

MOTHER TERESA WOMEN'S UNIVERSITY KODAIKANAL – 624 102

M.SC BIOTECHNOLOGY

Syllabus
(With Effect from 2021)



DEPARTMENT OF BIOTECHNOLOGY

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

1. About the Programme:

M.Sc., Biotechnology is a 2 year postgraduate program that is divided into 4 semesters. This programme is to develop the students theoretically knowledgeable and experimentally competent in the field of Biotechnology. This programme is designed in a way that it provides adequate knowledge of advanced Biotechnology and related subjects such as Advanced Biochemistry, Applied Microbiology, Molecular Biology and Genetics, Bioprocess Technology, Pharmaceutical Biotechnology, Omics and Genome Editing etc. The programme will facilitate students get skills and learn techniques in biological science. This advanced programme can help students in taking a career in Research as well as getting employed in companies like pharma, healthcare, agri-based and many other life science sectors.

2. Programme Educational Objectives (PEOs)

- PEO1:** To train the students in advanced areas of biotechnology and other related subjects and sensitizing them with all possible scopes.
- PEO2:** To endow the students with analytical and research skills, to enhance entrepreneurial accomplishments
- PEO3:** To prepare a knowledgeable generation of biotechnologists with proficient skills to excel in their careers.
- PEO4:** To enrich them with good communicative and technical skills to perform efficiently as an individual and as a team member in a professional environment.
- PEO5:** To develop biotechnologists with professional ethics in order to address socio-economic challenges and global issues logically.

3. Eligibility:

- A candidate who has passed Graduate in Life Sciences (Biotechnology/Botany/Zoology/Microbiology/Biochemistry/Environmental Science/Food Science and Herbal Sciences) and other Relevant Subject
- Candidate should have secured at least 55% in the above subject from any recognized University.

4. General Guidelines for PG Programme

- i. **Duration:** The programme shall extend through a period of 4 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	13	25	13	25
External	38	75	38	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: 90**

• **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
00-49	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 less 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 PG Programmes are also applicable for this Programme.

9. PROGRAMME SPECIFIC OUTCOMES (PSOs):

On completion of M.Sc Biotechnology programme, students will be able to

PSO1: attain knowledge in the fundamentals and applications of biotechnology to solve problems.

PSO2: gain proficient and practical knowledge on advanced and modern techniques to be used in research and industries.

PSO3: apply their knowledge and the skills for the betterment and advancement of their professional career.

PSO4: apply the research skill to nurture Entrepreneurial Endeavor by various funding schemes of government

PSO5 understand the ever evolving need of biotechnologist professionals and their impact in finding solutions for global issues pertaining to environment, health, food and agriculture.

10. PROGRAMME OUTCOME (PO)

On completion of M.Sc Biotechnology programme, students will be able to

PO1: gain in-depth knowledge in the advanced concepts and principles of Biotechnology and apply in research.

PO2: apply the knowledge of bio-techniques to identify solutions to problems in a systemic way.

PO3: perform the advanced techniques in the field of biology and related fields.

PO4: acquire professional ethics, leadership qualities and team-building skills to accomplish a common goal.

PO5: apply their skills of Bioinformatics to offer new insight for design and discovery of Drug

PO6: apply the theoretical and practical knowledge in securing a successful career as researcher, product developer, employee in industries and bio-business sectors,

educator or pursue higher studies.

PO7: use the scientific skills acquired to develop into a successful women entrepreneur and set up bio-business.

PO8: use the scientific knowledge obtained to contribute to the scientific society and research of our country.



M. Sc. BIOTECHNOLOGY

Sl. No.	Course Code	Course Title	Credits	Hours		CIA	ESE	Total
				L	P			
Semester I								
1.	P21BTT11	Core I- Advanced Biochemistry	4	5	-	25	75	100
2.	P21BTT12	Core II- Applied Microbiology	4	5	-	25	75	100
3.	P21BTT13	Core III – Molecular Biology and Genetics	4	5	-	25	75	100
4.	P21BTT14	Core IV – Bioprocess Technology	4	5	-	25	75	100
5.	P21BTP11	Core V - Practical in Advanced Biochemistry, Microbiology and Molecular Biology	4	-	6	25	75	100
6.	P21CSS11	Supportive Course I (Skill) - Computer skills for web designing and video editing	2	4	-	25	75	100
		Total	22	30		-	-	600
Semester II								
7.	P21BTT21	Core VI – Immunology and Immuno Technology	4	4	-	25	75	100
8.	P21BTT22	Core VII Genetic Engineering	4	5	-	25	75	100
9.	P21BTT23	Core VIII – Pharmaceutical Biotechnology	4	5	-	25	75	100
10.	P21BTT24	Core IX- Bioethics, Biosafety and IPR	4	4	-	25	75	100
11.	P21BTP22	Core X Practical in Immunology and Immuno Technology and Genetic Engineering	4	-	6	25	75	100
12.		Non Major Elective	4	4	-	25	75	100
13.	P21BTS21	Supportive Course II(Skill) – Phytochemistry	2	2	-	25	75	100
		Total	26	30		-	-	700
Semester III								
14.	P21BTT31	Core XI – Plant Biotechnology	4	4	-	25	75	100
15.	P21BTT32	Core XII- Animal Biotechnology	4	4	-	25	75	100
16.	P21BTT33	Core XIII – Applied Environmental Biotechnology	4	4	-	25	75	100
17.	P21BTT34	Core XIV - Omics and Genome Editing	4	5	-	25	75	100
18.	P21BTT35	Core XV – Bioinstrumentation and Biostatistics	4	5	-	25	75	100
19.	P21BTP33	Core XVI – Practical in Plant Biotechnology, Animal Biotechnology, Applied Environmental Biotechnology	4	-	6	25	75	100
20.	P21WSS33	Supportive Course III- Women Empowerment	2	2	-	25	75	100
		Total	26	30				700

Semester IV								
21.	P21BTE411	Elective-I* / Any MOOC courses [§]	4	4	-	25	75	100
22.	P21BTE421	Elective-II* / Any MOOC courses [§]	4	4	-	25	75	100
23.	P21BTR41	Project	8	22	-	25	75	100
			Total			16	30	300
Total			90	120				2300

Non Major Elective

The candidates who have joined the PG Programme, can also undergo Non Major Elective offered by other Departments.

Non Major Elective (NME) offered by Department of Biotechnology

NME - I: Industrial Waste Management (P21BTN211)

Additional Credit Courses (Mandatory)

1. Value Added Program I- (P21BTV11)Two Credits (First Semester)
2. Internship/Industrial Training – (P21BTI21)Two Credits- (Second Semester)
3. Online Courses-Two Credits- (P21BTO31) (Third Semester)
4. Value Added Program II- (P21BTV41)Two Credits (Fourth Semester)

Electives

1. Stem Cell Biology (P21BTE411)
2. Forest Conservation (P21BTE412)
3. NanoTechnology &Cancer Biology (P21BTE413)
4. Drug metabolism (P21BTE414)
5. Molecular Modelling and Drug designing (P21BTE421)
6. Wildlife Conservation (P21BTE422)
7. Human pathology (P21BTE423)
8. Biobusiness (P21BTE424)
9. Any MOOC[§]

Value Added Programme

1. Chromatographic Techniques (P21BTV11)
2. System Biology (P21BTV41)

Outside class hours

- Health, Yoga and Physical Fitness
- Library Information access and utilisation
- Employability Training

* Those who have CGPA as 9, and want to do the project in industry/institution during IV semester, may opt for these two papers in III semester.

[§] Students can take one 4 credit course in MOOC as an elective or two 2 credit courses in MOOC as electives with the approval of Department committee.

SEMESTER - I

Course Code	P21BTT11	ADVANCED BIOCHEMISTRY			
CORE I		L	T	P	C
Cognitive Level	K1: Recall	K2: Understand	K4:Analyze		
Learning Objective	<ul style="list-style-type: none"> To gain overall understanding of the biomolecules, their structure, classification and functions in the living system. To acquire knowledge on the metabolic reactions, biochemical pathways and cellular interactions and regulations. To understand the biosynthesis of biomolecules and disorders of metabolism. To know the Enzymes, its classification and enzyme kinetics 				
Unit I	Biomolecules				
Atom, Molecules & chemical bonds, Introduction to metabolism – anabolism and catabolism. Carbohydrates – Occurrence, chemical properties, stereo and optical isomerism, structure and classification. Metabolism and its regulation – Glycolysis, TCA cycle, Oxidative phosphorylation, pentose phosphate pathway and gluconeogenesis, ATP synthesis, Photosynthesis, Glycogenolysis. Disorders of carbohydrate metabolism.					
Unit II	Lipids				
Occurrence, chemical properties and classification-biosynthesis of fatty acids triglycerides, phospholipids and cholesterol – Oxidation of fatty acids, lipid storage and membrane lipids and their organization, Lipoproteins. Disorders of lipid metabolism. Vitamins – classifications, derivatives, hormones.					
Unit III	Amino acids and Proteins				
Amino acids: structure, classification and chemical properties, structure of peptide bond – protein: classification, amino acid composition. Protein structure – Primary structure, secondary structure – alpha helix and beta pleated structure, tertiary and quaternary structure. Protein metabolism and degradation: A.A oxidation & Urea cycle. Ramachandran plot. Model proteins myoglobin, hemoglobin and chymotrypsin. Disorders of amino acid metabolism.					
Unit IV	Nucleic acids				
DNA & RNA – structure of purine and pyrimidine bases, nucleotides and nucleotide biosynthesis, its regulation & degradation of purine and pyrimidine nucleotides – Biosynthesis of deoxyribonucleotides. Sequencing of nucleotides. Disorders of nucleic acid metabolism.					
Unit V	Enzymes				
Nomenclature and Classification – protein enzymes, coenzymes, prosthetic groups, cofactors, isoenzymes, ribozymes, abzymes: chemical properties of enzymes: types of specificity – absolute, group, stereochemical and geometrical; factors influencing enzyme activity – temperature, pH, concentration of enzyme, substrate and effect of ions; enzyme kinetics, types of enzyme inhibition – reversible, competitive, non-competitive, uncompetitive, irreversible inhibition; allosteric enzymes. Single substrate and multi substrate enzymes. Relevance of enzymes in metabolic regulation.					
Text Books	<ol style="list-style-type: none"> Sowbhaghya Lakshmi, Textbook of Biochemistry, Paras Medical Publisher, 2015 S.P. Singh, Textbook of Biochemistry, Publisher CBS Publishers & Distributors, 2015 				
References	1. Nelson, D.L and Cox, M.M. Lehninger Principles of Biochemistry, 8 th				

	<p>Edition, Macmillan worth Publishers,2021.</p> <p>2. Voet, D,Voet,J.G and Pratt, C.W. Principles of Biochemistry.,4th Edition, Publisher Wiley,2013.</p> <p>3. Mathews, C.K. & Van Holde, K.E. & Ahern, K G. Biochemistry. 4th Edition, Publisher AddisonWesley.2012.</p> <p>4. U. Satyanarayana. Biochemistry, Publisher Books and Allied (P) Ltd., Calcutta,2017.</p>
E-Reference links	<p>1. https://doi.org/10.1002/cbf.1216</p> <p>2. https://www.pdfdrive.com/biochemistry-biochemistry-e19576202.html</p> <p>3. https://www.pdfdrive.com/textbook-of-biochemistry-e14983388.html</p> <p>4. https://www.pdfdrive.com/biochemistry-genetics-molecular-biology-e18198970.html</p> <p>5. https://www.pdfdrive.com/lehninger-principles-of-biochemistry-5th-edition-e164892141.html</p>

Course Outcomes

Upon completion of this course the students will be able to		
CO1	know the structure and classification of biomolecules and important metabolic pathways	K1
CO2	understand the structure and functions of lipid molecules, vitamins and hormones	K2
CO3	know the properties and disorders of amino acids and proteins	K1
CO4	understand nucleotides, their structure, biosynthesis, its regulation & degradation	K1
CO5	analyze the basic concept of Enzymes in nomenclature and classification, factors influencing enzyme activity and enzyme inhibition	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	M	M	S	M	S	S	S	S	M	S
CO2	S	M	S	M	M	S	M	S	S	S	S	M	S
CO3	S	M	S	M	M	S	S	S	S	S	S	M	S
CO4	S	M	S	M	M	S	M	S	S	S	S	M	S
CO5	S	M	S	M	M	S	M	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks ;
Weakly Correlating (W) - 1 mark ;

Moderately Correlating (M) - 2 marks
No Correlation (N) - 0 mark

Course Code	P21BTT12	APPLIED MICROBIOLOGY				L	T	P	C
CORE II						5	-	-	4
Cognitive Level	K1: Recall	K2: Understand	K3: Analyze	K4: Apply					
Learning Objective	<ul style="list-style-type: none"> To gain knowledge on bacterial, fungal & viral diversity and their molecular taxonomy. To understand the key principles behind the microbial world and learn the epidemiology of microbial diseases. To learn the applications of microbial techniques in the field of medicine, industry, food, environment and agriculture. 								
Unit I	Medical Microbiology								
Introduction to Infectious diseases - Methods of transmission. Host parasite relationship. Causative agent, Epidemiology, Pathogenesis, Prophylaxis and Treatment - Staphylococcosis, Salmonellosis Aspergillosis, Candidiasis, Giardiasis, Mycoplasmosis, Malaria, Rickettsiosis, AIDS, Influenza , flu (H1N1) and Covid-19. Importance of nosocomial infections (hospital borne), mode of transmission of airborne pathogens.									
Unit II	Food Microbiology								
Production of distilled beverage - alcohol, wine, brandy and beer. Single cell protein and Baker's yeast. Food industry enzymes -source and application. Contamination and spoilage of meat, fish, milk, vegetables and fruits. - Principle of food preservation methods, Food quality and control. Determination of microorganisms in food -culture, microscopy and sampling methods									
Unit III	Agriculture Microbiology								
Microbial flora of soil – bacteria, fungi, algae and protozoa. Microbial interactions among soil microorganisms. Plant growth promoting bacteria. Introduction to Nitrogen fixing bacteria- Rhizobium. Phosphorus solubilizing bacteria –VAM, <i>Anabaena</i> –importance in agriculture. Disease causing microbes- <i>Xanthomonas oryzae</i> , <i>Puccinia</i> spp., Banana bunchy top virus									
Unit IV	Environmental Microbiology								
Microbial degradation of xenobiotics (DDT, PCB). Sewage and wastewater treatment. Microbial insecticides: NPV, <i>Bacillus thuringiensis</i> , <i>B. sphaericus</i> . Microbial removal of heavy metals: precipitation of metal sulphides by SRB. Bioleaching-recovery of metals from ores. Solid Waste Management-composting and Biogas. Plastic degrading organisms.									
Unit V	Industrial microbiology								
Production of alcohol (ethanol), acids (citric acid, lactic acid), solvents (ethanol, butanol), antibiotics (penicillin, cephalosporine), amino acids (lysine, aspartate), Statins, therapeutic products, Commercial production of fructose. Enzymes used for commercial purposes and their industrial production. Whole cell immobilization and industrial applications									
Text Books	<ol style="list-style-type: none"> Sarafaraz Ahmad, A Textbook of Applied Microbiology, Publisher Anmol Publications Pvt Ltd,2011 R.C.Dubey,A Textbook Of Microbiology, Publisher SChand 2011 V.S. Randhawa, Textbook Of Microbiology,Peepee Publishers and Distributors,2019 								
References	<ol style="list-style-type: none"> Jeffrey C. Pommerville,Fundamentals of Microbiology.15th Edition, Publisher Jones and Bartlette. 2018. Madigan Michael T, Martinko John M., Bender Kelly S. 2017.Biology of Microorganisms. 14th Edition, Publisher Pearson Educatio, 2017. Gerald J.Tortora, Microbiology,11th Edition, Publisher Pearson Education. 2016. 								

	<p>4. Greenwood D, Slack R and Peutherer J. Medical Microbiology, Publisher Churchill Livingstone, Hong Kong,2012.</p> <p>5. Ian L. Pepper, Charles P.Gerba, Terry J.Gentry, Environmental Microbiology, publisher Academic Press, 2014.</p>
E-Reference links	<p>1. https://www.pdfdrive.com/medical-microbiology-e18737002.html</p> <p>2. https://www.pdfdrive.com/microbiology-and-immunology-textbook-of-2nd-edition-e33405391.html</p> <p>3. https://www.pdfdrive.com/prescotts-microbiology-e166597880.html</p> <p>4. https://www.pdfdrive.com/food-microbiology-fundamentals-and-frontiers-e175273799.html</p>

Course Outcomes

Upon completion of this course the students will be able to		
CO1	understand the epidemiology and pathogenesis of microbes	K1
CO2	understand the role of microbes in food industry and gain knowledge on food spoilage	K2
CO3	acquire knowledge on soil microbes, learn the techniques in agricultural microbiology and able to apply it.	K3
CO4	know to distinguish microorganisms beneficial to environment and their applications	K4
CO5	gain knowledge in evaluating the role of micro-organisms in specific biotechnological processes in industries	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	S	S	S	S	S	S	S	S	M	S
CO2	S	S	S	M	M	S	S	S	S	S	M	M	S
CO3	S	S	M	S	M	S	S	S	S	S	M	M	S
CO4	S	S	M	S	M	S	M	S	S	S	S	S	M
CO5	S	S	S	S	S	S	S	S	S	S	S	S	M

Strongly Correlating (S) - 3 marks ;

Weakly Correlating (W) - 1 mark ;

Moderately Correlating (M) - 2 marks

No Correlation (N) - 0 mark

Course Code	P21BTT13	MOLECULAR BIOLOGY AND GENETICS			
CORE III		L	T	P	C
Semester	Semester-I	Credits:4		Hours/weeks: 5	
Cognitive Level	K1: Recall	K2: Understand	K3: Apply	K4: Analyze	
Learning Objective	<ul style="list-style-type: none"> To understand various concepts of molecular biology and the central dogma of life. To develop a comprehensive understanding in the mechanisms of replication, transcription and translation To gain extensive knowledge on DNA repair mechanisms and the regulatory pathways. To procure knowledge on Mutation and Gene arrangement 				
Unit I	Genetic Material / DNA Replication				
DNA as genetic material. The Geometry of DNA replication – Semi conservative replication of double– stranded DNA and Circular DNA molecules. Enzymes in DNA replication -prokaryotic and eukaryotic. DNA Polymerases, DNA ligase and DNA gyrase. Events in the replication fork – Continuous and discontinuous. Okazaki fragments. Initiation, Elongation, termination of replication. Eukaryotic DNA replication. Inhibitors of replication.					
Unit II	Transcription				
Basic factors of RNA Synthesis - RNA ploymerases – I, II and III – Transcription Mechanisms in prokaryotes and eukaryotes – chain Initiation, elongation and termination. Significance of pribnow box, TATA box, CAAT box and enhancers in transcription initiation. Rho dependent and Rho independent termination of transcription. Classes of RNA Molecules –Messenger, ribosomal and transfer RNA. Post –transcriptional and modification - RNA splicing –role of lysozyme – Spliceosomes, Group I and Group II introns Self-splicing. Capping and tailing of 5' and 3' termini of Eukaryotic mRNA molecules.					
Unit III	Translation				
Genetic code – Definition, deciphering of codons – Universality of the code – Wobble hypothesis and codon degeneracy - codon dictionary. Mechanism of protein synthesis - importance of Initiation (IF), elongation (EF) and releasing factors (RF) - post translational modifications – protein splicing and folding – role of molecular chaperones. Regulation of gene expression in prokaryotes – the operon model. Lactose, galactose and tryptophan operon. Feedback inhibition and Allosteric enzymes.					
Unit IV	Gene Transfer Mechanism				
Mechanisms of Genetic Exchange- Lateral and Horizontal gene transfer. Bacterial Conjugation - Hfr and F' strains, DNA Transformation- Lytic and Lysogenic infection. Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates.					
Unit V	Mutation and Gene arrangement				
Classes of mutations, spontaneous and induced mutation, mutagens, Reversion and suppression mutations, Ames test. Genetic characterization of mutants. DNA damages – DNA repair mechanism –photoreactivation, excision repair, recombinant repair and SOS function. Transposition-Transposons, structure, types and mechanism.					
Genetic Recombination - Homologous Recombination, enzymes, and models (Double-stranded invasion model and Meselson and Radding model). Site-specific recombination (Bacteriophage lambda). Short sequence recombination					
Text Books	1. Tom Strachan, Andrew Read, Human Molecular Genetics, Garland Science, 2018				

	<ol style="list-style-type: none"> 2. Verma P.S.,Agarwal V.K. Molecular Biology, Publisher S Chand,2010 3. James D. Watson,Molecular Biology of the Gene, Publisher Pearson Education,2017
References	<ol style="list-style-type: none"> 1. Gildroy Swan, Textbook of Molecular Biology. Syrawood Publishing House,2017. 2. David P. Clark, Nanette J. Pazdernik and Michelle R. McGehee. Molecular Biology. 3rd Edition,Elsevier,2018. 3. Kensal Holde Jordanka Zlatanova..The Evolution of Molecular Biology, 1st Edition, Academic Press, 2018. 4. Krebs JE Lewin B, Goldstein ES and Kilpatrick ST. Lewin's GENES XI Jones & Bartlett Publishers,2014. 5. B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P Walter, Garland Molecular Biology of the Cell , 6th Edition, Publishing (Taylor & Francis Group), New York & London,2014. 6. Harvey Lodish, Molecular Cell Biology. 7thEdition, W.H.Freeman and Company, New York, 2014.
E-Reference links	<ol style="list-style-type: none"> 1. https://www.pdfdrive.com/cell-division-genetics-and-molecular-biology-cell-division-genetics-and-molecular-biology-e22406140.html 2. https://www.pdfdrive.com/cell-biology-genetics-molecular-biology-evolution-and-ecology-e132225829.html 3. https://www.pdfdrive.com/molecular-cell-biology-molecular-cell-biology-e7302545.html 4. https://www.pdfdrive.com/biochemistry-genetics-molecular-biology-e18198970.html 5. https://www.pdfdrive.com/molecular-cell-biology-lodish-5th-ed-e15674865.html 6. https://www.pdfdrive.com/karps-cell-and-molecular-biology-e176035175.html

Course Outcomes

Upon completion of this course the students will be able to		
CO1	know the structure, types, replication process and function of both prokaryotic & Eukaryotic nucleic acids	K1
CO2	understand the RNA synthesis and processing, Protein synthesis and processing inside the cell	K2
CO3	illustrate the mechanisms behind control of gene expression and molecular recombination inside the cell	K3
CO4	differentiate methods of DNA repair mechanisms in the cell, know Gene mapping techniques and cellular signal transduction pathways	K4
CO5	learn the basic concept of Quorum sensing, recognize oncogenes and anti-oncogenes.	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	S	M	S	S	S	S	S	S
CO2	S	M	M	S	S	S	M	S	S	S	S	M	S
CO3	S	M	M	M	S	S	M	S	S	S	S	M	S
CO4	S	M	S	M	S	S	M	S	S	S	S	S	S
CO5	S	M	S	M	S	S	M	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks ;

Weakly Correlating (W) - 1 mark ;

Moderately Correlating (M) - 2 marks

No Correlation (N) - 0 mark



Course Code	P21BTT14	BIOPROCESS TECHNOLOGY				L	T	P	C
CORE IV						5	-	-	4
Cognitive Level	K1:Recall	K2:Understand	K3:Apply	K6: Create					
Learning Objective	<ul style="list-style-type: none"> To gain knowledge about the importance of microbes in industries To attain knowledge on fermentation techniques and different types of fermentation and fermentors. To acquire knowledge on upstream process and downstream processes for product recovery after fermentation. To understand the basics of primary and secondary metabolites production. 								
Unit I	Milestones of fermentation technology								
Identification of industrially important microorganism, primary and secondary screening, strain development and improvement for increase yield, product assays. Microbial growth and death kinetics, mathematical expression of bacterial growth.									
Unit II	Fermentor								
Designing and types of fermentor: liquid, solid state and immobilized, Media and ingredients for industrial fermentation, industrial sterilization of fermentor media and air. Types of heat exchangers, immobilization techniques, Bioreactor for cell cultures. Diauxic growth and factors affecting microbial growth.									
Unit III	Key Factors in Bioreactor								
Instrumentation for monitoring bioreactor and fermentation process – PH, temperature pressure dissolved O ₂ , air flow rate, shaft speed, foaming, viscosity and controlling. Batch, fed and continuous fermentation, large scale cultivation of plant and animal cells. Up-streaming process in product production.									
Unit IV	Downstream processing								
Recovery and purification of fermentation products – filtration, flocculation, centrifugation, cell disruption, liquid- liquid extraction, Solvent and super critical extraction, precipitation, chromatography, ultra filtration, drying, crystallization, lyophilization. Storage and packing of products.									
Unit V	Metabolite Production								
Production of primary metabolites such as organic acids like citric acid, glucamic acid, Lysine. Protease. Alcohols: Beer and Wine production. Production of Bioethanol. Secondary metabolites - Antibiotics: Penicillin V, Streptomycin and Ampicillin sodium salt. Flavouring and colour production.									
Textbooks	<ol style="list-style-type: none"> Vinay Sharma, Arindam Kuila, Principles and Applications of Fermentation Technology, Publisher Wiley-Scrivener, 2019 Stanbury, Peter F.; Hall, Steve, Principles of Fermentation Technology, Publisher Butterworth-Heinemann, 2015. Smita S. Patil, Fermentation Technology – II, Success Publications, 2015 								
References	<ol style="list-style-type: none"> Michael L. Shuler, Fikret Kargi, Bioprocess Engineering: Basic Concepts. Publisher Pearson Education India, 2015. Doran, Bioprocess Engineering Principles. Publisher Elsevier, 2012. Debabrata Das and Debayan Das. Biochemical Engineering: An Introductory Textbook. Jenny Stanford Publishing, 2017. Sarfaraz K. Niazi, Justin L. Brown. Fundamentals of Modern Bioprocessing. Publisher CRC Press. 2015. Pau Loke Show, Chien Wei Ooi, Tau Chuan Ling, Bioprocess Engineering 								

	:Downstream Processing, Published CRC Press, 2021 6. Essentials in Fermentation Technology, Berenjian, Aydin, Publisher Springer,2019.
E-Reference links	1. https://www.pdfdrive.com/bioprocess-technology-d27110100.html 2. https://www.pdfdrive.com/advances-in-bioprocess-technology-d186651074.html 3. https://www.pdfdrive.com/biotechnology-bioprocessing-d158764194.html

Course Outcomes

Upon completion of this course the students will be able to		
CO1	choose the industrially important organisms and create new designs for application	K6
CO2	understand the principles and techniques in different types and designs of fermenter	K1
CO3	know the bioreactor usage and fermentation process	K2
CO4	employ the knowledge in fermentation product purification and characterization	K3
CO5	discuss the industrial production of valuable bio-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	S	M	S	S	S	S	M	S	S	S	S	M	S
CO2	S	M	S	M	S	S	M	S	S	S	S	M	S
CO3	S	M	S	M	S	S	S	S	S	S	S	M	S
CO4	S	S	S	S	S	S	M	S	S	S	S	S	S
CO5	S	S	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	P21BTP11	PRACTICAL			L	T	P	C
CORE -V		ADVANCED BIOCHEMISTRY, MICROBIOLOGY AND MOLECULAR BIOLOGY			-	-	6	4
Cognitive Level	K1: Recall	K2: Understand	K4: Analyze					
Learning Objective	<ul style="list-style-type: none"> To learn how to estimate biomolecules such as DNA,RNA precisely To attain knowledge on isolation, characterization and identification of microbes To perform isolation of plasmid DNA To learn the basics of protein isolation and purification method 							
Experiments in Biochemistry	<ol style="list-style-type: none"> 1. Estimation of DNA by Diphenylamine 2. Estimation of RNA by Orcinol method. 3. Extraction and Estimation of starch from potato/ tapioca 4. Estimation of protein by Lowry's method 5. Enzyme assay: Estimation of salivary amylase from saliva & phosphatase from potato 6. Separation of amino acids by Paper chromatography 7. Separation of amino acids by Thin layer chromatography 8. Separation of pigments by Column chromatography 							
Experiments in Microbiology and Molecular Biology	<ol style="list-style-type: none"> 1. Isolation of microbes from different sources-water,food,sewage, soil 2. Measurement of microbial Size – Micrometry 3. Biochemical Characterization of Bacteria 4. Production of Hydrolytic enzymes – Protease, Amylase and Lipase 5. Anaerobic Cultivation- Fluid Thioglycolate broth 6. Antibiotic sensitivity assay- Disc and Well diffusion 7. SDS –PAGE 8. PCR 9. Isolation of Plasmid DNA 10. Isolation and precipitation by Ammonium sulphate and acetone 							
Text Books	<ol style="list-style-type: none"> 1. Damodaran Geetha K. Practical Biochemistry. Jaypee Brothers Medical Publishers,2016. 2. Apurba S Sastry, Essentials Of Practical Microbiology 2nd Edition Publishr Jaypee,2021. 							
References	<ol style="list-style-type: none"> 1. Gupta Prem Prakash. Essentials Of Practical Biochemistry. Jaypee Brothers Medical Publishers, 2017. 2. Apurba Sankar Sastry, Sandhya Bhat K. Essentials of Practical Microbiology. Jaypee Brothers Medical Publishers, 2018. 3. Advances in Molecular Techniques: Rakesh S. Sengar, Amit Kumar, Reshu Chaudhary, Ashu Singh, CRC Press, 1st Edition, 2018. 4. Ralph Rapley, David White. House Molecular Biology and Biotechnology, Publisher Royal Society of Chemistry.2021. 							
E-Reference Links	<ol style="list-style-type: none"> 1. https://www.labome.com/method/Protein-Quantitation.html 2. http://mbvi-au.vlabs.ac.in/ 3. https://vlab.amrita.edu/?sub=3&brch=77 4. https://www.vlab.co.in/ba-nptel-labs-biotechnology-and-biomedical-engineering 5. https://learn.chm.msu.edu/vibl/ 							

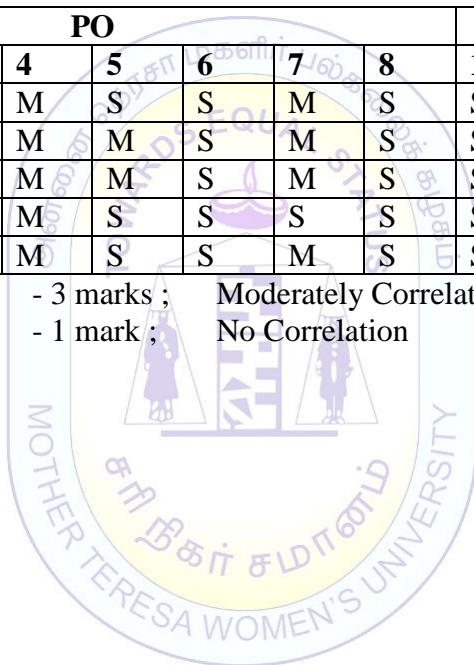
Course Outcomes

Upon completion of this course the students will be able to		
CO1	gain practical knowledge on estimation of biomolecules (DNA,RNA, Protein, Starch)	K1
CO2	experiment on various chromatography techniques such as Paper, Thin layer and Column chromatography	K4
CO3	gain hands on skill in isolation, identification and biochemical characterization of microbes from water, food, sewage, soil	K1
CO4	learn the method of isolation of Plasmid DNA and SDS PAGE	K2
CO5	know the techniques to isolate and precipitate protein	K1

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	M	S	S	M	S	S	S	S	M	S
CO2	S	S	M	M	M	S	M	S	S	S	S	M	S
CO3	S	S	S	M	M	S	M	S	S	S	S	S	S
CO4	S	S	S	M	S	S	S	S	S	S	S	S	S
CO5	S	S	S	M	S	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



SEMESTER –II

Course Code	P21BTT21	IMMUNOLOGY AND IMMUNO TECHNOLOGY				L	T	P	C
CORE VI						4	-	-	4
Cognitive Level	K1: Recall	K2: Understand	K3: Apply	K4: Analyze					
Learning Objective	<ul style="list-style-type: none"> • To understand the basic concepts of the various immune systems of human body. • To gain knowledge on antigen antibody reactions, humoral and cell mediated immunity. • To know the role of Immune system in Health and Disease - Complement system and its pathways, Autoimmune disorders • To obtain knowledge on the various immune techniques in diagnosis and Immunotherapy and various other applications. 								
Unit I	Immune System								
Historical perspectives in Immunology, Cells and organs of immune system, primary and secondary lymphoid organs, innate and acquired immunity, Antigens: Chemical and biological Factors affecting antigenicity/Immunogenicity and molecular nature, Haptens, adjuvants, Antibodies: structure and function, Immunoglobulin classes and subclasses (isotypic, allotypes, idiotypes and anti-idiotypic antibodies).									
Unit II	Humoral and Cell mediated immunity								
B-lymphocytes and their activation, Class switching mechanism, antibody genes and generation of diversity, cytokines, Thymus derived lymphocytes (T cells) - types, Activation of T-cells, Major histocompatibility Complex (MHC) Complex - Structure and its significance, MHC Class I and II molecules. Antigen processing and presentation process. Immune regulation mechanisms-immuno-induction, immunosuppression. Immuno-tolerance, Role of cytokines, lymphokines and chemokines.									
Unit III	Immune system in Health and Disease								
Complement system and its pathways, Gell and Coombs classification of Hypersensitivity reactions and Diagnosis and treatment. Autoimmune disorders, types, animal model and treatment. Immune response to infections: immunity to viruses, bacteria, fungi and parasites, Vaccines and their types, classification and immunization schedule. Disorders of Human Immune System: Primary and secondary immunodeficiency; Autoimmune disorders; Hypersensitive reactions; Cytokine related diseases.									
Unit IV	Molecular immunology & Immuno diagnosis								
Antigen antibody interaction – Precipitation reactions, Agglutination reactions, ABO Blood typing principles. Principles and applications of ELISA, Radio Immuno Assay (RIA), Immunofluorescence, fluorescence activated cell sorting (FACS) analysis. Role of stem cells technology in immunology, Production of humanized monoclonal antibodies, immunotherapy with genetically engineered antibodies. Recombinant Vaccines - recombinant vector vaccines, DNA vaccines ,Multivalent subunit vaccines, minicell vaccines and conjugate vaccines.									
Unit V	Transplantation and Tumor immunology								
Transplantation and its classification, Immunologic basis of graft rejection and its mechanism, Transplantation antigens, tissue typing role of MHC molecules in allograft rejection, Clinical transplantations, bone marrow, HSC transplantation and immune suppressive therapy. Tumors of the immune system, tumor antigens and immune response to tumors, tumor immunotherapy.									
Text Books	1. Sunil Kumar Mohanty, K Sai Leela,Textbook of Immunology, Publisher								

	<ol style="list-style-type: none"> Jaypee Brothers Medical Publishers,2014 Basir F,Textbook Of Immunology, Publisher Prentice Hall India Learning Private Limited,2012 Latha P.Madhavee,Textbook Of Immunology, Publisher S Chand & Company 2012
References	<ol style="list-style-type: none"> Kuby J. Immunology, 6th Edition. W.H. Freeman and Company, New York. 2006. Roitt I. 2017,Essential Immunology Blackwell Scientific Publications, Oxford 13th Edition Geoffrey Sunshine, Immunology: A Short Course Richard Coico, Wiley-Blackwell 7th Edition,2015. Abul K. Abbas and Andrew H. Lichtman, ,Cellular and Molecular Immunology, 2014, David K. Male, Jonathan Brostoff, David E. Roth, and Ivan M. Roitt, Immunology, 8th revised edition, Elsevier, 2012. Thao Doan, Roger Melvold, Susan Viselli, Carl Waltenbaugh, Immunology, Lippincott Illustrated Reviews Series, 2012.
E-Reference links	<ol style="list-style-type: none"> https://www.pdfdrive.com/microbiology-and-immunology-textbook-of-2nd-edition-e33405391.html https://www.pdfdrive.com/cellular-molecular-immunology-7th-edition-e157242744.html https://www.pdfdrive.com/basic-immunology-e21670961.html https://www.pdfdrive.com/medical-microbiology-virology-immunology-e43491517.html

Course Outcomes

Upon completion of this course the students will be able to		
CO1	thoroughly understand the basic concepts of immunology, cells and organs of immune system and types of immunity	K1
CO2	acquire knowledge on various immunological phenomena like activation, regulation and processing of various immune components in humoral and cell mediated immunity	K1, K2
CO3	interpret the role of Immune function in Health, vaccine and Disease	K3
CO4	analyze the immunological problems, understand various immuno diagnosis testing principles	K1,K4
CO5	explain the transplantation and its classification, tumors of the immune system - tumor antigens	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	M	M	M	M	S	M	M	M	M
CO2	S	M	M	S	M	M	M	M	S	M	S	M	M
CO3	S	M	S	S	S	S	M	S	S	S	S	S	S
CO4	S	S	S	S	M	S	S	S	S	S	S	S	S
CO5	S	S	S	S	M	S	M	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	P21BTT22	GENETIC ENGINEERING			
CORE VII		L	T	P	C
Cognitive Level	K1: Recall K3: Apply	K2: Understand K4: Analyze			
Learning Objective	<ul style="list-style-type: none"> To acquire knowledge on tools and techniques in genetic engineering To gain knowledge in choice of host for cloning, methods of gene transfer and screening procedure To understand the principles and application of PCR techniques, DNA sequencing methods To learn about genetically modified organisms and their benefits To realize ethical issues on genetic engineering. 				
Unit I	Tools for Gene cloning: Nucleases	12 hours			
Exonucleases and Endonucleases, Restriction Enzymes and its types, RNases, Methylases: CpG Methylase, Dam Methylase, Dcm Methylase, Polymerases: DNA Pol I, Klenow Fragments, Reverse Transcriptase, Taq & Pfu Polymerases, Ligases: T4DNA Ligase, <i>E.coli</i> DNA Ligase, T4 RNA Ligase, Topoisomerases: Type I&II, End Modifying Enzymes: Terminal Transferase, T4 Polynucleotide Kinase, Alkaline Phosphatases.					
Unit II	Cloning vectors	12 hours			
Plasmid Vectors (pBR322 and pUC), phage vectors (λ), cosmids. Phagemids. Expression vectors: (pRT plasmids), Shuttle vector. Viral vectors: Lentiviral Vectors, Retroviral Vectors, Adenoviral Vectors. Plant Vectors (Ti plasmids). Artificial vectors: BACs, YACs, HACs, PACs. Methods of Gene transfer - Physical methods Microinjection, Electrophoration, lipofection, Gene gun, Biolistics transformation. Chemical methods: Liposome mediated gene transfer, Calcium phosphate mediated gene transfer, DEAE- Dextran and polyethylene glycol mediated gene transfer. Choice of host organisms for cloning (<i>E.coli</i> and Yeast). Screening of recombinant clones - blue-white screening, Screening of transfected mammalian cells - Reporter Gene Assay, Luciferase reporter gene system.					
Unit III	Construction of DNA Libraries	12 hours			
Genomic library and c DNA library. Screening of Libraries and preservation of libraries - Methods for screening based on detecting a DNA sequence. Screening by hybridization - Colony hybridization and Plaque hybridization. Probes used for hybridization, Screening by PCR. Screening methods based on gene expression - Immunological screening, functional complementation. Protein Engineering: Site Directed Mutagenesis.					
Unit IV	PCR	12 hours			
Principle, Components and applications of PCR. Types of PCR: RT-PCR and real-time, and PCR. PCR based microbial typing: Bacterial identification based on 16S rRNA sequences- Amplified Ribosomal DNA Restriction analysis (ARDRA), Randomly Amplified Polymorphic DNA (RAPD). DNA sequencing Methods: Maxam and Gilbert method. Chain termination method, semiautomated method, automated method, Pyrosequencing and whole-genome shotgun sequencing method. Applications of DNA sequencing.					
Unit V	Applications of genetic engineering	12 hours			
Gene therapy, Types of gene therapy - Somatic gene therapy and Germ line gene therapy. Gene Therapy Strategies - Gene Augmentation Therapy (GAT), Targeted Killing of Specific Cells. Gene Therapy for Severe Combined Immunodeficiency Syndrome (SCID). Gene knockout mice, disease model, Transgenic animals, production of recombinant pharmaceuticals. Genetically modified foods - Production of extra nutrients in the food, Disease resistance and herbicide					

resistance. Degradation of toxic wastes – GMO. Ethical consideration of genetic engineering.	
Text Books	<ol style="list-style-type: none"> 1. Desmond S. T. Nicholl ,An Introduction to Genetic Engineering, Cambridge University Press,2018. 2. Mariana Ianello Giassetti, Tatjana Brankov, Genetic Engineering Principles And Methods, Scitus Academics,2019 3. T.A.Brown. An Introduction to Gene cloning & DNA analysis, 7th edition, Wiley balckwell, US. 2016.
References	<ol style="list-style-type: none"> 1. Bernard R.Glick and Cheryl L.Patten, Principles and Applications of Recombinant DNA - Molecular Biotechnology,5th Edition, ASM Press, United states, 2017 2. T.A.Brown, Genomes 4, Publisher Taylor and Francis, New York,2018. 3. Bernard R. Glick, Cheryl L. Patten. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 5th Edition Publisher,2017. 4. Isil Aksan Kurnaz,Techniques in Genetic Engineering, Publisher CRC Press, 2021. 5. Walter E. Hill, Genetic Engineering A Primer, Publisher CRC Press, 2019.
E-Reference links	<ol style="list-style-type: none"> 1. https://www.pdfdrive.com/molecular-biotechnology-principles-and-applications-of-recombinant-dna-4th-edition-e162050162.html 2. https://www.pdfdrive.com/molecular-biotechnology-principles-and-applications-of-recombinant-dna-e156918014.html 3. https://www.pdfdrive.com/recombinant-dna-technology-molecular-biology-and-paradigms-e11385991.html 4. https://www.pdfdrive.com/recombinant-dna-principles-and-methodologies-e185941491.html

Course Outcomes

	Upon completion of this course, the students will be able to	
CO1	acquire deep knowledge on the tools and techniques of gene cloning	K1,K2
CO2	know suitable eukaryotic and prokaryotic cloning vectors, transfer technique and screening techniques for cloning	K2
CO3	understand the procedure for construction of genomic libraries	K1
CO4	learn the principle of PCR techniques, its application and methods of DNA Sequencing	K3
CO5	analyze the important strategies of Gene therapy-types, production of recombinant pharmaceuticals and Genetically modified organisms by understanding the concepts and ethics	K2,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	S	M	S	S	S	S	S	S
CO2	S	S	S	S	S	S	M	S	S	S	S	S	S
CO3	S	S	S	S	S	S	M	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	M	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks ;

Weakly Correlating (W) - 1 mark ;

Moderately Correlating (M) - 2 marks

No Correlation (N) - 0 mark

Course Code	P21BTT23	PHARMACEUTICAL BIOTECHNOLOGY			
CORE VIII		L	T	P	C
		5	-	-	4
Cognitive Level	K2: Understand K3: Apply K4: Analyze				
Learning Objective	<ul style="list-style-type: none"> To know the basic concepts in Pharmaceutical Biotechnology and sources of biopharmaceuticals, drug isolation and evaluation To acquire knowledge on drug metabolism and principles of drug manufacturing To understand the process of drug development, approval process and manufacturing of biopharmaceuticals. 				
Unit 1	Introduction				
	Pharmaceutical Biotechnology and biopharmaceuticals. Sources of biopharmaceuticals - yeast, animal cell cultures, bacteria, fungi, plants, animals, transgenic plants. Drug isolation and evaluation. Formulation of biopharmaceutical products. Shelf life of protein based pharmaceuticals. Site specific delivery of protein drugs.				
Unit II	Pharmacokinetics and Dynamics				
	Routes of drug administration. Absorption of drugs. Bioavailability - factors influencing absorption and bioavailability. Drug distribution - plasma protein binding, placental transfer, blood-brain barrier. Mechanism of drug action, receptor theory, adverse effects of drugs, drug interactions.				
Unit III	Drug Metabolism and Manufacturing				
	Chemical reactions (proteolysis, deamination, oxidation, disulfide exchange), reduction, hydrogenation, dehydrogenation. Excretion Manufacturing principles - compressed tablets, controlled and sustained release dosage forms enteric coated tablets and capsules.				
Unit IV	Biopharmaceuticals				
	Vaccines, modern vaccine technologies, pharmaceutical aspects. Recombinant proteins as pharmaceutical drugs. Protein engineering, peptide chemistry and peptidomimetics. Catalytic antibodies. Monoclonal antibody based pharmaceuticals. Hematopoietic growth factors. Nucleic acid therapy in development. Pharmaceutical enzymes. Development of adhesion molecules.				
Unit V	Drug development and approval				
	Strategies for new drug discovery, lead compound, combinatorial approaches to drug discovery, pre-clinical and clinical trials. Phase I, II and III. Regulatory authorities - Food and Drug Administration (USA), European regulations- National security authorities, European medicine agency and new EU drug approval system.				
Text Books	<ol style="list-style-type: none"> Vyas S. P, Pharmaceutical Biotechnology, Publisher CBS, 2019. Pankaj Verma S. Jayaraman, Richa Ohri, Publisher Thakur publication pvt. ltd. 2019 Gary Walsh, Pharmaceutical Biotechnology: Concepts and Applications, Publisher Wiley India Pvt Ltd, 2011 				
References	<ol style="list-style-type: none"> Gilman et al. Goodman and Gilman's The Pharmacological Basis of Therapeutics. McGrawHill. 12th ed. 2011. Satoskar, Bhardarkar and Rege. Pharmacology and Pharmacotherapeutics. Poular Prakashan. 24th ed. 2015. Shargel L, Yu ABC, Wu-Pong S. Applied Biopharmaceuticals and Pharmacokinetics. McGraw-Hill. 6th ed. 2012. 				

	5. Vivekanand Kisan Chatap , Pawan Tiwari, Ashish Dixit, Textbook of Pharmaceutical Biotechnology, Paging Publishers, 2019.
E-Reference links	1. https://www.pdfdrive.com/pharmaceutical-biotechnology-fundamentals-and-applications-e164753639.html 2. https://www.kobo.com/us/en/ebook/pharmaceutical-biotechnology-2 3. https://www.pdfdrive.com/pharmaceutical-biotechnology-concepts-and-applications-d38535075.html

Course Outcomes

Upon completion of this course the students will be able to		
CO1	understand the scope of pharmaceutical biotechnology.	K2
CO2	know pharmacokinetics, metabolism, dynamics of drugs and the steps involved in drug discovery process	K2
CO3	illustrate the manufacturing principles in formulation of drugs and biopharmaceuticals.	K3
CO4	compare the production of recombinant proteins, enzymes and carbohydrate and nucleic acid based biopharmaceuticals.	K4
CO5	acquire knowledge on regulatory aspects in drug development and drug approval	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	M	M	M	M	M	S	S	M	M	M
CO2	S	M	S	M	S	S	M	M	S	S	M	M	M
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	M	S	S	S	S	S	S	S	S	S	S	S
CO5	S	M	M	S	M	M	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	P21BTT24	BIOETHICS, BIOSAFETY AND IPR	L	T	P	C
CORE IX				4	-	-
Cognitive Level	K1: Recall K2: Understand K3: Apply					
Learning Objective	<ul style="list-style-type: none"> To acquire knowledge on concepts of bioethics, emerging issues on genetic modification and recombinant DNA technology To procure knowledge on ethical, legal and socio economic aspects of gene therapy and reproductive cloning To learn about Intellectual property rights.– types, patentable and non-patentable – PCT and patent drafting. To acquire knowledge in biohazard and bio-safety level 					
Unit I	Introduction to bioethics					
concepts, ethical terms, issues on genetic modification and recombinant DNA technologies, ethics in agriculture and Environment benefits, risks, trans humanism and bioweapons. GM crops, Release of GMO to the environment. Special procedures for r-DNA based product production. Risk of genetic engineering, Ecocide-Eco terrorism. Emerging issues of biotechnology's impact on society.						
Unit II	Animal Ethics					
Animal rights, ethics of human cloning, Reproductive cloning, Ethical legal and Socio economic aspects of Gene therapy, Somatic, Embryonic and Adult stem cell research, ELSI of human genome project. Transgenic plants and animals. Challenges to public policy and regulations. CCAC Guidelines on Transgenic Animals (1997), CCAC Guidelines on Animal Welfare, Laboratory Animal Management, The Need for Ethical Review						
Unit III	Biohazards & Biosafety					
Primary containments for biohazards, Biosafety levels, recommended biosafety levels for specific microorganism, infectious agents and Infected animals. Environmental release of GMO and risk assessment. Biosafety regulations, r-DNA guidelines- National and international, levels of containment. Role of Intuitional biosafety committee, GEAC, RCGM, Cartagena protocol. CPCSEA Guidelines. Hazardous Materials Used in Biotechnology—Handling and Disposal, Good Manufacturing Practices, Good Laboratory Practices.						
Unit IV	IPR					
Introduction to IPR – types; copy rights, patents, trademarks, trade secret design rights, geographical indication, PVPR, patentable and non-patentable – PCT, importance of IPR, Types of Patent applications, PCT cost, procedure and requirements for international patenting- patent infringement – scope, litigation, meaning, case studies & examples. TKDL, Biopiracy. Patenting of biological material. Precautions to be taken before patenting.						
Unit V	Patent					
Introduction to WTO, GATT,WIPO,TRIPS, Patenting in India, Indian patent act, WIPO treaty budapest treaty, publication of patents-Gazette of India, Patenting by research students, lectures and scientist University/Organizational rules in India and aboard. Global scenario of patents and Indian position. IP as a determining factor in biotechnology.						
Text Books	1. Princy Louis Palatty , Ashish Kumar U , Russell Souza..A Textbook of Bioethics for Healthcare Professionals. Jaypee Brothers Medical Publishers (P) Ltd. 2017.					

	2. S.V. Damodar Reddy. Intellectual Property Rights -- Law and Practice, Publisher Asia Law House,2019.
References	<ol style="list-style-type: none"> 1. Lewis Vaughn. Bioethics: Principles, Issues, and Cases. Oxford University Press,2016. 2. Nithyananda. K. V. Intellectual Property Rights: Protection and Management Publisher Cengage Learning India Pvt. Ltd. 2019. 3. Sateesh MK, Bioethics and Biosafety, IK International, 2012 4. Ramesh Shahabdkar, S Sai Satyanarayana Reddy, Intellectual Property Rights, Publisher Notion Press,2019.
E-Reference links	<ol style="list-style-type: none"> 1. https://www.pdfdrive.com/bioethics-and-biosafety-in-biotechnology-e52867075.html 2. https://www.pdfdrive.com/bioethics-medicine-and-the-criminal-law-volume-1-the-criminal-law-and-bioethical-conflict-walking-the-tightrope-e176230762.html 3. https://www.pdfdrive.com/patents-and-standards-a-modern-framework-for-ipr-based-standardisation-e45986739.html

Course Outcomes

Upon completion of this course, the students will be able to		
CO1	get exposed to bioethics in gene cloning and emerging issues of biotechnology's impact on society.	K1
CO2	know the ethical, legal and socio economic aspects in latest biotechnological advancements and guidelines to be followed during animal experimentation	K2
CO3	illustrate bio-safety levels required in the laboratory and understand biohazards	K2
CO4	understand and inculcate knowledge on the principles of IPR types, patentable and non-patentables and infringement	K2
CO5	apply the learned patenting procedure in India and abroad	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	M	M	M	M	S	M	S	M	M
CO2	S	S	M	S	M	M	M	M	S	M	S	M	M
CO3	S	S	M	M	M	M	M	M	S	M	S	M	M
CO4	S	S	M	S	M	S	M	S	S	M	S	S	S
CO5	S	S	M	M	M	S	S	S	S	M	S	S	S

Strongly Correlating (S) - 3 marks ;

Weakly Correlating (W) - 1 mark ;

Moderately Correlating (M) - 2 marks

No Correlation (N) - 0 mark

Course Code	P21BTP22	PRACTICAL	L	T	P	C
CORE - X		IMMUNO TECHNOLOGY AND GENETIC ENGINEERING	-	-	6	4
Cognitive Level	K1: Recall K2: Understand K3: Apply K6: Create					
Learning Objective	<ul style="list-style-type: none"> To understand and develop skill sets in immunotechnology To obtain skill in Blotting techniques To learn the techniques in isolation and amplification of DNA To obtain skill to prepare competent cell and perform transformation experiments To understand molecular assays to solve biological problems 					
Experiments in Immuno Technology	1. Preparation of plasma and serum, Blood cell analysis – total count, differential count. 2. ELISA 3. FACS 4. Blotting techniques (Southern Blotting, Northern Blotting, Western Blotting) 5. Immune diffusion methods (Radial immunodiffusion, single immunodiffusion double immunodiffusion), Rocket electrophoresis, Immuno electrophoresis					
Experiments in Genetic Engineering	1. Isolation of DNA from Bacteria 2. DNA amplification by PCR 3. Restriction digestion of genomic or lambda DNA 4. Ligation 5. Preparation of competent cells, transformation of E.coli and screening of transformants					
Text Books	1. Asim Kumar Roy. Immunology Theory and Practical. Kalyani Publications, 2019. 2. M.R.Green and J. Sambrook (2012) Molecular cloning, A Laboratory Manual Vol. III. Fourth edition, Cold Spring Harbor Laboratory Press 3. Talwar, A Handbook of Practical and Clinical immunology, Publisher CBS, 2017					
References	1. Abbas et al. Cellular and Molecular Immunology. Elsevier. 9th ed. 2018. 2. Karthik Kaliaperumal und Senbagam Duraisamy Senthilkumar Balakrishnan. Practical Immunology A Laboratory Manual. 1 st Edition Publisher : LAP LAMBERT Academic Publishing, 2017. 3. Fred M. Ausubel et al. editors Current Protocols in Molecular Biology. John Wiley and Sons, Inc, 2017. 4. M.R.Green and J. Sambrook. Molecular cloning, A Laboratory Manual Vol. III. 4 th Edition, Cold Spring Harbor Laboratory Press, 2012. 5. Fred M. Ausubel. Current Protocols in Molecular Biology. John Wiley and Sons, Inc, 2017.					
E-Reference links	1. https://www.immunology.org/public-information/bitesized-immunology/experimental-techniques 2. https://www.nature.com/subjects/immunological-techniques					

	<ol style="list-style-type: none"> 3. https://currentprotocols.onlinelibrary.wiley.com/hub/journal/1934368x/aim-sandscope/ 4. https://www.apsnet.org/edcenter/disimpactmngmnt/labexercises/PlantBiotechnology/Pages/Activity4.aspx 5. http://www2.southeastern.edu/Academics/Faculty/jtemple/486/experiment%202.pdf 6. https://www.life.illinois.edu/molbio/geldigest/digest.html
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Course Outcomes

Upon completion of this course the students will be able to		
CO1	gain practical knowledge on immunological techniques	K1
CO2	perform immunodiagnosis tests in laboratories	K2
CO3	apply the immunodiagnosis knowledge in research	K3
CO4	choose and compare different PCR techniques for amplification of multiple copies of DNA	K6
CO5	procure skill in preparation of competent cells, transformation of <i>E.coli</i> and screening of transformants	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	S	S	S	S	S	S	S	S	S	S	M	S
CO2	S	S	S	M	M	S	S	S	S	S	S	M	M
CO3	S	S	S	M	M	S	S	S	S	S	S	M	S
CO4	S	S	S	M	M	S	S	S	S	S	S	M	S
CO5	S	S	S	M	M	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	P21BTS21	PHYTOCHEMISTRY			
SUPPORTIVE COURSE II		L	T	P	C
Cognitive Level	K1: Recall K2: Understand K4: Apply				
Learning Objective	<ul style="list-style-type: none"> To learn the effective procedures in extraction and purification of bioactive compounds To understand the structural analysis of bioactive compounds To gain knowledge on herbal medicine and phyto pharmaceuticals 				
Unit 1	Extraction Methods				
Polar and Non-polar solvents for extraction. Extraction – purification of bio-active compounds from plants - cold & hot extract. Soxhlet extraction - crude extracts purification by various solvents.					
Unit II	Bioactive Compounds				
Isolation of bioactive compounds- chromatographic techniques - thin layer chromatography- liquid chromatography - HPLC and UPLC.					
Unit III	Structural analysis of bioactive compounds				
IR spectroscopy - Mass spectroscopy – NMR spectroscopy.					
Unit IV	Herbal medicine				
History of herbal medicine - different types of herbal medicine - Ayurveda, Siddha and Unani - Pharmacological action - clinical research and traditional uses of Indian medicinal plants - <i>Eclipta alba</i> , <i>Gymnema sylvestre</i> , <i>Ocimum sanctum</i> , <i>Curcuma longa</i> .					
Unit V	Phytopharmaceuticals				
Phytopharmaceuticals and their health benefits - anthocyanins, carotenoids, lycopene, isoflavones, polyphenols, omega 3 - fatty acids, biological effects of resveratrol.					
Text Books	<ol style="list-style-type: none"> Shah B. Pharmacognosy and Phytochemistry, Publisher CBS,2019. Vaibhav Darvhekar Rageeb, Lodhi, Vadnere, A Textbook of Pharmacognosy & Phytochemistry, Publisher Everest Publishing House,2019 Deep Panhekar , Ms. Trupti P. Sawant, D. P. Gogle, Phytochemicals - Extraction, Separation & Analysis, Publisher Global Education Limited,2019 				
References	<ol style="list-style-type: none"> Padmini Shukla , Dr. Shashi Alok, Dr. Prabodh Shukla, Pharmacognosy and Phytochemistry, Publisher Nirali Prakashan, 2019. Kausar Jabeen ,Pharmacognosy And Phytochemistry – II, Publisher: SIA Publishers & Distributors Pvt Ltd,2020. Sapna Malviya, Swati Rawat, Pharmacognosy and Phytochemistry, Publisher : Oxford and IBH Publishers,2020. 				
E-Reference links	<ol style="list-style-type: none"> https://www.pdfdrive.com/textbook-of-pharmacognosy-and-phytochemistry-d184620437.html https://books.google.co.in/books?id=satDwAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0 https://www.pdfdrive.com/trease-and-evans-pharmacognosy-e58233029.html 				

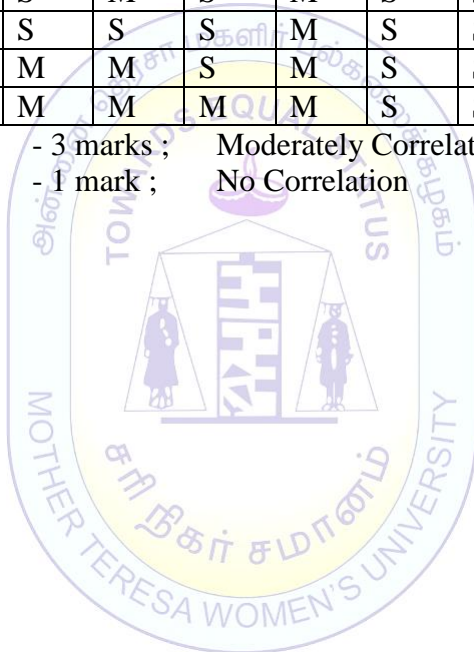
Course Outcomes

Upon completion of this course the students will be able to		
CO1	know the extraction and purification of bioactive compounds	K2
CO2	understand the principles of various chromatographic techniques	K2
CO3	acquire knowledge on the structural analysis of bioactive compounds using spectroscopy	K2
CO4	compare the medicinal properties of important medicinal plants	K4
CO5	know the importance and health benefits of phytopharmaceuticals	K1

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	M	S	S	S	S	S	M
CO2	S	S	S	S	M	S	M	S	S	S	S	S	S
CO3	S	S	S	S	S	S	M	S	S	S	S	S	S
CO4	S	S	M	M	M	S	M	S	S	M	S	M	M
CO5	S	S	M	M	M	M	M	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



SEMESTER-III

Course Code	P21BTT31	PLANT BIOTECHNOLOGY			
CORE XI		L	T	P	C
Cognitive Level	K1: Recall	K2: Understand	K3: Apply	K6: Create	
Learning Objective	<ul style="list-style-type: none"> • To imbibe knowledge in plant biotechnology and its application for increasing agricultural production, environment improvement, human nutrition and health. • To equip with theoretical knowledge regarding the techniques and applications of Plant Biotechnology, preservation of plant cells and Genetic Engineering. • To acquire knowledge on plant molecular biology, Genetic transformation in plants, metabolic engineering and molecular pharming • To learn about genome organization in plants, basic techniques in tissue culture and its applications. • To be aware of various ethical issues and guidelines for GMOs 				
Unit I	Plant Cell and Tissue culture				12 hours
Laboratory setup- Plant cell and tissue culture-culture media; composition and preparation, plant hormones, sterilization, Callus culture, Micropropagation, suspension culture, root tip culture, anther culture pollen culture, ovary culture, embryo culture, embryo rescue, large scale culture of plant cells					
Unit II	Regeneration of Plants				12 hours
Somoclonal variation, Somatic hybridization – protoplast isolation fusion and culture, synthetic seeds, germplasm conservation hardening and green house technology. Use of haploids in plant breeding. Selection of hybrid seeds and regeneration of hybrid plants.					
Unit III	Method of Gene transfer in plant cells				12 hours
Gene transfer – Agrobacterium mediated, viral vector and their application, Caulio virus, Baculo virus mediated, Direct nuclear transformation methods, Promoters, reporter genes and marker genes, terminator, marker free gene targetting. Gene silencing.					
Unit IV	Transgenic Plants				12 hours
Terminator seed technology – delayed fruit ripening, transgenic plants-plantibodies, golden ride, edible vaccine, insect resistant-Bt, <i>cry</i> genes of Bt and their gene expression, herbicide resistance-glyphospate, Disease resistant-antifungal proteins, Virus resistance-coat protein & nucleo capsid, Nematode resistant, Abiotic stress tolerant.					
Unit V	Plant as bioreactor				12 hours
Green & red fluorescent protein, starch and fructans. Nitrogen fixation and genes. Application of RFLP, RADP and DNA finger printing in plant biotechnology. Biosafety guidelines for research involving GMO's benefits and risks. IPR related to plants, IPP.					
Text Books	<ol style="list-style-type: none"> 1. S. Umesh, Plant Biotechnology. Publisher CRC Press.2019. 2. Hiru Ranabhatt , Renu Kapor. Plant Biotechnology. 1st Edition, Publiser WPI Publishing. 2018. 3. Chawla H S. Introduction To Plant Biotechnology. Publisher Oxford & IBH publishing.2020. 				
References	<ol style="list-style-type: none"> 1. Gresshoff Peter M. Plant Biotechnology and Development. Publisher: Taylor & Francis Inc. 2020. 2. Abdin, M.Z., Kiran, U., Kamaluddin, M., Ali, A. Plant Biotechnology: Principles and Applications, Publisher Springer. 2017. 3. Halford N..Plant Biotechnology: Current And Future Applications of 				

	Genetically Modified Crops, Publisher Wiley, 2015. 4. Smith RH. Plant Tissue Culture. 3 rd Edition, Publisher Elsevier. 2013.
E-Reference links	1. https://www.pdfdrive.com/plant-biotechnology-and-genetics-principles-techniques-e15853574.html 2. https://www.pdfdrive.com/plant-cell-and-tissue-culture-a-tool-in-biotechnology-e20389188.html 3. https://www.pdfdrive.com/principles-of-plant-biotechnology-e33514134.html 4. https://www.pdfdrive.com/plant-genomics-e28703875.html

Course Outcomes

	Upon completion of this course the students will be able to	
CO1	learn basic techniques and setup of plant tissue culture laboratory	K1
CO2	know the application and techniques of germplasm conservation, hardening and green house technology.	K2
CO3	get updated with the research in Plant transformation techniques	K3
CO4	gain knowledge about terminator seed technology, and research advancement and its production of plantibodies edible vaccine, in transgenic plants.	K6
CO5	acquire knowledge on application of techniques in plant biotechnology and describe biosafety guidelines for research involving GMO's and IPR	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	S	S	S	S
CO2	S	M	S	S	M	S	S	S	S	S	S	S	S
CO3	S	M	S	S	M	S	M	S	S	S	S	S	S
CO4	S	M	S	M	S	S	M	M	S	S	S	S	S
CO5	S	M	M	M	S	M	M	M	S	M	M	M	M

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

Course Code	P21BTT32	ANIMAL BIOTECHNOLOGY	L	T	P	C
CORE XII			4	-	-	4
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze K6: Create					
Learning Objective	<ul style="list-style-type: none"> To gain knowledge on the basics of Animal cell culture, transgenic animals, molecular markers and their applications. To obtain familiarity to biology and characteristics of cell culture and maintenance To understand the principles of gene knock out, molecular pharming and embryonic preservation To know about the stem cell technology and advanced techniques in animal biotechnology 					
Unit I	Animal cell culture					12 hours
Structure and organization of animal cell. History of animal cell culture technique. Constituents of culture medium; serum and supplements; Facilities for animal cell culture-infrastructure, equipment, culture vessels. Biology and characterization of cultured cells-cell adhesion, proliferation, differentiation, morphology of cells and identification. Animal cell culture-merits and demerits.						
Unit II	Primary cell culture					12 hours
Primary cell culture techniques - aggregation, Cell growth & viability determination. Measurement of cell death, Transformation and Cytotoxicity assays. chromosome analysis and antigenic markers, selectable markers for animal cells. Mass culture of cells - manipulation of cell line selection - types of cell lines - maintenance of cell lines - immobilization of cells and its application - synchronization of cell - cryopreservation - germplasm conservation and establishment of gene banks. Hazards and safety aspects of cell culture techniques.						
Unit III	Transgenic animals and Molecular pharming					12 hours
Knock out and Knock in, Suicide gene therapy Gene silencing. Animal Biotechnology for the production of regulatory proteins, blood products, cell culture based vaccines and hormones and other therapeutic proteins. Embryonic preservation and its uses in endangered animals.						
Unit IV	Gene therapy and Diagnostics methods					12 hours
Gene therapy – IVF & Embryo transfer, Gene transfer techniques, Tissue engineering, Organ transplant. Synthetic viral vectors in gene transfer. Biotechnological applications for HIV. Diagnostics and therapy. DNA based diagnosis of genetic diseases, DNA barcoding. Oncogenes and anti-oncogenes. Genetic engineering approaches for genetic disorder correction. Transgenic animals as models for human disease						
Unit V	Stem cells					12 hours
types – Hematopoietic stem cells, Mesenchymal stem cells, embryonic stem cells, fetal stem cells, Adult stem cells- characterization, isolation, cultures. Stem cells as vector for cancer therapy. Collection, processing, preservation and banking of Umbilical cord blood stem cells. 3D culture, human cloning, ethical limits and mapping of human genome. Commercial application of animal cell culture						
Text Books	1. A.K. Srivastava, RK. Singh. Animal Biotechnology, CBS Publishers & Distributors Pvt Ltd, India, 2018. 2. M .M. Ranga..Animal Biotechnology, 3 rd Edition, Agrobios, India. 2017.					

	3. B. Singh, S.K. Gautam, Textbook of Animal Biotechnology, Publisher The Energy and Resources Institute, TERI,2013
References	1. Birbal Singh, Gorakh Mal, Sanjeev K. Gautam, Manishi Mukesh. Advances in Animal Biotechnology. Springer, 2019. 2. Singh, B., Mal, G., Gautam, S.K., Mukesh, M. Advances in Animal Biotechnology. Publisher Springer, 2019. 3. Rodrigues, Gabriela, Roelen, Bernard A. J, Concepts and Applications of Stem Cell Biology, Publisher Springer, 2020.
E-Reference links	1. https://www.pdfdrive.com/animal-cell-biotechnology-e22743665.html 2. https://www.pdfdrive.com/animal-biotechnology-1-reproductive-biotechnologies-e187110512.html 3. https://www.pdfdrive.com/animal-cell-biotechnology-e177857548.html 4. https://www.pdfdrive.com/molecular-biotechnology-principles-and-applications-of-recombinant-dna-4th-edition-e162050162.html

Course Outcomes

Upon completion of this course , the students will be able to		
CO1	know the requirements to establish the cell culture laboratory	K1
CO2	understand the methods to perform primary cell culture techniques, mass production, storage methods, germplasm conservation and establishment of gene banks.	K2
CO3	interpret the practical difficulties in sources of contamination in cell culture and importance of transgenic animals and Molecular pharming	K3
CO4	apply the precise gene therapy treatment for advanced medical treatment of human diseases	K4
CO5	learn the concept of collection, processing and preservation of stem cells and to create stem cell banks that will ensure a future generation free from genetic disorders	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	S	S	S	M	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	M	S	S	S	S	S	S	S	S	S
CO3	S	M	S	M	S	S	M	S	S	S	S	M	S	S
CO4	S	S	S	S	S	M	M	S	S	M	S	M	S	S
CO5	S	S	S	M	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	P21BTT33	APPLIED ENVIRONMENTAL BIOTECHNOLOGY			
CORE XIII		L	T	P	C
		4	-	-	4
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze				
Learning Objective	<ul style="list-style-type: none"> To understand the concept of natural resources, environmental pollution and remediation using biotechnology. To know about the environmental hazards, solutions to protect the environment and sustainable development. To gain knowledge on remediation of contaminated environments (land, air, water), and environment-friendly processes such as green manufacturing technologies and sustainable development. To understand the most important environmental problems such as global warming, ozone depletion, waste disposal and to acquire skills To solve the environmental problems through biotechnological approach and to become environmental conscious. 				
Unit I	Introduction to Environment				
Environment components, Role of Biotechnology in Environmental protection, Biodiversity, values and types, Indian traditions for the conservation of Biodiversity- Sacred groves - Sthalavrikshas. Insitu conservation- biosphere reserves, sanctuaries and national parks – Exsitu conservation- Botanical Gardens, Zoos, Gene bank, seed bank, Plant tissue culture, and environmental Protection act, Mass movements.					
Unit II	Pollution				
Types of environmental pollution. Sources and effects of water, air, soil, thermal, noise and oil pollution: Bioindicators and biosensors for detection of pollution. Biomagnification. Global Environmental problems- Green house effect, global warming and climate change, Ozone depletion, Photochemical Smog and acid rain.					
Unit III	Water Pollution and control				
Physical-chemical parameters of water–water pollutants, Marine Pollution-minamata disease, Pollution in River Ganga and Cauvery; Eutrophication; Water Quality standards; Waste water treatment-primary, secondary-ASP, RBC, OP, anaerobic digestion.					
Unit IV	Solid waste management				
Types of solid wastes, sources and effects, solid waste disposal-land filling, composting, Vermicomposting, incineration, Biogas production, 5R concepts, Radioactive wastes, types of Radiation, Sources and effects of radiation, Disposal - Deinococcus radiodurans. Chenobyl disaster and Love canal episode. Eco – mark, Biodegradable plastics and Ecomark					
Unit V	Bioremediation and Biodegradation				12 hours
Bioremediation, types and mechanism, Bioremediation of dyes, Biodegradation of recalcitrant xenobiotics-pesticides-hydrocarbons, degradative plasmids. GEMs, Microbial Transformation of Heavy Metals-Bioleaching, Bioaccumulation, Biosorption, and Bioprecipitation of Heavy Metals. Phytoremediation; Biopesticides and Biofertilizers.					
Text Books	1. B.K.Sharma.2019.Environmental Chemistry, Krishna Prakashan Media (P) Limited. 2. Pramod Kumar,Vipin Kumar, Pravin Kumar Sachan,Environmental Biotechnology, Publisher WPI Publishing,2019				
References	1. Inyinbor Adejumo A., Adebisin Babatunde O., Oluyori Abimbola P.,				

	<p>Adelani-Akande Tabitha A., Dada Adewumi O. and Oreofe Toyin A. 2018. Water Pollution: Effects, Prevention and Climatic impact.</p> <p>2. Daniel Vallerio, Environmental Biotechnology: A Biosystems Approach, Publisher Elsevier, 2015.</p> <p>3. Pramod Kumar, Vipin Kumar, Environmental Biotechnology, Publisher Woodhead Publishing India, 2018</p>
E-Reference links	<p>1. https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=80588&printable=1</p> <p>2. http://mjcetenvsci.blogspot.com/</p> <p>3. https://nptel.ac.in/courses/120/108/120108005/</p>

Course Outcomes

Upon completion of this course , the students will be able to		
CO1	be aware on need for Environmental protection and conserve the floral and faunal diversity	K1
CO2	understand and identify the environmental issues, gain knowledge on the types of pollution and ways to preserve the environment	K2
CO3	apply the knowledge of water chemistry to prevent water pollution	K3
CO4	inculcate knowledge about solid wastes management and its importance	K2
CO5	compare the eco-friendly techniques and apply the methods for environmental protection	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	M	S	M	S	S	M	S	M	S
CO2	S	M	M	S	M	S	M	S	S	M	S	M	S
CO3	S	S	S	S	M	S	S	S	S	S	S	S	S
CO4	S	S	S	S	M	S	S	S	S	S	S	S	S
CO5	S	S	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	P21BTT34	OMICS AND GENOME EDITING	L	T	P	C
CORE XIV				5	-	-
Cognitive Level	K1: Recall K2: Understand K3: Apply					
Learning Objective	<ul style="list-style-type: none"> To learn about prokaryotic and eukaryotic genomes, general methods of genome sequencing techniques, genome analysis and annotations and applications of genomics. To acquire knowledge in the contemporary computational tools for gene analysis To know about molecular systems biology, molecular systems network and its applications To learn about proteomics, metabolomics, interactomics and its applications in the field of medicine, agriculture and industries 					
Unit I	Genome and Genome sequencing					12 hours
Genome structure and organization – Eukaryotic genome - Organelle genome- Genomics of Microbes and Microbiomes – Genome sequencing technologies –Comparative genomics and its applications.						
Unit II	Functional genomics					12 hours
Large scale gene expression analysis –Experimental methods - Computational tools for expression analysis-Hierarchical clustering – Gene expression analysis– STS-EST-GSS-Assessing levels of gene expression using ESTs - cDNA databases – Transcriptome analysis and applications. Metagenomics.						
Unit III	Molecular systems biology					12 hours
Introduction – methodologies – constraint and kinetic modeling – Biomass objective function - metabolic simulation - biotechnological applications – Molecular network biology – Medical and clinical genomics - Pharmacogenomics and drug discovery – Agriculture genomics and its applications						
Unit IV	Proteomics					12 hours
Structural and functional features – Qualitative proteome technology (Gel-based and Gel-free) – Quantitative proteome technology – Functional proteome technology – Methods, algorithms and tools in computational proteomics - Proteome databases – Protein engineering resources. Metabolomics.						
Unit V	Interactomics					12 hours
Techniques to study protein-protein interactions - Modelling of proteomic networks – Interactome databases - Label-free nanotechnologies in proteomics – Modificomics – Proteomics applications in clinical and biomedicine - Application of proteomics in agricultural biotechnology – Industrial proteomics and its applications						
Text Books	<ol style="list-style-type: none"> Bhattacharya, Anjanabha, Parkhi, Vilas, Char, Bharat. CRISPR/Cas Genome Editing. Strategies And Potential For Crop Improvement. Publisher Springer. 2020. Rintu Banerjee, Garlapati Vijay Kumar , S.P. Jeevan Kumar. OMICS-Based Approaches in Plant Biotechnology.Publisher Wiley. 2019. Kevin Davies, Editing Humanity: The CRISPR Revolution and the New Era of Genome Editing, Publisher Pegasus Books,2020 					
References	<ol style="list-style-type: none"> Yiping Qi. Plant Genome Editing with CRISPR Systems.Methods and Protocols. Publisher Springer. 2019. 					

	<ol style="list-style-type: none"> George M. Church, Krishnarao Appasani..Genome Editing and Engineering: From TALENs, ZFNs and CRISPRs to Molecular Surgery. Publisher Cambridge University Press.2018 Debmalya Barh, Vasudeo Zambare, Vasco Azevedo. OMICS,Applications in Biomedical, Agricultural, and Environmental Sciences.Publisher CRC Press. 2013. Yu Liu..Omics in Clinical Practice: Genomics, Pharmacogenomics, Proteomics, and Transcriptomics in Clinical Research. Publisher Apple Academic Press. 2014 Turksen, Kursad. Genome Editing. Publisher Springer. 2016.
E-Reference Links	<ol style="list-style-type: none"> www.genomic.org.uk/ https://www.britannica.com/science/genomics https://www.sciencedirect.com/journal/genomics

Course Outcomes

On completion of this course, student would be able to		
CO1	understand the structure of prokaryotic and eukaryotic genomes	K1
CO2	employ the computational tools for gene analysis	K3
CO3	know the key concepts in molecular systems biology and list its applications	K2
CO4	understand the functional proteome technology and metabolomics.	K2
CO5	gain knowledge about the modelling of proteomic networks and identify its applications in clinical biomedicine.	K1,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	M	S	M	M	S	S	S	M	M	M
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	M	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	M	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	P21BTT35	BIOINSTRUMENTATION AND BIOSTATISTICS			L	T	P	C
CORE XV					5	-	-	4
Cognitive Level	K1: Recall K2: Understand K3: Apply K6: Create							
Learning Objective	<ul style="list-style-type: none"> To understand the principles and working methods of microscopes, centrifuges, spectrometers, electrophoresis. To gain knowledge in experimental designing and data collection techniques. To acquire knowledge on applications of statistics in research. 							
Unit I	Microscopy							
Principle and applications of light, phase contrast, fluorescence, inverted, scanning and transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, confocal laser scanning microscopy, field emission scanning electron microscope, cytophotometry and flow cytometry. Micrometry, lyophilizer, Preparation of microbial, animal and plant samples for microscopy. Principles of colorimetry and spectroscopy.								
Unit II	Centrifugation							
Basic principle and applications – gradient and density centrifuge, Ultracentrifugation-velocity and buoyant density, Principle methodology and applications of gel – filtration, ion –exchange and affinity chromatography; Thin layer, liquid and gas chromatography; High performance liquid chromatography, ultra sonicator, pH meter, FT-IR.								
Unit III	Principle of biophysical method							
X ray diffraction, fluorescence, UV, visible, IR. Atomic absorption and plasma emission spectroscopy, NMR, MS, ELISA reader, Electrophoresis: Principle and applications of Native, SDS, 2D – gel electrophoresis, isoelectric focusing, isotachophoresis, MADI-TOF-TOF, Microarray Techniques.								
Unit IV	Data collection and Presentation of data							
Collection and presentation of experimental data. Brief description and tabulation of data and its graphical representation. Measures of central tendency: arithmetic mean, median, mode, geometric mean, Harmonic mean. Measures of dispersion: range, interquartile range, standard deviation and standard error.								
Unit V	Hypothesis testing							
Hypothesis testing - Idea of two types of errors and level of significance. Tests of significance: Parametric (F & t test); Non parametric: Chi square tests. Simple linear regression and correlation. Analysis of variance. SPSS.								
Text Books	<ol style="list-style-type: none"> Dubey Diwedi, Usman, Srivastava. Biostatistics and Research Methodology. Publisher S VikaS and Company. 2019. L. Veerakumari. Bioinstrumentation. 1st Edition Mjp Publishers. 2011. B Annadurai, A Textbook of Biostatistics, Publisher New Age International Private Limited, 2017 							
References	<ol style="list-style-type: none"> John G Webster . Bioinstrumentation .Publisher Wiley.2021. Akash Ved. Biostatistics & Research Methodology. Publisher Thaukur Publication.2019. MJ Reily. 2019. Bioinstrumentation. CBS Publishers & Distributors B Annadurai. A Textbook of Biostatistics. Publisher New Age International 							

	Private Limited.2017. 5. Norman T.S. Bailey. Statistical Methods in Biology. Cambridge University Press, UK. 2012.
E-Reference links	<ol style="list-style-type: none"> https://www.pdfdrive.com/biostatistical-methods-biostatistical-methods-e15213717.html https://www.pdfdrive.com/biostatistics-e42988735.html https://www.pdfdrive.com/introductory-biostatistics-e15112721.html https://www.pdfdrive.com/introductory-biostatistics-e176105301.html https://www.pdfdrive.com/bioinstrumentation-instructional-resources-technology-austin-e15581883.html

Course Outcomes

Upon completion of this course the students will be able to		
CO1	know the principle and applications of different types microscopes, cytometer and calorimeter	K1
CO2	understand the importance centrifugation and chromatographic techniques	K2
CO3	know to apply the knowledge in identification of biopolymer structures, understand the principles of spectroscopic and electrophoretic techniques	K3
CO4	develop skill in collection and presentation of biological data through biostatistics	K3
CO5	bring out solutions to solve the biological research problems through statistics	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	M	M	S	S	S	S	S	S	M	S
CO2	S	M	S	M	M	S	S	S	S	S	S	M	S
CO3	S	M	S	M	M	S	S	S	S	S	S	M	S
CO4	S	M	M	M	M	S	M	S	S	S	S	M	S
CO5	S	M	M	M	M	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	P21BTP33	PRACTICAL	L	T	P	C
CORE XVI		PLANT BIOTECHNOLOGY & ANIMAL BIOTECHNOLOGY, APPLIED ENVIRONMENTAL BIOTECHNOLOGY	-	-	6	4
Cognitive Level	K1: Recall K2: Understand K4: Analyze K6: Create					
Learning Objective	<ul style="list-style-type: none"> • To learn to set up a plant cell culture and animal cell culture laboratory • To acquire knowledge on culturing callus and root tip, and also gain skill on transformation techniques • To gain skills on handling and maintenance of animal cell culture. • To acquire knowledge on analysis and estimation of different parameters in waste water 					
Experiments in Plant Biotechnology	<ol style="list-style-type: none"> 1. Introduction to the laboratory and general safety practices for plant cell culture. 2. Preparation of media, stock preparation and sterilization techniques. 3. Plant genomic DNA extraction. 4. Micropropagation using shoot tip. 5. Callus culture. 6. Root tip culture 7. Synthetic seed preparation 8. Protoplast isolation 9. Transformation using <i>Agrobacterium tumefaciens</i>. 10. Size analysis of DNA by agarose gel electrophoresis. 					
Experiments in Animal Biotechnology	<ol style="list-style-type: none"> 1. Introduction to the laboratory and general safety practices for animal cell culture. 2. Isolation of fibroblast from chick embryo 3. Virus inoculation methods 4. Isolation of genomic DNA from Animal cells 5. Quantification of DNA by spectroscopic method 6. Cell growth analysis 7. Cell viability test – MTT 8. Revival of frozen cell lines 9. Sub culture of Adherence cell lines 10. Handling of Animal (Mice) – Different routes of drug Administration 					
Experiments in Applied Environmental Biotechnology	<ol style="list-style-type: none"> 1. Sampling techniques of water 2. Estimation of total alkalinity 3. Estimation of chloride 4. Estimation of total hardness 5. Estimation of Calcium 6. Estimation of DO, BOD and COD 7. Estimation of phosphate 8. Estimation of Nitrate 9. Estimation of chromium 10. Estimation of ferrous ion 					
Text Books	1. Madhavi Adhav. Practical Book of Biotechnology & Plant Tissue Culture. Publisher Chand, 2010.					

	<ol style="list-style-type: none"> Kiran Musunuru. Genome Editing: A Practical Guide to Research and Clinical Applications. 1st Edition. Publisher Academic Press Inc. 2021. G Lakshmi Swarajya, P Prabhu Prasadini, Environmental Science: A Practical Manual, Publisher BS Publications, 2018
References	<ol style="list-style-type: none"> Vargas V M L, Plant Cell Culture Protocols 4th Edition, Publisher Springer. 2018. Jayanta Kumar Patra , Gitishree Das , Swagat Kumar Das, Hrudayanath Thatoi A Practical Guide to Environmental Biotechnology. Publisher Springer. 2020. Patra, J.K., Das, G., Kumar Das, S., Thatoi, H. A Practical Guide to Environmental Biotechnology. Publisher Springer. 2020. American Public Health Association, American Water Works Association and Water Pollution Control Federation, Standard Methods for the Examination of Water and Wastewater, 22nd edition, American Public Health Association, Inc, Washington DC. 2012 Turksen, Kursad. Genome Editing. Publisher Springer. 2016.
E-Reference links	<ol style="list-style-type: none"> https://www.jove.com/science-education/11112/plant-tissue-culture https://www.plantcelltechnology.com/blog/meristem-and-shoot-tip-culture https://phytocultures.com/plant-tissue-culture/the-procedure https://www.microscopemaster.com/cell-culture.html https://www.youtube.com/watch?v=F17aAmzZdMw https://www.youtube.com/watch?v=9BvTFowr0rI https://madhavuniversity.edu.in/animal-tissue-culture.html https://vlab.amrita.edu/index.php?sub=3&brch=258&sim=1450&cnt=5 https://www.mpcb.gov.in/sites/default/files/water-quality/reports/LSD-NEERI-%20Water%20Quality%20Analysis.pdf

Course Outcomes

Upon completion of this course the students will be able to		
CO1	imbibe practical knowledge in plant cell culture techniques	K1
CO2	understand and gain skills in transformation techniques for plant cells	K2
CO3	learn procedures of culture media preparation, animal cell culture, analysis of cell viability and storage of cells	K4
CO4	gain knowledge about analysis of water quality and solve the problem to the society	K6
CO5	identify the environmental problems, find solution using biotechnology	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	S	S	S	M	S	S	S	S	S	S	S	S
CO2	S	S	S	S	M	S	S	S	S	S	S	M	S
CO3	S	S	S	S	M	S	S	S	S	S	S	M	S
CO4	S	S	S	S	M	S	S	S	S	S	S	M	S
CO5	S	S	S	S	M	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

SEMESTER IV

Course Code	P21BTE411	CHOICE - I	L	T	P	C
ELECTIVE - I		STEM CELL BIOLOGY	4	-	-	4
Cognitive Level	K1: Recall K2: Understand K4: Analyze K6: Create					
Learning Objective	<ul style="list-style-type: none"> • To gain knowledge in the key concepts of stem cell biology • To learn the characteristics of embryonic and adult stem cells • To understand the use of stem cells in organ regeneration • To imbibe the ethics in the usage of stem cells in therapy and research 					
Unit I	Stem cell					
Introduction- Embryonic stem cells, Blastula, Inner cell mass, Totipotent, pluripotent, multipotent and Induced pluripotent stem cells characterization, potency, self-renewal, cell division, and differentiation						
Unit II	Cell proliferation and differentiation					
Pathways involved in stem cell proliferation, differentiation, and dedifferentiation - Signal transduction pathways and signalling molecules involved cellular proliferation, differentiation, and dedifferentiation. Relationship between cellular proliferation and differentiation concerning stem cells						
Unit III	Embryonic stem cells					
How embryonic stem cells are obtained, in vitro multiplication: embryonic stem cells gene manipulation and nuclear transfer technology. Adult stem cells - Methods to obtain stem cells from adults (Amniotic fluid, cord blood cells, Mesenchymal stem cells.). Induced pluripotent technology (IPS), genes, and their mode of action in inducing stemness in adult cells. Advantages and disadvantages of IPS technology						
Unit IV	Organ regeneration using Stem cells					
Heart regeneration, angiogenesis, kidney regeneration, a neurodegenerative disorder, spinal cord injury, tissue engineering. Ethics in using Embryonic stem cells - Human stem cell research: Ethical consideration; Stem cell religion consideration; Stem cell-based theories: Preclinical regulatory consideration, and Patient advocacy.						
Unit V	Application of stem Cells					
Overview of embryonic and adult stem cells for therapy in Neurodegenerative diseases; Parkinson's, Alzheimer's, Spinal Cord Injuries and other brain Syndromes; Tissue system Failures; Diabetes; Cardiomyopathy; Kidney failure; Liver failure; Cancer; Hemophilia.						
Text Book	<ol style="list-style-type: none"> 1. Cheria E, Stem cells JP brothers medical publishers, 2011. 2. Robert Lanza, Essentials of Stem Cell Biology, Publisher Academic Press, 2013 3. Mary Clarke, and Jonathan Frampton, (2020), Stem Cells Biology and Application, Taylor and Francis. 2020 					
References	<ol style="list-style-type: none"> 1. Atala A, Progenitor and Stem Cell Technologies and Therapies Wood head publishing, 2012. 2. Phinney DG, Adult stem cells: Biology and methods of analysis Humana press, 2011. 3. Marek J. Łos, Andrzej Hudecki and Emilia Wiechec. Publisher Elsevier, Stem Cells and Biomaterials for Regenerative Medicine. 2019. 					

	4. El-Badri Abdelkodous, Nagwa. Regenerative Medicine and Stem Cell Biology.2020.
E-Reference links	<p>1. https://www.law.berkeley.edu/files/stem_cell_day1_part2_shelanski.pdf</p> <p>2. https://www.bjcancer.org/Sites_OldFiles/_Library/UserFiles/pdf/stem_cell_handbook.pdf</p> <p>3. https://go.openathens.net/redirector/tulane.edu?url=http://www.sciencedirect.com/science/book/9780123815354</p>

Course Outcomes

Upon completion of this course, the students will be able to

CO1	know the potency and characteristics of stem cells	K1
CO2	understand stem cell proliferation, differentiation and dedifferentiation	K2
CO3	compare and contrast the characteristics of embryonic stem cells and adult stem cells	K4
CO4	acquire knowledge on the methods of organ regeneration using stem cells and understand the ethics in stem cell research	K2
CO5	evaluate the applications of stem cells in treating neurodegenerative diseases	K1,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	M	M	S	M	S	S	S	S	M	M
CO2	S	M	M	S	M	S	S	S	S	S	S	M	M
CO3	S	M	S	S	M	S	M	S	S	S	S	M	M
CO4	S	S	S	S	M	S	S	S	S	S	S	S	S
CO5	S	S	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	P21BTE412	CHOICE -II	L	T	P	C
ELECTIVE -I		FOREST CONSERVATION	4	-	-	4
Cognitive Level	K1: Recall K2: Understand K4:Analyze					
Learning Objective	<ul style="list-style-type: none"> To acquire knowledge on composition and structure of forest. To know the techniques in establishment, growth and quality of forest vegetation. To understand the role of forests in environmental sustenance. To learn about the manipulations in management and establishment of forest vegetation. 					
Unit I	Silviculture					
Definition, objectives and scope of Silviculture. Status of forests in India and their role. General Silvicultural Principles : methods of propagation, grafting techniques; site factors; nursery and planting techniques-nursery beds, polybags and maintenance, water budgeting, grading and hardening of seedlings; special approaches; establishment and tending.						
Unit II	Forest Types					
Introduction to trees and their general classification under different forest types. Important tree families and their peculiar characters. Types of trees and canopy structure. Coniferous and broad leaved tree species. Trees in tropical, sub-tropica, temperate and alpine regions.						
Unit III	Forest soil and conservation					
Forests Soils, classification, factors affecting soil formation; physical, chemical and biological properties. Soil conservation - definition, causes for erosion; types - wind and water erosion; conservation and management of eroded soils/areas, wind breaks, shelter belts; sand dunes; Role of forests in conserving soils.						
Unit IV	Forest Management and Management Systems					
Objective and principles; techniques; stand structure and dynamics, sustained yield relation; rotation, normal forest, growing stock; regulation of yield; management of forest plantations, commercial forests, forest cover monitoring. Approaches viz., (i) site-specific planning, (ii) strategic planning, (iii) Approval, sanction and expenditure, (iv) Monitoring (v) Reporting and governance.						
Unit V	Forest Disturbance					
Injuries to forest - abiotic and biotic, destructive agencies, insect-pests and disease. Role of afforestation and forest regeneration in absorption of CO ₂ . Effect of wild animals on forest regeneration, human impacts; encroachment, poaching, grazing, live fencing, shifting cultivation and control.						
Text Books	1. L.S.Khanna, Principles and Practice Of Silviculture, Publisher Khanna bandhu,2015 2. Nyland R.D.Silviculture concepts and Applications, Publisher CBS,2015 3. Sagwal S.S. A Textbook of Silviculture,Publisher Kalyani,2017 4. Mark S. Ashton, Matthew J. Kelty. The Practice of Silviculture: Applied Forest Ecology, Publisher Wiley,2018					

References	<ol style="list-style-type: none"> 1. Francesco Ferrini, Cecil C. Konijnendijk van den Bosch, Alessio Fini, Routledge Handbook of Urban Forestry, Routledge,2017 2. Sergius Alexander Wilde ,Forest Soils: Their Properties and Relation to Silviculture, Publisher Forgotten Books,2019 3. Kevin Laughlin O'Hara,Multiaged Silviculture: Managing for Complex Forest Stand Structures, Oxford University Press, 2014
E-Reference links	<ol style="list-style-type: none"> 1. https://forestrypedia.com/download/general-silviculture-notes-by-naeem-javid-muhammad-hassani/ 2. http://www.westbengalforest.gov.in/upload/development/cm24.pdf 3. https://www.forestrynotes.in/ 4. http://www.fao.org/3/ap467e/ap467e00.pdf 5. https://www.geospatialworld.net/article/forest-management-information-system-fmis-2/

Course Outcomes

Upon completion of this course, the students will be able to		
CO1	acquire knowledge on forests in India and their role	K1
CO2	understand the trees and their general classification under different forest types	K2
CO3	compare the role of forests in conserving soils	K4
CO4	know the Forest Management and Management Systems	K1
CO5	gain knowledge about the causes, importance of afforestation deforestation and reforestation	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	M	M	M	M	S	S	S	S	M	S
CO2	S	S	M	M	M	S	S	S	S	S	S	M	S
CO3	S	M	M	M	M	S	S	S	S	S	S	S	S
CO4	S	M	M	S	M	S	M	S	S	S	S	M	S
CO5	S	M	M	S	M	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	P21BTE413	CHOICE -3	L	T	P	C
ELECTIVE -I		NANOTECHNOLOGY AND CANCER BIOLOGY	4	-	-	4
Cognitive Level	K1: Recall K2: Understand					
Learning Objective	<ul style="list-style-type: none"> To gain knowledge and basic understanding of nanotechnology and cancer. To learn the properties of nanomaterials, and the principles behind advanced experimental and computational techniques for studying nanomaterials. To attain knowledge on synthesis of nanomaterials, characterization and their application in almost all the field to the benefit of humankind. 					
Unit I	Nanotechnology					
Definition – Quantum dots, Nanowires & properties, 2D films. Nano scale materials. Nanopores. Characterization of Nanoparticles and Nanomaterials.						
Unit II	Application of nanotechnology					
Nano sensors-types & its applications, Nano carriers for drug delivery-polymeric NP, Micelles, Micro emulsions, Lipoproteins as pharmaceutical carriers. Solid lipid NP as drug carriers. Nanocapsules-Preparation, Characterization & therapeutic applications. Nano medicine-Biopharmaceuticals. Implantable materials, Devices, Surgical aids, diagnostic tools, Genetic testing, Imaging.						
Unit III	Applications of Nanotechnology					
Nanotechnology for cancer research & therapy. Environmental nano remediation technology. Thermal, physico-chemical and Biological methods. Nano filtration for the treatment wastes, removal of organics, Inorganics and pathogens. Nanotechnology for water purification.						
Unit IV	Cancer					
Epidemiology of cancer, cancer types, characteristics of cancer cells, carcinogenesis: Cancer initiation, promotion and progression, termination. Factors responsible for Carcinogenesis; Physical, Chemical and Biological.						
Unit V	Tumour immunology					
Tumour antigens, cytokines, vaccine development, immunotherapy and its limitations, Tumour cell evasions of immune defenses. Principles of chemotherapy and chemoprevention.						
Text Books	<ol style="list-style-type: none"> Kleinsmith , Principles of Cancer Biology, Publisher Pearson Education India,2016 Sunipa Roy, Chandan Kumar Ghosh, Chandan Kumar Sarkar, Nanotechnology:Synthesis to Applications, Publisher CRC Press,2018 Ann-Marie Broome, Cancer Nanotechnology, Academic Press. 2018 					
References	<ol style="list-style-type: none"> Geoffrey M.Cooper and Robert E.Hausman. The Cell: A Molecular Approach 7th Edition, ASM Press, Washington D.C. & Sinauer Associates, Inc, Sunderland, Massachusetts.2016. Gerald Karp, Harris, D. Cell and Molecular Biology – Concepts and Experiments (ed), John Wiley & Sons Inc, New York,2016.. Sanyog Jain Kaiser Raza Ashish Kumar Agrawal Ankur Vaidya 1st Ed, Nanotechnology Applications for Cancer Chemotherapy, Elsevier. 2020 					

E-Reference links	<ol style="list-style-type: none"> https://books.google.co.in/books?id=81vBBwAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0 https://www.pdfdrive.com/cancer-nanotechnology-methods-and-protocols-d158801917.html https://www.pdfdrive.com/introduction-to-cancer-biology-d58366931.html https://www.pdfdrive.com/nanotechnology-and-nanosensors-introduction-to-nanotechnology-d187619895.html
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Course Outcomes

Upon completion of this course the students will be able to		
CO1	know nanotechnology, nanomaterial and nanoparticles	K1
CO2	acquire knowledge on the application of nanotechnology in different field and use as problem solving solution	K2
CO3	update the research trends in Nanotechnology for cancer research and therapy	K2
CO4	attain knowledge about epidemiology of cancer, cancer types, characteristics of cancer cells in molecular aspects	K2
CO5	gain knowledge on vaccine development, chemotherapy and chemoprevention	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	M	M	M	M	M	S	S	S	M	M	M
CO2	S	S	S	M	M	M	M	S	S	S	M	M	S
CO3	S	S	S	S	M	S	S	S	S	S	S	S	M
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 Code	P21BTE414	CHOICE -4	L	T	P	C
ELECTIVE - I		DRUG METABOLISM	4	-	-	4
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze					
Learning Objective	<ul style="list-style-type: none"> To understand the classification of drug and mechanism of action of drugs To gain knowledge on pharmacokinetics To know about the drugs for metabolic disorders and its toxicity 					
Unit I	General Pharmacology					
Introduction to pharmacology, sources of drugs, Classification of drugs based on sources, dosage forms, route of administration, site of action of drugs. Mechanism of action, concept of receptors, combined effect of drugs, factors modifying drug action. Dose response curve- ED50 and LD50.						
Unit II	Pharmacokinetics					
Absorption and distribution of drugs, importance of drug – protein interaction. Drug metabolism: chemical pathway of drug metabolism, phase I and phase II reactions, role of cytochrome P450, non- microsomal reactions of drug metabolism, drug metabolizing enzymes. Drug elimination of liver and kidney						
Unit III	Therapeutics					
Biochemical mode of action of antibiotics- penicillin and chloramphenicol, actions of alkaloids, antiviral and antimalarial substances. Biochemical mechanism of drug resistance- sulphonamides. Drug potency and drug efficacy. General principles of chemotherapy: chemotherapy of parasitic infections, fungal infections, viral diseases. Introduction to immunomodulators and chemotherapy of cancer.						
Unit IV	Screening for pharmacological activity					
Analgesic, anti-inflammatory and antipyretic agents, gastrointestinal drugs, antiulcer and laxatives, antioxidants, anticancer and anti-fertility agents. Drugs for metabolic disorders like antidiabetic, anti-hyperlipidemic, anti-obesity and hepatoprotective agents						
Unit V	Clinical Toxicology					
Definition, classification of toxicity – occupational, environmental and pharmaceutical. Types of toxins and their mechanism of action. Factors affecting toxicity- Drug tolerance, intolerance, addiction, allergy, hypersensitivity, antagonism and synergism. Methods of detection. Drug abuses and their biological effects. Rational prescription of drugs. Toxicity of anticancer drugs. Clinical symptoms of toxicity and marker parameters.						
Text Books	<ol style="list-style-type: none"> Jack P. Utrecht, William Trager, (2007) 1st Ed, Drug Metabolism Chemical and Enzymatic Aspects, Taylor and Francis. Gibson, G. Gordon, Skett, Paul, (1986), 1st Ed, Introduction to Drug Metabolism, Springer US. Caira, Mino R., Ionescu, Corina, (2005), 1st, Ed, Drug Metabolism, Current Concepts, Springer Netherlands 					
References	<ol style="list-style-type: none"> Michael D. Coleman . Human Drug Metabolism, 3rd Edition, 2018. Bertram Katzung, Anthony Trevor.. Basic and Clinical Pharmacology, McGraw Hill Professional. 2014 Golan, David E., Armen H. Tashjian, and Ehrin J. Armstrong, Principles 					

	of pharmacology: the pathophysiologic basis of drug therapy. Lippincott Williams & Wilkins. 2011. 4. Paul G. Pearson, Larry C. Wienkers, Handbook of Drug Metabolism, Publisher CRC Press, 2021
E-Reference links	1. https://www.pdfdrive.com/drug-metabolism-e-library-fakultas-kedokteran-uwks-d3133731.html 2. https://www.pdfdrive.com/principles-of-pharmacology-the-pathophysiologic-basis-of-drug-therapy-d157890965.html 3. https://www.pdfdrive.com/pharmacology-d33542642.html 4. https://www.pdfdrive.com/basic-clinical-pharmacology-e34443843.html

Course Outcomes

Upon completion of this course, the students will be able to		
CO1	classify drugs and their mechanism of action	K2
CO2	illustrate the importance of experimental models and know drug metabolism	K3
CO3	compare the action of antibiotics and distinguish between cancer therapies for parasitic, fungal and viral disease	K4
CO4	know the pharmacological activity of the drugs used in different metabolic disorders	K2
CO5	classify toxins, types, detection methods and the factors affecting toxicity	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	M	S	S	M	S	S	S	S	M	S
CO2	S	S	S	M	S	S	S	S	S	S	S	S	S
CO3	S	M	S	M	S	S	M	S	S	S	S	M	S
CO4	S	M	S	M	S	S	M	S	S	S	S	S	S
CO5	S	M	M	M	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	P21BTE421	CHOICE -1	L	T	P	C
ELECTIVE II		MOLECULAR MODELLING AND DRUG DESIGNING	4	-	-	4
Cognitive Level	K2: Understand K3: Apply K4: Analyze					
Learning Objective	<ul style="list-style-type: none"> To know the concepts in Quantum mechanics, molecular modelling and molecular dynamics To learn the basic modelling techniques to explore biological phenomena at the molecular level To attain knowledge in protein-ligand interaction study by docking and visualization tools for molecular modelling. 					
Unit I	Quantum mechanics & concepts in molecular modelling					
Coordinate systems, potential energy surfaces. Introduction to quantum mechanics. Force Fields - Bond stretching; angle bending. torsional terms; non-bonded interactions; electrostatic interactions; Vander Waals interactions						
Unit II	Molecular Dynamics and Monte Carlo simulation					
Design constraints, Potentials in MD simulation, Molecular dynamics algorithms.						
Unit III	Analysis and Properties					
Geometry optimization, Vibrational frequencies: potential energy surface, harmonic vs. fundamental frequencies, zero-point vibrational energies.						
Unit IV	Modelling					
Homology modeling, Ab initio, Protein Threading. Drug design - Structure-based methods to identify lead compounds: finding lead compounds by searching 3D databases; de novo ligand design.						
Unit V	Molecular Docking					
Docking - molecular modeling in drug design – structure-based drug design – pharmacophores - QSAR.						
Text Books	<ol style="list-style-type: none"> Moore E A, Molecular Modelling And Bonding, C Publishing.2002 Schneider, Molecular Design Concepts And Applications, John Wiley. 2008 Rajesh Kumar, Anju Sharma, Tiwari , Introduction To Drug Designing And Development by Kumar, Nova. 2014 Cohen Claude N. Guidebook On Molecular Modeling In Drug Design, Elsevier India. 2014 					
References	<ol style="list-style-type: none"> Leach AR, Molecular Modeling, Principles & Applications, Pearson education Ltd, UK. 2010. Arjun S, Drug Discovery, Design & Development Lambert Academic publishing. 2013. Clark T, Thurston DE, and Banting L, Drug Design Strategies: Computational Techniques & Applications Royal society of chemistry, 2012. Kukul, Andreas, Molecular Modeling of Proteins, Publisher Springer, 2015. 					
E-Reference links	<ol style="list-style-type: none"> https://www.mdpi.com/books/pdfview/book/1187 https://www.kobo.com/us/en/ebook/molecular-modelling-and-drug-design https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6539951/ 					

4. https://link.springer.com/article/10.1007/BF02834015
5. http://www.drugdiscoverytoday.com/view/25419/molecular-modeling/

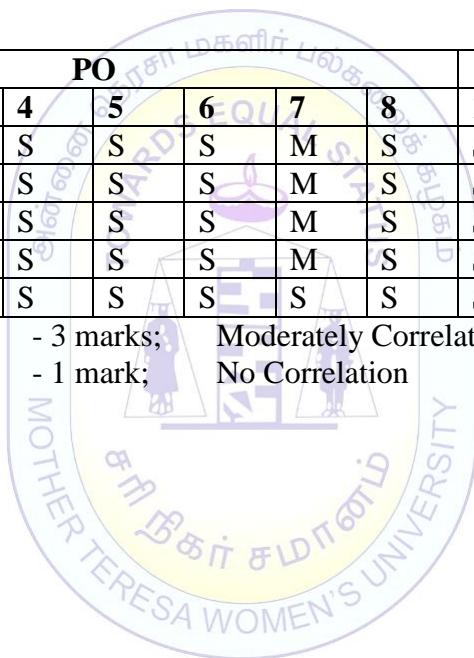
Course Outcomes

Upon completion of this course the students will be able to		
CO1	know the concepts of Molecular modelling	K2
CO2	employ different designs and potentials in molecular dynamics simulation	K3
CO3	illustrate the concept of optimization and vibrational frequencies	K3
CO4	understand homology modelling and the methods to identify lead compounds	K3
CO5	compare different drug designs for molecular modelling by docking	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	M	S	S	S	M	S	S	S	S	S	S
CO2	S	S	S	S	S	S	M	S	S	S	S	S	S
CO3	S	S	S	S	S	S	M	S	S	S	S	S	S
CO4	S	S	S	S	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 Code	P21BTE422	CHOICE - 2	L	T	P	C
ELECTIVE - II		WILD LIFE CONSERVATION	4	-	-	4
Cognitive Level	K1: Recall K2: Understand					
Learning Objective	<ul style="list-style-type: none"> To understand about habitat analysis, Human-wildlife interactions To know about the concepts of wildlife management 					
Unit I	Introduction					
Values and ethics of wildlife conservation; importance of conservation. Conservation vs protection Concept of Buffer zones, Wildlife corridors, Strategies to reduce human-wildlife interactions.						
Unit II	Habitat analysis					
Types of Habitats & their major ecological factors. Ecological Succession & climax ecosystems (e.g. Sholas). Maximizing usage of Habitat resources by populations. Insular habitats & insular flora & fauna Extreme. Habitats and their flora & fauna (Dark Caves, deep sea etc.). Evaluation and management of wild life - Physical parameters and Biological Parameters; Standard evaluation procedures: Faecal analysis of ungulates and carnivores. Geographical Information System (GIS), Global Positioning System (GPS) and Remote Sensing (RS).						
Unit III	Human-wildlife interactions					
Poaching, illegal trading, conflict management and shifting from extraction to preservation; effect of extinction of a species on ecosystem; Forest landscape restoration. Conservation Vs protection. Concept of Buffer zones, Wildlife corridors Strategies to reduce human-wildlife interactions Role of Government and NGOs in controlling human-wildlife interactions. Socio-economic issues related to human-wildlife interaction.						
Unit IV	Concepts of Wildlife management					
Protected Area Network (PAN), WWFN, IUCN, and CITES. Wild life Legislation – Wild life Protection act (1972), its amendments and implementation. IUCN Red data book and red list categories (only names), Protected areas National parks & sanctuaries, Community reserve; Important features of protected areas in India; Project Tiger and Project Elephant.						
Unit V	Sustainable wildlife management					
Natural resource management. Eco tourism / wild life tourism in forests; various Environmental movements in India: Bishnoi movement, Chipko movement, Narmada bachao andolan, Silent valley movement, Baliyapal movement.						
Text Books	<ol style="list-style-type: none"> 1. Reena Mathur, Wildlife Conservation and Management, Rastogi Publications, 2018 2. Singh S K, Textbook of Wildlife Management, Publisher CBS, 2020 3. Goutam Kumar Saha, Subhendu Mazumdar, Wildlife Biology: An Indian Perspective, Publisher PHI Learning, 2017 4. Jagbir Singh, Ecotourism, I.K. International Publishing House Pvt. Ltd. 2010 5. S.K. Singh, Textbook Of Wildlife Management, Publisher CBS Publishers & Distributors Pvt Ltd, India, 2018 					
References	<ol style="list-style-type: none"> 1. Sutherland, W.J. The Conservation Handbook: Research, Management and Policy. Blackwell Sciences 2010 2. Woodroffe R., S. Thirgood and A. Rabinowitz. People and Wildlife, Conflict or Coexistence? Cambridge University Press, 2011 3. McCleery, Robert A, Moorman, Christopher, Peterson, M. Nils, Urban 					

	Wildlife Conservation, Springer, 2014 4. David A. Fennell, Ecotourism, Publisher Routledge, 2014
E-Reference links	1. https://www.pdfdrive.com/wildlife-ecology-conservation-and-management-2nd-edition-d184311905.html 2. https://www.pdfdrive.com/comprehensive-wildlife-conservation-strategy-e38430632.html 3. https://www.pdfdrive.com/wildlife-ecology-and-management-wildlife-producers-association-e9899184.html

Course Outcomes

Upon completion of this course, the students will be able to		
CO1	understand the values and ethics of wildlife conservation	K2
CO2	gain knowledge on the salient features of habitats and their ecological factors and standard procedure for assessment and management of wild life	K2
CO3	attain the basic knowledge of human-wildlife interactions and socio-economic issues related to human-wildlife interaction.	K1
CO4	understand the concepts of wildlife management and wild life protection act	K2
CO5	identify the value and importance of Eco tourism	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	M	M	S	M	S	S	S	S	M	S
CO2	S	M	S	M	M	S	M	S	S	S	S	M	S
CO3	S	M	S	M	M	S	S	S	S	S	S	M	S
CO4	S	M	S	M	M	S	M	S	S	S	S	M	S
CO5	S	M	S	M	M	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	P21BTE423	CHOICE -3	L	T	P	C
ELECTIVE - II		HUMAN PATHOLOGY	4	-	-	4
Cognitive Level	K1: Recall K2: Understand K3-Apply K4: Analyze					
Learning Objective	<ul style="list-style-type: none"> To acquire a theoretical knowledge in general pathology and mycology. To gain knowledge about systemic pathology and Tumours in Gastrointestinal system, Respiratory tract and Breast To understand and acquire knowledge on Transfusion Medicine and Clinical pathology 					
Unit I	General Pathology					
Introduction, History of pathology, Cell injury and cell death, Cellular accumulations, Inflammation and repair, Circulatory disturbances, Immunological disorders, Infections, Neoplasia						
Unit II	Mycology					
Human Fungi - morphology and reproduction. Classification of fungi .Opportunistic fungi. Superficial mycotic infection. Fungi causing subcutaneous mycoses. Fungi causing systemic infections. Laboratory diagnosis of fungal infections.						
Unit III	Systemic Pathology					
Gastrointestinal system. Disorders of mouth, salivary glands ,esophagus, stomach , intestines, rectum and anal canal. Respiratory tract – infections, inflammations, environmental, immunological and neoplastic disorders and their identification. Breast - Tumors and tumor like conditions. Pathogenesis pathology and diagnosis.						
Unit IV	Haematology					
Development and morphology of blood cells, bone marrow, general alterations in diseases. Anaemia – deficiency, hemolysis and other causes. Disorders of hemostasis and coagulation. Disorders of leucocytes and platelets – quantitative, qualitative and in neoplastic proliferations. Paraproteinemia and plasma cell disorders.						
Unit V	Transfusion Medicine					
Essentials of blood bank serology and transfusion medicine. Clinical Pathology - Basic principles and methods employed in tissue processing, paraffin and frozen sections and staining procedures including tissue microarrays.						
Text Books	<ol style="list-style-type: none"> Husain A. Sattar, Fundamentals of Pathology. Published by PathomaLLC. 2017. Harsh Mohan. Textbook of Pathology, 7th Edition. Jaypee Brothers,Medical Publishers Pvt. Limited,2014. Vinay Kumar Abul Abbas Jon Aster. Pathologic Basis of Disease 9th Edition. Elsevier. 2014. 					
References	<ol style="list-style-type: none"> Shivraj Sudha, Essentials of General Pathology, Publisher: Wiley India Pvt. Ltd,2019. L. Maximilian Buja, Gerhard R. F. Krueger, Human Pathology. Publisher Saunders,2013 Inderbir Singh, Human Histology with Colour Atlas and Practical Guide, Publisher JPB,2011 					

E-Reference links	<ol style="list-style-type: none"> https://www.pdfdrive.com/pathology-handbook-capital-pathology-e36414786.html https://www.pdfdrive.com/genitourinary-pathology-a-volume-in-foundations-in-diagnostic-pathology-series-high-yield-e176374227.html https://www.pdfdrive.com/harsh-mohan-textbook-of-pathology-e52206258.html https://www.pdfdrive.com/fundamentals-of-pathology-pathoma-2018-e185838619.html https://www.pdfdrive.com/pathology-usmle-step-1-volume-1-basic-pathology-e187109588.html
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Course Outcomes

Upon completion of this course, the students will be able to		
CO1	understand the basics of pathological disorders	K2
CO2	gain knowledge on fungal diseases and diagnosis	K1
CO3	acquire knowledge on Systemic pathology and disorders in blood	K2
CO4	illustrate the developments in blood cells and explain their disorders	K3
CO5	compare the different staining techniques in clinical pathology	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	M	M	M	M	S	S	S	S	M	S
CO2	S	M	M	M	M	M	M	S	S	S	S	M	S
CO3	S	M	S	M	M	M	M	S	S	S	S	M	S
CO4	S	M	S	M	M	S	M	S	S	S	S	M	S
CO5	S	M	S	S	M	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	P21BTE424	CHOICE - 4	L	T	P	C
ELECTIVE- II		BIOBUSINESS	4	-	-	4
Cognitive Level	K1: Recall K2: Understand K3: Apply K5: Evaluate					
Learning Objective	<ul style="list-style-type: none"> To gain knowledge on different aspects of biobusiness. To acquire information about various sector in bio business To understand IPR related to biobusiness 					
Unit I	Fundamentals of Bio business					
History of evolution of Bio Business, Importance of Finance for Bio business –Sectorial support by Government of India - policies, and frameworks.						
Unit II	Overview of Bio business in various sectors					
Healthcare, Industrial life-Sciences, Agriculture and Agri-biotechnology, Environment and Environmental Biotechnology.						
Unit III	Business Models in Bio business					
Product Based-Service Based-Subscription Based-Integrated Models.						
Unit IV	Best Practices					
Current Good Manufacturing Practices (cGMP), Current Good Laboratory Practices (cGLP).						
Unit V	IPR					
Determining "patentability"; Industry-wise implications; use of patents – relevant case studies highlighting its importance. Importance of IPR in the Pharmaceutical Industry- Drug development-Product/Process Patenting- Marketing. Technology transfer, Licensing						
Text Books	<ol style="list-style-type: none"> Lawrence J. Gitman, Carl McDaniel, Amit Shah, Monique Reece, Linda Koffel, Bethann Talsma, James C. Hyatt Introduction to Business, Publisher OpenStax, 2018. Lenssen, Gilbert G., Smith, Craig, Managing Sustainable Business, Springer, 2019. 					
References	<ol style="list-style-type: none"> Shahi, G. BioBusiness in Asia: How Asian Countries Can Capitalize on the Life Science Revolution. Pearson Prentice Hall. 2004. Xu, Xiaozhou, Introduction to Entrepreneurship, Springer, 2020 Vashney, Fundamentals of Entrepreneurship, Sahitya Bhawan Publications, 2019. 					
E-Reference links	<ol style="list-style-type: none"> https://www.wur.nl/en/show/biobusiness.htm https://www.bio.org/save https://www.bio-rad.com/webroot/web/pdf/lse/literature/Biobusiness.pdf https://www.the-scientist.com/tag/biobusiness https://www.crg.eu/en/content/training-courses/biobusiness-entrepreneurship 					

Course outcomes

Upon completion of this course, the students will be able to		
CO1	know the history of bio business, support from government and the current scenario	K1
CO2	collect details of the various sectors of bio business	K5
CO3	differentiate the types of business models viz. product, subscription	K2
CO4	understand the importance of cGMP and cGLP	K3
CO5	get knowledge on the role of IPR in bio business	K4

Mapping of COs with POs & PSOs:

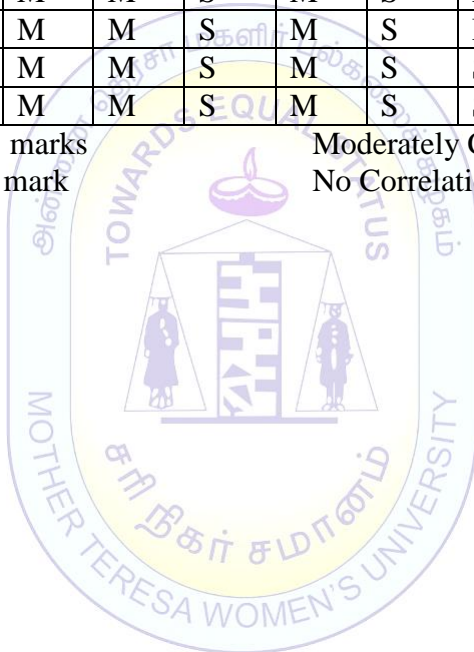
CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	M	M	S	M	M	S	M	S	M	S	S	M	S
CO2	M	M	S	M	M	S	M	S	M	S	S	M	S
CO3	M	M	S	M	M	S	M	S	M	S	S	M	S
CO4	M	M	S	M	M	S	M	S	S	S	S	M	S
CO5	M	M	S	M	M	S	M	S	S	S	S	M	S

Strongly Correlating (S)- 3 marks

Weakly Correlating (W) - 1 mark

Moderately Correlating (M) - 2 marks

No Correlation (N) - 0 mark



Course Code	P21BTN211	INDUSTRIAL WASTE MANAGEMENT	L	T	P	C
NME			4	-	-	4
Cognitive Level	K1: Recall K2: Understand K3-Apply K4: Analyze					
Learning Objective	<ul style="list-style-type: none"> To impart knowledge on effluent characteristics and effects on environment To understand the importance of industries for development To develop skill for designing ETP for industries 					
Unit I	Industries					
Types of industries and Importance of industries – Industrial pollution –characteristics of industrial effluents –effects of industrial effluents on streams and land. Environmental laws related to prevention and control of industrial effluents. Waste audit.						
Unit II	Wastewater Treatment					
Primary, Secondary and advanced treatment: Classification and application of physical unit processes with principles and process analysis, biological waste water treatment - UASB, Wastewater disposal and Reuse. Sludge disposal:						
Unit III	Sugar mills and Distilleries, Tanneries, Fertilizer industries and pharmaceutical industries					
Sources, characteristics of wastes, effects on receiving water bodies and Treatment of their wastes and disposal.						
Unit IV	Cement industries					
Sources of pollution and wastes. Effect of wastes. Control technique of pollution. thermal power plants, Sources of pollution, characteristics of pollutants and their effects. Pollution control techniques.						
Unit V	Hazardous waste management					
Biotechnological application of hazardous waste management and management of Resources: bioremediation, phytoremediation, Use of microbial systems, Waste water treatment using root zone treatment by plants, Reclamation of wasteland: biomass production for Biogas.						
Text Books	<ol style="list-style-type: none"> Lagrega, Hazardous Waste Management, Medtech, 2015 Frank R. Spellman, Handbook of Water and Wastewater Treatment Plant Operations, CRC Press, 2013 Patwardhan. A.D., Industrial Wastewater Treatment”, Prentice Hall of India, New Delhi 2010. Pandey, “Environmental Management” Vikas Publications, 2010. 					
References	<ol style="list-style-type: none"> Balagurusamy, Nagamani, Chandel, AnujK. Biogas Production, From Anaerobic Digestion to a Sustainable Bioenergy Industry, Springer, 2020 Karin M. Ekström, Waste Management and Sustainable Consumption, Publisher Routledge, 2014 Ram Chandra, Environmental Waste Management, CRC Press, 2015 Sengupta, Debashish, Dubey, Brajesh K., Goel, Sudha, Treatment and Disposal of Solid and Hazardous Wastes, Springer, 2021 					

E-Reference links	<ul style="list-style-type: none"> • https://www.mysciencework.com/publication/download/lecture-notes-cell-biology-1636c320/adc18b1228577d5353c56fdf7b69b6de • https://gurukpo.com/Content/Bsc-biotech/Cell_Biology.pdf • https://www.microscopemaster.com/cell-biology.html • https://microbenotes.com/category/cell-biology/
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Course outcomes

Upon completion of this course the students will be able to		
CO1	gain knowledge on effect of industries waste on environment and environmental legislation	K1
CO2	understand the basic of common waste water treatment	K2
CO3	acquire knowledge on effluent characteristic and treatment process of various industrial effluent	K1
CO4	analyse the characteristics of effluent and student can able to design treatment process for industries	K4
CO5	apply biotechniques to control the hazards waste pollution	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	S	M	M	S	S	S	M	S	S	S
CO2	S	S	S	M	M	S	S	S	S	S	S	S	S
CO3	S	S	S	M	M	S	S	S	S	S	S	S	S
CO4	S	S	S	M	M	S	S	S	S	S	S	S	S
CO5	S	S	S	M	M	S	S	S	S	S	S	S	S

Strongly Correlating (S)- 3 marks
Weakly Correlating (W) - 1 mark

Moderately Correlating (M) - 2 marks
No Correlation (N) - 0 mark

Course Code	P21BTV11	CHROMATOGRAPHIC TECHNIQUES	Total Hours	C
Value Added Programme			30	2
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze			
Learning Objective	<ul style="list-style-type: none"> To learn the basics of advanced chromatographic techniques, their principles and applications To acquire knowledge on data collection and data interpretation of chromatographic techniques To know how to analyze and compare the chromatograms with library databases 			
Unit I	Chromatography techniques			
Introduction- Types, Basic Principles and application of various chromatography techniques.				
Unit II	HPLC			
History, Principle, components- column and detector, working mechanism-isocratic and gradient methods. Application of HPLC. Safety considerations.				
Unit III	GC-MS			
History, Principle, components-column, detector, working mechanism and application of GC-MS. Safety considerations.				
Unit IV	HPLC & GC-MS			
Instrumentation: Calibration of instrument, Sample & solvent preparation, operation –parameters of HPLC and GC-MS.				
Unit V	HPLC & GC-MS Results interpretation			
Chromatogram peak analysis with their mass and compared with library database.				
Text Books	<ol style="list-style-type: none"> L Veerakumari, Bioinstrumentation, MJP Publishers, 2015. Elsa Lundanes, Chromatography: Basic Principles, Sample Preparations and Related Methods, Wiley, 2013 Dettmer-Wilde, Katja, Engewald, Werner, Practical Gas Chromatography, Springer, 2014 			
References	<ol style="list-style-type: none"> Reilly M J, Bioinstrumentation, Publisher CBS, 2018. Hans-Joachim Hübschmann, Handbook of GC-MS: Fundamentals and Applications, Wiley, 2015. 			
E-Reference links	<ol style="list-style-type: none"> https://microbenotes.com/types-of-chromatography/ https://nptel.ac.in/content/storage2/courses/103108100/module7/module7.pdf https://www.aweimagazine.com/article/chromatographic-techniques/ https://www.sciencedirect.com/topics/engineering/chromatographic-technique 			

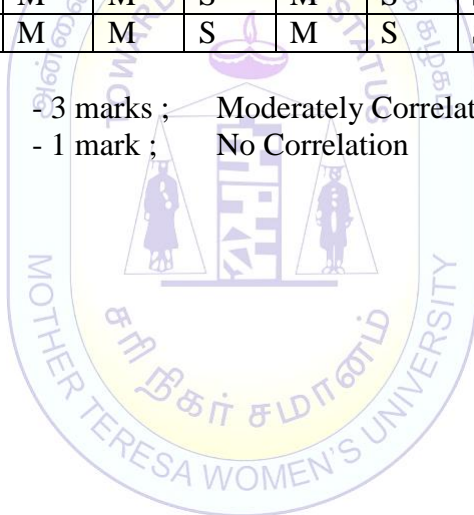
Course outcome

Upon completion of this course, the students will be able to		
CO1	compare the method in chromatography	K4
CO2	know the principle, components and working of HPLC	K1, K2
CO3	perform confidentially the experimentation with GC-MS and apply in research and analysis	K3, K4
CO4	calibrate and operate HPLC and GCMS	K1, K2, K3
CO5	learn and interpret the HPLC and GCMS data	K1, K2, K3, 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	M	S	M	S	S	S	M	S	S
CO2	S	S	S	M	M	S	M	S	S	S	S	S	S
CO3	S	S	S	S	M	S	M	S	S	S	S	S	S
CO4	S	S	S	M	M	S	M	S	S	S	S	M	S
CO5	S	S	S	M	M	S	M	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	P21BTV42	SYSTEM BIOLOGY	Total Hours	C
Value Added Programme			30	2
Cognitive Level	K1: Recall K2: Understand K3: Apply			
Learning Objective	<ul style="list-style-type: none"> To know the basic concepts in pharmaceutical industry To understand drug development, approval process and manufacturing of biopharmaceuticals. To know the steps involved in drug discovery process 			
Unit I	Introduction and Biological networks			
Introduction - System-level Understanding of Biological Systems - Advanced Measurement Systems - Introduction to Biological Networks and Basic Concepts – Metabolic, Signaling and Regulatory networks - Why build and study models? - Characterizing dynamic states - Formulating and studying dynamic network models - Properties of dynamic states - Network structure versus dynamics				
Unit II	Standard models and Approaches in systems biology			
Metabolism- enzyme kinetics and thermodynamics- Michaelis - Menten Kinetics - metabolic networks- metabolic control analysis - Signal transduction- introduction- function and structures- interactions- structural components - signaling selected biological processes - mathematical models - prediction of biological systems.				
Unit III	E-Cell project			
Organization - History - Research group - modeling methods – formalism - techniques numerical simulation algorithm-mathematical analysis methods-software environment-projects models-applications chemotaxis - molecular clock-circadian rhythms-oxidation stress-multi-enzyme systems.				
Unit IV	Systems biology software			
Systems biology software project: About the project-model inter change-code use-bio-models-online services-SBML Layout viewer-SBML validation-simulation translator-model repository-SBW broker - Jurnac-J-designer- BioSpice – BioUMC - CellDesigner – Cytoscape - Dizzy-Oscillator- Virtual cell - virtual rice project.				
Unit V	Introduction to synthetic biology			
Definition – Synthetic Biology versus Systems Biology - Synthesis and Engineering Tools - DNA Synthesis - Protein Engineering - Pathway Engineering - Genome Engineering - Computational and Theoretical Tools – Genomics, Proteomics and Metabolomics Tools - Applications in Synthetic Biology – Molecular, Pathway and Whole Cell Levels - Challenges and Future Perspectives.				
Text Books	<ol style="list-style-type: none"> Joseph DiStefano, Dynamic Systems Biology Modeling and Simulation, Publisher Academic Press, 2015 Vikram Singh, Pawan K. Dhar, Systems and Synthetic Biology, Publisher Springer Nature, 2015 Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald, Systems Biology, Publisher Wiley-Blackwell, 2016 Eberhard Voit, Systems Biology, Publisher Garland Science, 2017 			
References	<ol style="list-style-type: none"> Bernhard . Palsson, Systems Biology – Simulation of Dynamic Network States, Cambridge Univ. Press, UK, 2011. Huimin Zhao (Ed.), Synthetic Biology: Tools and Applications, Academic 			

	Press, Elsevier, USA,2013. 3. Kayvan Najarian, Siamak Najarian,Shahriar Gharibzadeh,Christopher N. Eichelberger, Systems Biology and Bioinformatics A Computational Approach, CRC Press,2017
E-Reference links	1. www.systems-biology.org/ 2. https://www.sysbiol.cam.ac.uk/ 3. https://www.systemsbio.org/

Course Outcomes

Upon completion of this course the students will be able to		
CO1	understand the comprehensive measurements of biological systems.	K2
CO2	know the factors involved in Biological System Design.	K1
CO3	gain knowledge on the systems biology tools: E-Cell	K2
CO4	know the networking of genes and protein interaction networks.	K1
CO5	relate the engineering principles in Synthetic Biology and its applications.	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	S	M	S	M	M
CO2	S	S	S	M	S	S	S	S	S	S	S	M	S
CO3	S	S	S	S	S	S	S	S	S	S	S	M	S
CO4	S	S	S	S	S	S	S	S	S	S	S	M	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
