	S	M	M	S	M	S	M	M	S	M	S	M	S
CO4	M	S	M	M	S	S	S	S	S	S	S	S	M
CO5	S	M	S	S	M	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks ;Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ;No Correlation (N) - 0 mark

Course Code	U21BTE642	FOOD BIOTECHNOLOGY	L	T	P	C
Elective	IV		3	-	-	3
Cognitive Level	K2 : Understand K3 : Apply K4: Analyze					
Learning Objective	• To learn the concepts of Food Biotechnology • To gain knowledge on role of microorganism in food industry • To Know about the applications of biotechnology					
Unit I	**Biotechnological appoarches in food processing**:					
Food Biotechnology -Scope, Importance and applications in fields of medicine, agriculture, industry and environment. Microorganisms associated with food biotechnology – Bacteria, Yeast, Mould						
Unit II	**Enzymes in food industry:**					
Proteases, glucose oxidase, catalase, lactase.Definition, Properties of enzymes, Microorganisms producing enzymes, Enzymes used in the production of fruit juices, beer and distilled alcoholic drinks, processing steps of wine and beer.						
Unit III	**Production of Cultures for Food Fermentation:**					
Culture of food microbes -Preparation of nutrient media, Sterilization and disinfection, inoculation techniques, Staining methods, Microbial examination						
Unit IV	**Fermentation Technology:**					
Fermentation – Definition, Fermentation process,Fermented food Products. , Advantages of fermented products.Organic acids and Sweeteners Organic acids – Production of citric acid, acetic acid, lactic acid Sweeteners						
Unit V	**Single Cell Protein:** Single cell Protein: Definition, Microorganisms used for					
	SCP, Advantages of SCP, Limitations of SCP. Food and Biotechnology - Application of Plant and Animal Biotechnology in Food industry – Approaches of genetic engineering in foods					
References	**Text Books** 1. Ananthanarayan and Paniker's, Textbook of Microbiology, Eleventh Edition ,University press, 2020. 2. V.K.Joshi,Food Biotechnology,Principles and Practices,I K International Publishing House,2012. 3. S.C.Bhatia,Food Biotechnology,Wood Head publishind India pvt ltd,2016.					
	Reference Books 1. Byong H Lee, Fundamentals of food Biotechnolgy,Wiley					

	Publishers,2015 2. G N Foster, food Biotechnology,CBS Publishers and Distributors,2020 3. Lee BH, Fundamentals of Food Biotechnology, John Publisher, 2014.		
E-reference links:	1. http://www.businessdictionary.com/definition/foodbiotechnology.html 2. http://www.mrothery.co.uk/genetech/genetechnotes.htm 3. http://www.mrothery.co.uk/genetech/genetechnotes.htm 4. http://drs.cift.res.in/bitstream/handle/123456789/4540/Sterlization%20technique%20used%20in%20microbiology.pdf?s 5. https://www.aladdine.com/up_files/docs/Types%20of%20culture%20media%20used%20in%20microbiology.pdf		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1	gain knowledge importance and applications of Food Biotechnology	**K2**
	CO2	learn about the importances of enzymes used in food industry	**K3**
	CO3	apply the techniques and methods for the preparation of culture media, sterilization, inoculation and staining	**K4**
	CO4	knowledge on fermentation process and its application	**K3**
	CO5	understand the knowledge in production of single cell protein and its uses.	**K2**

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	M	M	M	S	S	S	M	S	S	S	M	S	S
CO2	S	S	M	M	M	S	M	S	S	S	S	M	M
CO3	S	S	M	M	M	S	S	S	M	M	S	S	S
CO4	S	S	M	M	M	M	M	S	S	M	M	S	S
CO5	M	S	S	S	S	M	S	S	S	M	M	S	S

Strongly Correlating (S) - 3 marks ;Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ;No Correlation (N) - 0 mark

Course Code	U21BTS61	MUSHROOM CULTIVATION	L	T	P	C
SBE	V		2	-	-	2
Cognitive Level	K2: Understand K3: Apply K5: Evaluate K6: Create					
Learning Objective	• To gain knowledge on mushroom cultivation and harvesting methods • To learn the nutritional value of mushroom • Acquire entrepreneur opportunities					
Unit I	**Mushroom Morphology:**					
Different parts of a typical mushroom & variations in mushroom morphology. Key to differentiate Edible from Poisonous mushrooms.						
Unit II	**Mushroom Classification**:					
Based on occurrence- Epigenous & Hypogenous,Natural Habitats - Humicolous, Lignicolous& Coprophilous, Colour of spores- white, yellow, pink, purple brown & black, Morphology- fruiting layers exposed to air, fruiting layers not exposed to air, plants with predominantly pitted cap, cap saddled shape & saucer shape, Structure and texture of fruit bodies-gilled fungal & pore fungal.						
Unit III	**Biology of Mushrooms:**					
Button, Straw & Oyster- General morphology, distinguishing characteristics, spore germination and life cycle.						
Unit IV	**Nutrient Profile of Mushroom:**					
Protein, amino acids, calorific values,carbohydrates, fats, vitamins & minerals.						
Unit V	**Economic Importance:**					
Antiviral value, antibacterial effect, antifungal effect,anti-tumour effect, haematological value cardiovascular & renal effect, in therapeutic diets, adolescence, for aged persons & diabetes mellitus.						
References	**Textbooks** 1.Pathak, Yadav and Gaur,Mushroom production and processing technology, Agrobios publishers,2011. 2.Shubhrata. R.Mishra ,Techniques of Mushroom cultivation, Discovery publishing House, 2014. **Reference Books** 1.Roger Philips ,Mushroom : A Comprehensive guide to mushroom identification , Macmillan Publishers , 2013. 2. Dr. Ravinder Singh Rana& Dr. IshaSlathia, Mushroom cultivation and its disease , Sankalp publications, 2020. 3. D.P.Tripathi ,Mushroom cultivation , Oxford and IBH publishers ,2017 .					

E-reference links:	1. http://www.botany.hawaii.edu/faculty/wong/BOT135/Lect19.htm 2. https://mushroomsite.com/2020/09/06/parts-of-a-mushroom/ 3. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=103103 4. https://www.medicalnewstoday.com/articles/278858#benefits 5. https://www.mushroom-appreciation.com/nutritional-value-of-mushrooms.html#sthash.LGpqFLPo.dpbs
Course Outcomes	Upon completion of this course, the students will be able to

	CO1	easily differentiate edible and Poisonous mushroom	**K2**
	CO2	differentiate the various types of mushroombased on occurrence, colour and morphology.	**K3**
	CO3	compare the germination and lifecycle of different mushrooms.	**K5**
	CO4	explain the nutrional benefits of mushrooms.	**K2**
	CO5	evaluate the medicinal properties of mushrooms.	**K6**

\Mapping of COs with POs & PSOs:

CO	**PO**								**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	M	S	M	S	S	S	S	M	S
CO2	S	S	M	M	S	S	M	M	S	S	S	S	S
CO3	S	S	S	M	S	M	S	S	M	S	M	S	S
CO4	M	M	S	S	S	S	S	S	S	S	S	M	M
CO5	M	M	S	S	S	S	S	S	S	M	S	M	S

Strongly Correlating (S) - 3 marks ;Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ;No Correlation (N) - 0 mark

Course Code	U21BTS62	SINGLE CELL PROTEIN	L	T	P	C
SBE	VI		2	-	-	2
Cognitive Level	K1: Recall K2: Understand K3: Apply					
Learning Objective	• To understand the key concept and historical background of algal biomass as non-conventional food • To know about the application of SCP and mass cultivation of spirulina • To acquire the knowledge about the uses of spirulina and steps of mass cultivation					
Unit I						
Algal biomass as non- conventional food : Introduction, Concept and need, Advantages, disadvantages and Sources of non-conventional food						
Unit II	**Introduction to SCP production**					
Historical use and rediscovery of *Spirulina* importance – morphology, taxonomy and habitat of *Spirulina* – biochemical composition including proximate composition – amino acids – unsaturated fatty acids – minerals and vitamins. Human health benefits of *Spirulina*.						
Unit III	**Spirulina cultivation methods :**					
Spirulina cultivation for single cell protein - SCP Introduction, Systematic position, thallus structure, Merits of Spirulina cultivation, Methods of cultivation- Small scale cultivation, Mass cultivation, Harvesting of Spirulina, Flow chart of Spirulina cultivation, Limiting factors for Spirulina cultivation, Spirulina products –Powder, Biscuits, Tablets						
Unit IV	**Procedure of Spirulina cultivation**					
Principle, Requirement, chemicals, Sample or Inoculum of Spirulina, procedure, observations, Harvesting, results and records, precautions Visit to a spirulina cultivation laboratory in nearby area (Students are expected to prepare a model of spirulina cultivation laboratory, a visit report and to submit the same at the time of practical examination.						
Unit V	**Production and Packing**					
Natural production – laboratory cultivation – small scale commercial production – commercial and mass cultivation (tank construction, culture medium, strain selection, scaling up of the process) – importance of light and pH in *Spirulina* cultivation – harvesting, drying and packing						
Text Books	1.Umar Bacha, Muhammad Nasir, Single Cell Protein: Production and Evaluation for Food Use Evaluation for Food Use,Lambert Publication,2011 2. Robert Henrikson ,Spirulina - World Food: How this micro algae can transform your health and our planet,2010 3. Amos Richmond , Qiang Hu, Handbook of Microalgal Culture: Applied Phycology and Biotechnology,Wiley,2013					
References	1. Paul M. Coates, Joseph M. Betz, Marc R. Blackman Encyclopedia of Dietary Supplements, 2010.					

<table>
<tr><td></td><td colspan="3">2. Biswas S., Datta M. and Ngachan S.V, Mushrooms: A Manual for Cultivation, PHI, 2012.
3. Aaron Baum, Grow Your Own Spirulina Superfood: A Simple How-To Guide Kindle Edition, 2013.
4. Aaron Baum, Grow Your Own Spirulina Superfood: A Simple How-To Guide, 2013.
5. Selvendran D, Large Scale Algal Biomass (Spirulina) Production in India. In: D. Das Algal Biorefinery: An Integrated Approach, Springer. 2015.</td></tr>
<tr><td>E-References Link</td><td colspan="3">1.https://www.researchgate.net/publication/329170462_IPR_Biosafety_Bioethics
2.https://biocyclopedia.com/index/biotech_biosafety_ipr_ipp.php
3.https://link.springer.com/chapter/10.1007/978-981-10-2961-5_14</td></tr>
<tr><td>Course outcomes</td><td colspan="3">Upon completion of this course, the students will be able to</td></tr>
<tr><td></td><td>CO</td><td>Course Outcomes</td><td>Knowledge Level</td></tr>
<tr><td></td><td>CO1</td><td>understand the advantages and disadvantages of algal mass</td><td>K1, K2</td></tr>
<tr><td></td><td>CO2</td><td>learn the production of SCP</td><td>K1, K2, K3</td></tr>
<tr><td></td><td>CO3</td><td>acquire knowledge on spirulina cultivation</td><td>K1, K2, K3</td></tr>
<tr><td></td><td>CO4</td><td>illustrate the steps of spirulina cultivation</td><td>K1, K2, K3</td></tr>
<tr><td></td><td>CO5</td><td>gather information regarding natural production, mass cultivation and process</td><td>K1, K2, K3</td></tr>
</table>

Mapping of CO with PO & PSO:

CO	PO								PSO				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	S	S	M	S	S	S	S	S	S
CO2	S	S	S	M	S	S	S	S	S	S	S	S	S
CO3	S	M	S	S	M	S	M	S	S	M	S	S	M
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	M	S	S

Strongly Correlating (S) - 3 marks ; Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark; No Correlation (N) - 0 mark

Course Code	U21BTV51	DIARY TECHNOLOGY	L	T	P	C
Value Added Programme			30	-	-	2
Semester	Semester-V	Credits:2	Hours/weeks: 30			
Cognitive Level	K1: Recall K2: Understand K3: Analyze K4: Apply K5:Evaluate					
Learning Objective	• To learn about the basic applications of microorganisms. • To understand the identification of microorganisms using advanced microbiological methods • To identify any microorganisms, predict the intermediate metabolism of any microbe used in industrial production processes, • To understand the pathogenesis of micro organisms					
Course Outcomes	Upon completion of this course the students will be able to					
	CO1	list the benefits of milk and milk products.	K1			
	CO2	knowthe salient features of milk.	K2			
	CO3	illustrate the ways to produce hygienic dairy products	K3			
	CO4	compare the benefits of traditional and modern dairy products	K4			
	CO5	understand the right ways to store and preserve dairy products	K5			
Unit I	Introduction to Diary technology					
Need – Benefits and application of Diary technology						
Unit II	Physical chemistry of milk					
Chemistry of milk - condensed and dried milks. Salient features of Milk						
Unit III	Introduction to diary microbiology					
Microorganisms in milk – the ways of hygienic milk production.						
Unit IV	Traditional dairy products					
Fat rich dairy products and other related products						
Unit V	Packing and storaging of milk products					
Refrigeration and air conditioning						

References	**TextBooks** 1.M. K Srivastava ,Hand book on Analysis of Milk: Chemical & Microbial Analysis of Liquid Milk , CBS Publishers & Distributors,2015. 2.Sukumar De ,Outlines of Dairy Technology, Oxford University Press Indian Branch,2019.
	Reference Books 1.M. P. Mathur, D. Datta Roy, P. Dinakar, Textbook of Dairy Chemistry ,Indian Council of Agricultural Research, New Delhi.2011. 2.R. Fernandez ,Microbiology Handbook of Dairy Products, , Medtech Publishers.2018. 3.Norman N. Potter, Joseph H. Hotchkiss ,Food Science, , CBS Publishers & Distributors , 2019.
E-reference links:	1.https://www.myvmc.com/lifestyles/milk-and-milk-products-dairy-products/ 2. https://academic.oup.com/advances/article/5/2/131/4557960 3.https://medcraveonline.com/MOJFPT/health-benefits-of-milk-and-functional-dairy-products.html 4. https://www.britannica.com/topic/dairy-product 5.https://www.milkmeansmore.org/10-reasons-to-include-milk-and-milk-products-in-your-diet/

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	M	S	M	S	S	S	S	S	S	M	M	S
CO3	S	M	M	S	S	S	S	S	S	S	S	M	S
CO4	S	M	M	S	S	S	S	S	S	S	S	S	M
CO5	S	M	S	S	S	S	S	S	S	S	S	S	M

Strongly Correlating (S) - 3 marks ;Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ;No Correlation (N) - 0 mark