MOTHER TERESA WOMEN'S UNIVERSITY

KODAIKANAL – 624 102

DEPARTMENT OF BIOTECHNOLOGY

M.Sc BIOTECHNOLOGY

Curriculum Framework, Syllabus, and Regulations

(Based on TANSCHE Syllabus under choice Based Credit System – CBCS)

(For the candidates to be admitted from the Academic Year 2023-2024)

Mother Teresa Women's University, Kodaikanal
Department of Biotechnology
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 Biochemistry, Molecular Genetics, Molecular Cell Biology 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/EnvironmentalScience/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.**

WRITTEN EXAMINATION QUESTION PAPER PATTERN

Theory Paper (Bloom's Taxonomy based)

(Common for UG, PG, Certificate, Diploma and P.G.Diploma Programmes)

Intended Learning Skills	**Maximum 75 Marks** **Passing Minimum: 50%** **Duration: Three Hours**
Memory Recall/Example/ Counter Example / Knowledge about the Concepts/Understanding	**Part–A (10x2=20Marks)** Answer ALL questions **Each Question carries 2 marks**
	Two questions from each Unit
	Question 1 toQuestion10
Descriptions/Application (problems)	**Part–B (5x5=25Marks) Answer ALL questions** **Each question carries 5 Marks**
	Either - or Type Both parts of each question from the same Unit
	Question 11 (a) or 11(b) to **Question 15(a) or 15(b)**
Analysis/Synthesis / Evaluation	**Part-C (3x 10 = 30 Marks)** **Answer any THREE questions** **Each question carries 10 Marks**
	There shall be FIVE questions covering all the five units
	Question 16 to Question 20

***Minimum credits required to pass: 91**

- **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

SEMESTER I

S.No.	Course code	Course Components	Name of Course	Inst. Hours	Credits	Exam HRS	Max. Marks	
							CIA	External
1	P23BTT101	Core Paper-1	Biochemistry	7	5	3	25	75
2	P23BTT102	Core Paper-2	Cell and Molecular Biology	7	5	3	25	75
3	P23BTP103	Core Practical-I	Biochemistry, Microbiology, Cell AndMolecular Biology	6	4	3	25	75
4	P23BTE11A/ P23BTE11B/ P23BTE11C	Elective -I	(A) Microbiology (B)Virology (C)Basic Analytical Methods	5	3	3	25	75
5	P23WSG101	Elective-II Generic course	Women Empowerment	5	3	3	25	75
6	P23BTM101	Mandatory Extra credit course*	Genetics	4	3*	3	25	75
			Total Credits		**20+ 3***			

***extra credit**

SEMESTER II

S.No.	Course code	Course Components	Name of Course	Inst. Hours	Credits	Exam HRS	Max. Marks	
							CIA	External
1	P23BTT204	Core Paper-4	Immunology	6	5	3	25	75
2	P23BTT205	Core Paper-5	Genetic Engineering	6	5	3	25	75
3	P23BTP206	Core Practical- II	Immunology and Genetic Engineering	6	4	3	25	75
4	P23BTE22A/ P23BTE22B	Elective –III	(A) Developmental and Stem cell Biology (B) Enzyme Technology	4	3	3	25	75
5	P23BT CSG202	Elective-IV Generic course	Cyber security	4	3	3	25	75
6	P23BTS201	NME-I Skill enhancement course	Pharmaceutical Technology	4	2	3	25	75
		Total Credits : 22						

SEMESTER III

S .No.	Course code	Course Components	Name of Course	Inst. Hours	Credits	Exam HRS	Max. Marks	
							CIA	External
1	P23BTT307	Core Paper-7	Plant Biotechnology	6	5	3	25	75
2	P23BTT308	Core Paper-8	Animal Biotechnology	6	5	3	25	75
3	P23BTT309	Core Paper-9	Microbial Biotechnology	6	5			
4	P23BTP310	Core Practical- III	Plant, Animal and Microbial Biotechnology	6	4	3	25	75
5	P23BTE33A/ P23BTE33B/ P23BTE33C	Elective –V	A)Genomics and Proteomics B)Food and Nutrition C)Herbal Biotechnology	3	3	3	25	75
6	P23BTN302	NME- II	Mushroom Cultivation	3	2	3	25	75
7	P23BTI301	Internship/ Industrial activity*		-	2	3	25	75
Total				**30**	**26**			

Internship/ Industrial activity*- The students should submit a report of size 25 to 40 pages

SEMESTER IV

S .No.	Course code	Course Components	Name of Course	Inst. Hours	Credits	Exam HRS	Max. Marks	
							CIA	External
1	P23BTT411	Core Paper-11	Bioinformatics	6	5	3	25	75
2	P23BTT412	Core Paper-12	Research Methodology	6	5	3	25	75
3	P23BTPR41	Project with Viva voce	Dissertation	10	7			
4	P23BTE44A/ P23BTE44B	Elective-VI	A)Bioethics, Biosafety, and IPR B)System Biology	4	3	3	25	75
5	P23BTS403	Skill Enhancement / Professional Competency Skill	Nano Biotechnology	4	2	3	25	75
6	P23EAS401	Extension activity		-	1			
Total				**30**	**23**			

Course code	P23BTT101	SEMESTER I	Credits	L	T	P	Hrs
CORE PAPER-1		BIOCHEMISTRY	5	7	-	-	7
Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply						
Aim	To enable the students to understand the basic concepts of biochemistry and biomolecules and also to learn the various metaboliccycles and also to analyze the significance of biochemical findings.						
Learning Objective	1. To learn the physical &chemical nature of Biomolecules 2. To learn various types of Biomolecules 3. To develop knowledge on intermediary metabolism of Carbohydrate, Proteins & Lipids 4. To teach the basics & advance of enzyme and their classification 5. To develop a piece of knowledge in clinical biochemistry						
Course outcome	1. After studied unit 1, the students will be able to identify the nature of solvents and solutionsconcerning pH and its important. 2. After studied unit 2, the students will be able to classify carbohydrates, proteins lipids, andnucleic acids of biomolecules. 3. After studied unit 3, the students will be able to describe the biomolecules involved inintermediary metabolism. 4. After studied unit 4, the students will be able to explain enzymes and enzyme kinetics 5. After studied unit 5, the students will be able to apply Biochemistry, in clinical biochemistryprocedures.						
Units	**Course Contents**						**Teaching hours**
Unit I	Basic Concepts: Units of measurements of solutes in solution, e.g. Normality, Molality, Molarity. The hyper and hypotonic solution, pH, pK, acids, bases, ionic bonds, covalent bonds, and secondary bonds (hydrogen bonds and Vander Waal‟ bonds)						**12 hours**
Unit-II	Biomolecules: Definitions, nomenclature, classification, structure, chemistry, and properties of carbohydrates, Definitions, nomenclature, classification, structure, chemistry, and properties of amino acids and proteins (hemoglobin, myoglobin, and plasma proteins), lipids and Nucleic acids,						**12 hours**
Unit-III	Metabolism: Metabolism of Carbohydrates, EMP, TCA, HMP. Glycogen metabolism, Gluconeogenesis. Amino Acids- Transamination, Deamination, Urea cycle. Lipids and Nucleic Acids-Their Biosynthesis. Mechanism of Oxidative Phosphorylation and Its Inhibitors, Uncouplers, Photophosphorylation						**12 hours**
Unit-IV	Enzymology: Enzymes: general aspects (classifications and structure). The allosteric mechanism, regulatory and active sites, and active energy. Iso-enzymes. Enzyme kinetics (MM, LB plot, Km) and hormones.						**12 hours**

Unit-V	Clinical biochemistry: Blood sugar level, Factors controlling blood sugar level – hypo, hyperglycemia, Diabetes mellitus, types – GTT. Metabolism of bilirubin- jaundice-types. Differential diagnosis and liver function tests. Renal functional test and gastric function test.	**12 hours**
Unit-VI	**Internal Assessments, Seminars, and Guest lecture**	**05 hours**
	Total Teaching hours	**65**

Textbook

1. J.L. Jain, S. Jain and N. Jain. Fundamentals of Biochemistry. S. Chand & Co, 2016.
2. Ambika Shanmugam. Biochemistry. Published by Wolters Kluwer, 8th Edition, 2016.
3. A.C. Deb. Fundamental of Biochemistry. New Central Book Agency, 2012
4. Biochemistry,7th Edition,jermy M.Berg John, Tymoczko,Lubertstryer 2012.W.H,freeman & company ,NewYork 2.
5. Molecular Bio methods handbook, 2nd edition R.Rapley & J.M Walker,2008, Humanapress.
6. Principles of Biochemistry, 5th Edition AL. Lehninger ,D.L. Nelson and M.M Cox .,2008.worth publishers , NewYork.
7. Biochemistry 4THEdition,G.Zubay,1998. Mc Millan publishing Co. NewYork.

Reference Book:

1. D.L. Nelson and M.M. Cox. Lehninger Principles of Biochemistry, WH Freeman Publishers, 7th Edition, 2017.
2. V.W. Rodwell, D.A. Bender, K.M. Botham, P.J. Kennell and P.A. Weil. Harper's Illustrated Biochemistry, 30th Edition. McGraw Hill, 2015.
3. Wilson and Walker. Principles and Techniques of Practical Biochemsitry, 6th edition, Cambridge University, Press. 2005.
4. Upadhyaya A Upadhyaya K and Nath. Biophysical Chemistry: Principles and Techniques, 3rd Edition. Himalayan publications, 2009.
5. M.N. Chatterjee and Rana Shinde, Textbook of Medical Biochemistry, 8th Edition. Jaypee Brothers Medical Publishers (P) Ltd., 2012.
6. Biochemistry – 4th edition Donald voet and Judith G.Voet ,VP Publishers 2011 steitz and A.M.Weiner ,The Benjamin /CUMMINGS publ.Co.,Inc.,California,2013
7. Genes VI(9th Ed).Benjamin Lewin, oxford universitypress,uk.,2007 10. Molecular biology of cell (5thedition)
   brucealberts,alexanderjohnson,Julianlewis,martinraff,keithRoberts,peterwalter ,garland sciencepublications.2008
8. Molecular Biology (5th edition).weaver .R.F,McGraw Hillpublications,2011. Cell and molecular biology : concepts and experiments (5th edition).geraldkarp,wiley publications,2013

E-Reference

1. https://nptel.ac.in/courses/104105076, https://oli.cmu.edu/courses/biochemistry-open-free/, https://onlinecourses.nptel.ac.in/noc20_cy10/preview,
2. E-Books: https://www.pdfdrive.com/biochemistry-books.html,
3. E-E-Journals: Process Biochemistry (Elsevier), Journal of Cellular Biochemistry (Wiley)

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	M	M	S	S	S
CO2	M	M	M	S	S	M	S	S	M	M
CO3	M	M	M	S	S	S	S	M	M	M
CO4	S	S	S	M	M	M	S	S	M	S
CO5	M	M	M	S	M	S	M	M	S	S

PO – Programme Outcome, CO – Course outcome S – Strong, = 3, M – Medium, L – Low (may be avoided)

Course code	P23BTT102	SEMESTER I	Credits	L	T	P	Hrs
CORE PAPER-2		CELL AND MOLECULAR BIOLOGY	5	7	-	-	7

Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply	
Learning Objective	1. To understand the basic concepts of the prokaryotic and eukaryotic cells. 2. To Understand the individual and coordinated functions of various cell organelles. 3. To familiarize the student with various aspects of cell and molecular biology streams including cellular organization and their interactions in DNA replication, protein biosynthesis, and translational regulation 4. To develop a comprehensive understanding of the complete cellular and molecular function of cell organelles in terms of cell-to-cell interaction, gene regulation, cellular signaling. 5. To impart the molecular biology knowledge in applications of various human health care	
Course outcome	1. After studied unit-1, the student will be able to equip with a basic knowledge of thestructural and functional properties of cells. 2. After studied unit-2, the student will be able to understand process of cell division andreplication process. 3. After studied unit-3, the student will be able to understand the occurrence of central dogma of life in the cell and the machineries involved to initiate and inhibit RNA and proteinsynthesis. 4. After studied unit-4, the student will be able to control of gene expressions in prokaryotes and eukaryotes and transposable elements. 5. After studied unit-5, the student will be able to understand mechanism of epigenetic controlsand cancer biology.	
Units	**Course Contents**	**Teaching hours**
Unit I	**Cell Biology:** Structure and function of cells in prokaryotes and eukaryotes; Structure and organization of Membrane - Membrane Model, active and passive, transport channels and pumps, Structure& Biogenesis of Mitochondria and Chloroplast. Structure of Endoplasmic reticulum, Golgi complex, lysosomes.	**12 Hours**
Unit-II	**Cell division:** Mitosis, Meiosis, regulation of cell cycle; factorsregulating cell cycle. Nucleic acid structure, Genome Organization. DNA replication: Enzymes and mechanisms of DNA replication in prokaryotes and eukaryotes, Telomeres, telomerase and end replication. Role of telomerase in aging and cancer. DNA replication models DNA damage, Mutations, DNA repair and recombination.	**12 hours**

Unit-III	**Transcription:** Basic mechanism in prokaryotes and eukaryotes. RNA polymerase, Reverse transcriptase and regulation. Post- transcriptional processing: 5'-Cap formation; 3'-end processing and polyadenylation; splicing: RNA editing; Nuclear export of mRNA; mRNA stability. Translation- Prokaryotic and eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination, Regulation of translation, co-and post-translational modifications of proteins and localization.	**12 hours**
Unit-IV	**Gene regulation:** Prokaryotic gene regulation- Operon concept ; Lac operon and tryptophan operon. Eukaryotic gene regulation: Chromatin Structure, Regulation at transcriptional Level: DNA binding domains of the regulatory proteins. Biochemistry and applications of ribozyme technologies. Transposable genetic elements	**12 hours**
Unit-V	**Epigenetics:** Epigenetic regulation of gene expression, Modifications, Cancer Epigenetics. Cancer Biology: Viral and cellular oncogenes; Tumor suppressor genes - Structure, function and mechanism of action of pRB and p53, p21, BRACA1.Oncogenes as transcriptional activators.	**12 hours**
Unit-VI	**Internal Assessments, Seminars, and Guest lecture**	**05 hours**
	Total Teaching hours	**65**

Textbook:

1. Molecular cell Biology, by Darnell, Lodish, Baltimore, Scientific American Books,Inc.,1994.
2. Molecular and cellular Biology, Stephen L.Wolfe, Wadsworth PublishingCompany,1993.
3. Cell and Molecular Biology: Concepts and Experiments 5th Ed,Gerald Karp. Wiley publications,2013.
4. Cell biology D E Sadava CBS Publishers & Distributors, 2009

Reference Book:

1. Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd.,Oxford,1991.
2. Molecular Biology of the Gene (4th Edition), J.D.Watson, N.H.Hopkins, J.W.Roberts,
3. J.A. Steitz and A.M.Weiner, The Benjamin/Cummings Publ. Co., Inc., California,1987.
4. Genes VI (6th Edition) Benjamin Lewin, Oxford University Press, U.K.,1998
5. Molecular biology of cell – Albert Bruce et al.,1994 3rdEd
6. Molecular Biology-Weaver. R. F. 3rd ed. Mc Graw Hill publication ,2005
7. The Molecular Biology of Cancer: S. Pelengaris, M. Khan. Blackwell Publication.2002

E.Reference

1. Swayam- Molecular biology course by Dr.Nayan K. Jain, Gujarat University
2. Swayam- Cell Biology by Dr K. Sanatombi
3. NPTEL - Molecular Cell Biology by Prof.D. Karunagaran
4. https://www.coursera.org/courses?query=molecular%20biology
5. https://www.cdc.gov/labtraining/training-courses/basic-molecular-biology/index.html

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome S – Strong, = 3, M – Medium, L – Low (may be avoided)

Subject code	P23BTP103	**SEMESTER I**	**Credits**	**L**	**T**	**P**	**Hrs**
CORE PRACTICAL- I		**Lab In Biochemistry Microbiology Cell & Molecular Biology**	**4**	**-**	**-**	**6**	**6**

Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply	
Learning Objective	To learn the principles of the various analytical instrument. To teach the SOP of analytical instruments. To study the different chromatography separation methodologies To study different electrophoresis isolation methodologies To learn advanced microscopic methods in image processing	
	Course Contents	Teaching hours
Biochemistry	1. Determination of Chl.a, Chl.b& total Chl. By Arnon method. 2. Estimation of Carbohydrates 3. Estimation of salivary amylase activity in relation to substrate/pH/Temperature 4. Estimation of blood glucose &urea 5. Estimation of LDH. 6. Estimation of total serum proteins 7. Estimation of creatinine in urine. 8. Paper / thin layer chromatography	10 hours
Microbiology	1. Sterilization techniques 2. Preparation of culture media(Selective and Enriched media) 3. Staining techniques- Simple, Differential, Negative staining and Motility studies 4. Determination of Bacterial growth curve 5. Enumeration of bacteria from environmental samples- soil, water, air and milk. 6. Pure culture techniques - Streak, pour plate and spread plate. 7. Biochemical tests for identification of bacteria (IMViC, TSI, Catalase,Oxidase) 8. Antimicrobial assay, phenol coefficient, agar plate sensitivity method. 9. Water quality analysis – MPN method. 10. Milk quality analysis – MBRT method	08 hours

Cell & Molecular Biology	1. Isolation of Genomic DNA from *E.coli* 2. Isolation of plasmid DNA from *E.coli* 3. Elution & quantification of DNA from agarose gel. 4. Preparation of competent cells and transformation 5. PCR 6. Isolation of Total RNA from bacteria 7. Synthesis of cDNA by Reverse transcription polymerase chain reaction	13 hours
Total Teaching hours		50
Text Book 1. Introduction to Practical Biochemistry, E.F Plummer Mu, PlummerTata McGraw-HillEducation,1998. 2. Molecular cloning: a laboratory manual,4th ed. J.Sambrook, Fritsch and T.Maniatis.coldspring harbor laboratory press ,NewYork,2012 3. Essential cell biology : a practical approach volume 1: cell structure. John Davey,J.Michaellord. Oxford university press,USA,2003 4. Principles and techniques of biochemistry and molecular biology (7th ed).keithWilson(editor),john walker (editor),Cambridge universitypress,2010		
Reference Book 1. Principles and Techniques of Practical Biochemistry (Paperback) by KeithWilson (Editor),John Walker (Editor), John M. Walker (Author) " Fifth Edition2000 2. Introductory Practical Biochemistry (Hardcover).by S. K. Sawhney; RandhirSingh (Editor)2005 3. Principles of Physical Biochemistry (2nd Edition) by Kensal E van Holde,Curtis Johnson, andPui Shing Ho (Hardcover – April 16,2005) 4. Physical Biochemistry: Applications to Biochemistry and Molecular Biologyby David M.Freifelder (Paperback – Aug 15,1982) 5. Instrumental Methods of Chemical Analysis by G R Chatwal and S KAnand (Hardcover –Jun1980).		
Course Material: 1. Microbiology- A Laboratory manual P. Gunasekaran . New age publications, New delhi,1995. 2. Molecular cloning-A Laboratory manual. Sambrook, J , Fritsch. E.F, and T.Maniatis, 2ndEdition. Cold spring Harbor Laboratory press, New York,1989. 3. Laboratory exercise of Microbiology, J.P. Harley and L.M. Prescott, 5th Edition, the McGraw-Hill companies,2002. 4. Microbiology: A Laboratory Manual, J.G. Cappuccino and N. Sherman, Addison-Wesley,2002. 5. Laboratory Manual of Experimental Microbiology,R.M.Atlas, A.E.Brown and L.C.Parks, 1995. Mosby,St.Louis,2002. 6. Laboratory manual in General Microbiology, N.Kannan, Panimapublishers. 7. Bergeys Manual of Determinative Bacteriology. Ninth Edition J.G.Holt, N.R.Krieg.,Lippincott Williams, Wilkin publishers, 2000.		**8.**

Course code	P23BTE11A	SEMESTER I	Credits	L	T	P	Hrs
ELECTIVE -I		MICROBIOLOGY	3	5	-	-	5

Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply
Learning Objective	1. To understand the History of Microbiology. 2. To well understand the Nutritional classification of bacteria, etc. 3. To obtain knowledge about Sterilization and Disinfection. 4. To obtain knowledge of Microbial diversity. 5. To know the basic Microbial community in natural habitats.
Course outcome	1. After studying unit 1 the students will be able to identify the Classification of microorganismspractical's. 2. After studying unit 2 the students will be able to identify and differentiate the pure culturetechnique. 3. After studying unit 3 the students will be able to identify and describe the chemotherapeuticagent 4. After studying unit 4 the students will be able to identify and explain enzymes and theirregulations by kinetic parameters 5. After studying unit 5 the students will be able to identify and cross-examine theBiotechnological applications of Extremophiles

Units	Course Contents	Teaching hours
Unit I	History of Microbiology - Classification of microorganism – Kingdom - Protista, Prokaryotic and eukaryotic microorganisms, Five kingdom concept of classification, Archaebacteria, Eubacteria, and eukaryotes. Microscope - Light field, Dark field, Fluorescent and Electron microscope, Prokaryotic and Eukaryotic cell structure. Staining techniques - Simple and Differential staining.	**12 hours**
Unit-II	Nutritional classification of bacteria, Isolation, cultivation, enumeration, and preservation of microbes; Culture media and its types - Pure culture technique - Growth curve; Axenic culture, Synchronous culture, Continuous culture; Effect of physical and chemical factors on microbial growth.	**12 hours**
Unit-III	Sterilization and Disinfection: Moist heat, Dry heat, Radiation, Filtration, Phenols, Halogens, Phenol coefficient method. Antibiotics - Inhibitors of Nucleic acid, protein, and cell wall synthesis. Chemotherapeutic agents - Antimicrobial susceptibility test.	**12 hours**
Unit-IV	Microbial diversity- methods to assess microbial diversity, Culture dependent, and culture-independent methods. Molecular analysis of bacterial community; Denaturating Gradient Gel Electrophoresis (DGGE), Terminal Restriction Fragment Length (TRFL) Polymorphism (T- RFLP), Amplified Ribosomal DNA and Restriction Analysis(ARDRA).	**12 hours**

Unit-V	Microbial community in natural habitats – air, water, soil, food, and milk. Food and milk-borne diseases, Extremophiles- habitant & Classification, Halophiles, Thermophiles, Alkaliphiles, Acidophiles, Biotechnological applications of Extremophiles.	**12 hours**
Unit-VI	**Internal Assessments, Seminars, and Guest lecture**	**05 hours**
	Total Teaching hours	**65**

Textbook:

1. Microbiology 3rd Edition by Dave Wessner (Author), Christine Dupont (Author), TrevorCharles (Author), Josh Neufeld (Author) 3rd edition (December 3, 2020)
2. Fundamentals of Microbiology 12th Edition by Jeffrey C. Pommerville (Author) 12th edition (March 29, 2021)
3. Burton's Microbiology for the Health Sciences 11th Edition by Paul G. Engelkirk (Author) 11th edition (October 10, 2018)
4. Brock Biology of Microorganisms plus Pearson Mastering Microbiology with Pearson eText, Global Edition 15th Edition 15th edition (March 27, 2018)
5. Microbiology: An Evolving Science Fifth Edition by Joan L. Slonczewski (Author), John W. Foster (Author), Erik R. Zinser (Author) Fifth edition (July 1, 2020)
6. Microbiology with Diseases by Taxonomy, Loose-Leaf Plus Mastering Microbiology with Pearson eText -- Access Card Package (6th Edition) 6th Edition 6th edition (January 14, 2019)

Reference Book:

1. Medical Microbiology: A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Diagnosis and Control. With STUDENT CONSULT Online Access (Greenwood,Medical Microbiology) 17th Edition by David Greenwood BSc PhD DSc FRCPath (Author), Richard C. B. Slack MA MB BChir FFPHM MRCPath DRCOG (Author), John F. Peutherer BSc MB ChB MD FRCPath FRCPE (Author), & 1 more Churchill Livingstone; 17th edition (June 6, 2007)
2. Microbiology Experiments: A Health Science Perspective Paperback – International Edition, January 1, 2018MC GRAW HILL; 9th edition (January 1, 2018)
3. Hugo and Russell's Pharmaceutical Microbiology, 8th Edition 8th Edition by Denyer (Author) Wiley-Blackwell; 8th edition (August 12, 2011)
4. Clinical Bacteriology Hardcover – August 1, 1980 by E Joan Stokes E Arnold; Fifth Edition (August 1, 1980)
5. Review of Medical Microbiology and Immunology (Medical Microbiology & Immunology (Levinson)) 9th Edition (March 10, 2006)

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	S	S	S
CO2	M	M	M	S	S	M	S	S	M	M
CO3	M	M	M	S	M	S	S	M	M	M
CO4	S	M	S	M	M	S	S	S	M	S
CO5	M	M	M	S	M	S	M	M	S	M

PO – Programme Outcome, CO – Course outcome S – Strong, M – Medium, L – Low (may be avoided)

Course code	P23BTE11B	SEMESTER I	Credits	L	T	P	Hrs
ELECTIVE 1		VIROLIGY	3	5	-	-	5

Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply
Learning Objective	Contrast differences in virus architecture and classification. To understand the viral diagnostic and detection methods. Distinguish characteristics of normal cells and virus-infected cells. Explain and apply methods used in research and diagnosis of viral diseases. Describe cellular and therapeutic antiviral strategies and social stigmas against infected individuals.
Course outcome	After studied unit-1, the student will be able to–describe and review the General Virology and cultivation of viruses After studied unit-2, the student will be able to –know the Viral diagnostic and detection methods After studied unit-3, the student will be able to - explain viral replication strategies; and compareand contrast replication mechanisms used by viruses relevant to human disease After studied unit-4, the student will be able to - discuss principles of virus pathogenesis After studied unit-5, the student will be able to - explain host antiviral immune mechanisms at a cellular and molecular level and vaccine strategies and mechanisms of antiviral drugs

Units	Course Contents	Teaching hrs
Unit I	General Virology: Structure of viruses: Enveloped and non-enveloped viruses, Capsid symmetries-icosahedral, polyhedral and helical, structural proteins- matrix proteins and lipoproteins, viral genomic organization and replication- types of nucleic acids, protein-nucleic-acid interactions and genome packaging, Virus related structures-viroids and prions. Cultivation of viruses: Inovo, In vivo, Ex vivo/In vitro. Cytopathic effect-pock forming unit.	10 hours
Unit-II	Viral diagnostic and detection methods: Sample processing-enrichment and concentration, Direct methods of detection-light microscopy (inclusion bodies), electron microscopy, Immuno diagnosis, hemagglutination, Complement fixation, neutralization, Western blot, Radioactive Immuno precipitation Assay (RIPA), Flow Cytometry and Immuno histochemistry. Nucleic acid-based diagnosis: Nucleic acid hybridization, PCR, microarray and nucleotide sequencing, LINE probe assay.	08 hours
Unit-III	Bacterio phages and plant viruses: Bacterio phage: Morphology, genome organization, classification-Lifecycle-Lytic and Lysogenic Cycle, Head and tail phages-T4 phage- phage-Filamentous Bacteriophages-174-M13,phage therapy for control of bacterial poultry diseases. Viral Disease in Plants: Histological, physiological and cytological changes in infected plants, Behavior of viruses in plants, Methods for detection of plant viruses, Transmission of plant viruses through vectors-insects, nematodes and fungi.	13 hours
Unit-IV	Clinical virology: Pathogenesis, clinical symptoms, epidemiology and prophylaxis of DNA Viruses-pox virus, Herpes Virus, Adenovirus, Hepatitis Virus. RNA Viruses-Picorna Virus, Orthomyxo Virus, Rabies Virus, HIV. Oncogenic viruses; Virus-induced cell transformation and oncogenesis, Mechanism of cell transformation by tumor viruses, Retrovirus mediated	08 hours

	oncogenesis.	
Unit-V	Viral vaccines and anti-viral drugs: Viral vaccines, conventional vaccines-killed and attenuated, Modern vaccines-DNA vaccines, recombinant DNA/protein vaccines, subunits vaccines, peptide vaccines, anti-idio type vaccines, edible vaccines, immuno modulators (cytokines), adjuvants to increase immunogenicity of vaccines. Antivirals: Interferons, 21 designing and screening for antivirals, mechanisms of action, anti retrovirals-mechanism of action and drug resistance.	05 hours
Unit-VI	**Internal Assessments, Seminars, and Guest lecture**	**5 hours**
	Total Teaching hours	**65**

Textbook:

1. Virology principles and application John Carter and Venetia Saunders (2007) John Wiley and Sons publishers.
2. Principles of Virology 4th edition Jane Flint.
3. Real –Time PCR: Current technology and applications 1st edition (2009) edited by Julie Logan *et al*.,
4. Analytical techniques in DNA sequencing edited by Brian K. Nunnally
5. Medical Microbiology: with student consult by Patrick R. Murray Ph.D. (Author), Ken S. Rosenthal PhD Saunders; 7th edition.
6. Antiviral Agents, Vaccines and Immunotherapies. Stephen K. Trying. October 2004. Marcel Dekker.

Reference Book:

1. International Congress on Taxonomy of Viruses ;http://WWW.ncbi.nlm.nih.gov/ICTV
2. Knipe David M.,PeterM.Howley, Diane E.Griffin,Rober t A.Lamb,Malcolm A. Martin,BernardRoizman, Stephen E .Straus,(2007),Field's Virology, 5th Ed. Lippincott Williams &Wilkins
3. Cann Alan j, (2000),DNA virus Replication, Oxford University press
4. https://www.yourgenome.org/facts/what-is-PCR-polymerase-chain-reaction.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

PO – Programme Outcome, CO – Course outcome S – Strong, M – Medium, L – Low (may beavoided)

Subject code	**P23BTE11C**	**SEMESTER I**	**Credits**	**L**	**T**	**P**	**Hrs**
ELECTIVE I		**BASIC ANALYTICAL METHODS**	**3**	**5**	**-**	**-**	**5**
Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply						
Learning Objective	To learn the principles of the various analytical instrument. To teach the SOP of analytical instruments. To study the different chromatography separation methodologies To study different electrophoresis isolation methodologies To learn advanced microscopic methods in image processing						
Course outcome	After studied unit 1 the students will be able to know the significance of instruments concerningdiagnostic procedures. After studied unit 2 the students will be able to handle qualitative and quantitative chromatographictechniques After studied unit 3 the students will be able to handle centrifugation and separate samples forfurther practical's/research After studied unit 4 the students will be able to handle different qualitative and quantitativeelectrophoresis techniques After studied unit 5 the students will be able to handle microscopes and validate microscopicimages.						
Units	Course Contents				Teaching hours		
Unit I	Electrochemical techniques- basic principles- The pH electrode- Ion-selective gas- sensing and oxygen electrodes. Elementary details of biosensors. Beer- Lambert law, light absorption, and its transmittance. Basic principles & brief outline of instrumentation of UV- Visible Spectroscopy: Infrared Spectroscopy. NMR. Mass spectrometry. Spectrofluorometric, Flame photometry, Atomic absorption spectrophotometry– Principles, instrumentation, and applications				10 hours		
Unit-II	Introduction & classification of chromatography. Theory, instrumentation & applications of Column chromatography, TLC, Paper chromatography, GC, HPTLC, HPLC - detection methods, and systems qualitative and quantitative aspects applications				08 hours		
Unit-III	Centrifugation- basic principles-instrumentation-centrifugation units. Nature of particles centrifugation methods and accessories. Sedimentation velocity- sedimentation equilibrium-cell fractionation method. Differential, density gradient, isopycnic, and equilibrium centrifugation. Preparative and analytical ultracentrifugation techniques. Isoelectric focusing, blotting methods, western-				13 hours		

	southern and northern- application- methods in life sciences and biotechnology.	
Unit-IV	General principles. Factors affecting the migration rate – sample, electric field, buffer, and supporting medium. Tiselius moving boundary electrophoresis. PAGE. SDS– PAGE. Pulse-field gel electrophoresis. Cellulose acetate membrane electrophoresis. Agarose gel electrophoresis	08 hours
Unit-V	Radio isotopic techniques: Introduction to radioisotopes, Detection. Measurement and uses of radioisotopes, Counting efficiency and autoradiography. Principles of microscopy, Fluorescent, Transmission and Scanning electron microscopy, confocal microscopy. Biotechnological applications Microscopy. Microtome analysis and measurement of images	05 hours
Unit-VI	Internal Assessments, Seminars, and Guest lecture	5 hours
Total Teaching hours		50

Text Book

1. Keith Wilson, John M Walker. Principles and techniques of biochemistry and molecularbiology. Cambridge University Press. 7th edition, 2017.
2. Shawney. Practical Biochemistry. Narosa Publishing, 1995.
3. Upadhyaya A Upadhyaya K and Nath. Biophysical Chemistry: Principles and Techniques, 3rdEdition. Himalayan publications, 2009.
4. Frifelder and M. Malacinski. Essentials of Molecular Biology, Jones & Bartlett, 5th Edition,2015.
5. R.D. Braun. Introduction to Instrumental Analysis. Pharma Book Syndicate, 2006.
6. Chatwal and Anand. Instrumental Methods of Analysis. 5th Edition, Himalayan publication,2007.
7. Jag Mohan. Organic Spectroscopy, Principles and Application. Narosa Publishing House, 2ndEdition, 2007.

Reference Book

1.Principles and Techniques of Practical Biochemistry (Paperback) by KeithWilson (Editor), John Walker (Editor), John M. Walker (Author) " Fifth Edition2000

2.Introductory Practical Biochemistry (Hardcover).by S. K. Sawhney; RandhirSingh (Editor)2005

3.Principles of Physical Biochemistry (2nd Edition) by Kensal E van

4.Holde,Curtis Johnson, andPui Shing Ho (Hardcover – April 16,2005)

5.Physical Biochemistry: Applications to Biochemistry and Molecular Biologyby David M.Freifelder (Paperback – Aug 15,1982) 6. Instrumental Methods of Chemical Analysis by G R Chatwal and S Kanand (Hardcover –Jun1980).	
Course Material: 1. Website links: https://www.edx.org/course/basic-analytical-chemistry, 2. E-Books: http://shvaiko.ru/wp-content/uploads/2010/02/Analytical-Techniques-Julia-C.-Drees- Alan-H.-B.-Wu.pdf tml, https://www.uvm.edu/~gpetrucc/courses/chem196/Textbooks/Manahan%20- 3. %20Fundamentals%20of%20Environmental%20Chemistry/1491Ch25.pdf,E-journals: https://onlinelibrary.wiley.com/series/8247, 4. https://link.springer.com/chapter/10.1007/978-3-642-75490-6_15,	

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	M	S	M	S	S
CO2	M	S	M	M	M	S	S	S	M	M
CO3	S	M	M	S	S	M	M	S	M	S
CO4	M	S	S	M	M	S	M	M	S	S
CO5	S	M	S	M	S	M	S	M	S	S

PO – Programme Outcome, CO – Course outcome, S – Strong, M – Medium, L – Low

Course code	P23BTT204	SEMESTER II	Credits	L	T	P	Hrs
CORE IV		IMMUNOLOGY	5	6	-	-	6

Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply	
Aim	To provide the students insights into the various aspects of immunology such as classical immunology, clinical immunology, immunotherapy and diagnostic immunology.	
Learning Objective	To Learn the basic components and principles of defense mechanism against infections To Understand the properties antigens and structure and types of Immunoglobulin To understand principle behind Antigens- Antibody reactions. To Expedite how the immune system recognizes foreign antigen and thesignificance of self/non-self-discrimination To Enrich the students' knowledge with respect to different applications of Immunotechnology	
Course outcome	After studied unit-1, the student will be able to know about basics of Immunity and various components ofImmune system After studied unit-2, the student will be able to understand about Antigens and structural properties ofImmunoglobulin After studied unit-3, the student will be able to understand principle of antigen-antibody reaction and theirtypes After studied unit-4, the student will be able to how immune cells are signaled, processed and destroyed After studied unit-5, the student will be able to know various immunological technologies.	
Units	**Course Contents**	**Teaching hours**
Unit I	Introduction to the study of Immunology: Historic perspective, Overview and Concepts, Humoral and cellular- Mediated Immunoresponses. Components of immunity, Innate and Adaptive immunity. Haematopoiesis and differentiation of immune cells. Cells and Tissues of the immune system: Cells involved in the Immune response: Macrophages, B and T lymphocytes, Dendritic cells, Natural killer and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast cells. The lymphoid organs: Thymus, Bone marrow, Spleen, lymph nodes, MALT.	12 hours

Unit-II	Antigens and Immunogenicity. Nature of Antigens and antibodies. Theories of Antibody formation. Antibody structure, structural basis of Antibody diversity; Immunoglobulin as Anitgen, Properties of immunoglobulin and subtypes. Complement and its role in Immune Responses.	12 hours
Unit-III	Antigen - Antibody Reaction, Strength of Antigen and Antibody reaction, Cross reactivity, Precipitation and Agglutination reactions, Radioimmunoassay and ELISA. B-cell generation, activation and differentiation. Antibody production, Regulation and Diversity.	12 hours
Unit-IV	Cytokines: structure of Cytokines; function of Cytokines. Complement fixation. Structure and function of MHC class I and II molecules - antigen recognition and presentation, HLA typing, Cellular Immunity. Hypersensitivity Reactions, Types of Hypersensitivity, Immune tolerance, Autoimmunity and transplantation.	12 hours
Unit-V	Hybridoma secreting monoclonal antibodies-Recombinant antibody molecules. Catalytic Antibodies. Vaccine technology including DNA vaccines. Immunological techniques for identification of infectious diseases : immune-electrophoresis, western blot, flowcytometry and immune-fluorescence microscopy including *in situ* localization techniques such as FISH and GISH.	12 hours
Unit-VI	Internal Assessment: Assignments, Seminars and Guest lecturers	5 hours
Total Teaching hours		65 hours

Textbook:

1. Parham, P. (2014). The Immune System (4th edition). W. W. Norton &Company.
2. Murphy, K., Travers, P., Walport, M., &Janeway, C. (2012). Janeway'sImmunobiology. New York: Garland Science.
3. Paul, W. E. (1993). Fundamental Immunology. New York: Raven Press. Goding, J. W. (1986). Monoclonal Antibodies: Principles and Practice
4. C.V.Rao. 2002, An Introduction to Immunology, Narosa Publishing House,Chennai.

Reference Book:

1. Immunology (7th ed) J.Kuby ,W.H freeman and company , newYork.2013
2. Basic immunology updates ed: functions and disorders of immune system (3rd ed). abulk.abbas,Andrew H.HLictman ,saunders publishers , newYork,2010
3. Immunology: an introduction (4th) I.R Tizard, saunders college publishers, newYork.
4. Essential immunology (11th ed).peterdelves,seamusmartin,dennjis burton, Ivan Roitt, Wiley –Blackwell publication, Singapore,2006
5. Immunology (Lippincotts illustrated reviews series) thaodoan, roger melvold, susanviselli, CarlWaltenbaugh, Lippincott Williams & Wilkins publications2012
6. Fundamental immunology (7th ed) William e Paul, Lippincott Williams & Wilkins publications,2012
7. Essentials of clinical immunology (6th ed) Helen chapel ,Manselhaeney, Siraj misbah, Neil snowden,Wiley-Blackwell publications,2014
8. Monoclonal antibodies principles and practice(3rd ed) W.Goodings, academic press,2010

9. Monoclonal antibodies :P methods and protocols (2nd ed) .Vincentossipo, Nicolas fisher, Humanapress,2014
10. Essentials of clinical immunology (6th ed).Helen chapel, Manselhaeney, ,Siraj misbah, Neil Snowden,Wiley- Blackwell publications,2014 J.Kuby, 2003, Immunology 5th edition, W.H. Freeman and Company, Newyork..
11. I.R.Tizard, 1995, Immunology: An Introduction, 4th edition , Saunders College Publishers, NewYork.
12. I.Roitt, 1994, Essential Immunology, Blackwell Science,Singapore.
13. Bul and K.Abbas, 1994, Cellular and Molecular immunology
14. Current Protocols in Immunology 3 Volumes, Wiley Publications1994.
15. Monoclonal Antibodies: Principles and Practice, J. W. Goding, 1983. AcademicPress
16. Hybridoma Technology in the Biosciences and medicine, T.A. Springer, 1985. Plenum Press NY

E-Reference

1. https://nptel.ac.in/courses/102/105/102105083/
2. https://www.coursera.org/specializations/immunology

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

PO – Programme Outcome, CO – Course outcome S – Strong , M – Medium, L – Low

Course code	P23BTT205	SEMESTER II	Credits	L	T	P	Hrs
CORE V		GENETIC ENGINEERING	5	6	-	-	6

Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply
Aim	To modify the genes to enhance the capabilities of the organisms beyond what is normal. Ethical controversy surrounds the possible use of both of these technologies in plants, nonhuman animals, and humans.
Learning Objective	To understand the basis of Enzyme, Ligases in Genetic Engineering Tools. To well understood the Cloning Vectors. To obtain knowledge about Gene cloning strategies and transformation techniques. To obtain the knowledge of Selection, Screening, and analysis of recombinants. To know the basic Genetic Engineering Techniques- Application of rDNA technology
Course outcome	1. After studying unit 1 the students will be able to identify the tools which are used in Genetic Engineeringand exhibit them their practical's. 2. After studying unit 2 the students will be able to differentiate methods in Cloning Vector. 3. After studying unit 3 the students will be able to describe the Techniques in Gene cloning – Physical,chemical and methods. 4. After studying unit 4 the students will be able to explain techniques amo recombine recombinants likePCR, DNA sequencing, etc 5. After studying unit 5 the students will be able to analyze and can cross-examine the Genetic Engineeringof patients who visit the Lab.

Units	Course Contents	Teaching hours
Unit I	Tools of Genetic Engineering: Enzymes - endo &exo nucleases, Restriction endonucleases- types, nomenclature, recognition sequences and mechanism of action; Isochizomers, Iso customers - star activity, Methylation, and modification. Ligases – types (NAD and ATP dependent), mechanism of action. Role of Kinases, phosphatases, polynucleotide phosphorylase, polynucleotide kinases, terminal transferase, Alkaline phosphatase, Reverse transcriptase - Taq polymerase.	12 hours
Unit-II	Cloning vectors: General characteristics of vectors, Brief account of naturally occurring plasmids. The promoter, MCS, Ori, and Marker genes-lac Z. Construction of pBR 322, pBR325, pBR327, pUC8 , pUC 18 & 19 vectors, and Expression vectors, Bacteriophage vectors, Lambda phage, Insertion vectors, Replacement vectors, Cosmids, Phagemids, Mini chromosomes, BAC‟s, YAC‟s, Shuttle vectors, Ti plasmids, Vectors for animals-SV40 and Bovine papillomavirus.	12 hours

Unit-III	Gene cloning strategies and transformation techniques: Chimeric DNA, Cloning strategies- ligation, Transformation and selection, use of adaptors and linkers, Homopolymer tailing in cDNA cloning, genomic DNA libraries, Short gun method, Partial digestion, End modification, Cloning from mRNA- Isolation and purification of RNA, Synthesis of cDNA, Isolation of plasmids, Cloning cDNA in plasmid vectors, Cloning cDNA in bacteriophage vectors. cDNA library. Advanced cloning strategies- synthesis and Cloning of cDNA, PCR amplified DNA. Transformation techniques: Preparation of competent cells, Physical methods - Electroporation, Microinjection, Gene gun, chemical methods - PEG, DEAE, $CaCl_2$, calcium phosphate precipitation method, liposome-mediated method	12 hours
Unit-IV	Selection, screening, and analysis of recombinants: Genetic selection - Insertional inactivation, Antibiotic Resistant genes, lac Z genes, Blue white screening, α - Complementation, colony hybridization, Immunological screening, Plaque hybridization, Blotting techniques, DNA sequencing - chemical and enzymatic methods, PCR and its variants, Preparation of radio labelled and non - radiolabelled probes and its applications.	12 hours
Unit-V	Applications of rDNA technology: Production of vaccines – Hepatitis B, Edible Vaccine, Hormones – Somatotropin, Humulin, Blood clotting factor VIII, Interferons, Diagnostics of inherited disorders and infectious diseases, Gene therapy, ADA- Cystic fibrosis.	12 hours
Unit-VI	Internal Assessments, Seminars, and Guest Lecture	05 hours
	Total Teaching hours	65 hours

Textbook:

1. Concepts of Genetics (Masteringgenetics) 12th Editionby William Klug (Author), Michael Cummings (Author), Charlotte Spencer (Author), Michael Palladino (Author), Darrell Killian (Author)
2. Genetics: A Conceptual Approach Sixth Edition by Benjamin A. Pierce (Author) W. H. Freeman; Sixth edition (December 19, 2016)
3. Genetics: From Genes to Genomes, 5th edition 5th Editionby Leland H. Hartwell (Author), Michael L.Goldberg (Author), Janice A. Fischer (Author), Leroy Hood (Author), Charles F. Aquadro (Author)McGraw-Hill Education; 5th edition (September 5, 2014)
4. Genetics: Analysis of Genes and Genomes: Analysis of Genes and Genomes 9th Editionby Daniel L. Hartl (Author), Bruce Cochrane (Author) Jones & Bartlett Learning; 9th edition (December 14, 2017)
5. Principles of Genetics 6th Edition by D. Peter Snustad (Author), Michael J. Simmons (Author) John Wiley and Sons; 6th edition (August 23, 2011)
6. An Introduction to Genetic Engineering 3rd Edition, author : Desmonds S.T. Nicholl, University of Paisley May 2008.
7. Gene Cloning and DNA Analysis: An Introduction 7th Edition by T. A. Brown Wiley-Blackwell; 7th edition(January 19, 2016)
8. Biotechnology: Applying the Genetic Revolution 1st Editionby David P. Clark BA (honors)Christ's College Cambridge 1973
PhD University of Brsitol (England) 1977

(Author), Nanette Pazdernik Academic Cell;1st edition (September 19, 2008)

Reference Book:

1. An Introduction to Genetic Engineering (Studies in Biology) 2nd Edition **by** Desmond S. T. Nicholl
2. Genetically Engineered Foods (Volume 6) (Handbook of Food Bioengineering, Volume 6) 1st Editionby Alexandru Mihai Grumezescu (Editor), Alina Maria Holban (Editor) 2017.
3. Genetically Engineered Foods Hardcover – January 1, 2021 by Armando Mills (Author) ED-Tech Press; 1stedition
4. Genetic Engineering: A Christian Perspective Paperback – December 27, 2019 by Michael Scaife.

E-Reference

1.Website links: https://www.genome.gov/genetics-glossary/Genetic-Engineering
2.https://www.amazon.in/s?k=genetic+engineering+book&hvadid=82669701180826&hvbmt=bp&hvdev=c&hvq mt=p&tag=msndeskstdin-21&ref=pd_sl_3hztgcyjhj_p

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	S	S	S
CO2	M	M	M	S	S	M	S	S	M	M
CO3	M	M	M	S	S	S	S	M	M	M
CO4	S	S	S	M	M	M	S	M	M	S
CO5	M	M	M	S	S	S	M	M	S	S

PO – Programme Outcome, CO – Course outcome S – Strong, M – Medium, L – Low

Subject code	**P23BTP206**	**SEMESTER II**	**Credits**	**L**	**T**	**P**	**Hrs**
PRACTICAL II		**Lab in Immunology and Genetic Engineering**	**4**	**-**	**-**	**6**	**6**
Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply						
Learning Objective	To learn the principles of the various analytical instrument. . To teach the SOP of analytical instruments. . To study the different chromatography separation methodologies . To study different electrophoresis isolation methodologies To learn advanced microscopic methods in image processing						
	Course Contents					Teaching hours	
Immunology	1. Blood grouping 2. Lymphocyte subset identification and enumeration. 3. Radial immuno-diffusiontest. 4. Ouchterlony double diffusion 5. Immuno electrophoresis 6. Rocket Immunoelectrophoresis 7. Latex Agglutination 8. Quantitative Precipitin assay 9. Complement fixation test 10. ELISA 11. WesternBlotting 12. Antigen-antibody reaction (precipitation and agglutination reactiontests).					10 hours	
Genetic Engineering	1. Isolation of genomic DNA from the given sample and its molecular weight determination					08 hours	

	2. Isolation of RNA from the given sample and its molecular weight determination 3. Isolation of plasmid DNA from the given sample 4. Restriction digestion of Lambda phage DNA 5. Ligation of DNA and analysis by electrophoresis 6. DNA amplification by PCR and RAPD 7. Preparation of competent cells and transformation by CaCl2 method and Selection oftransformed colony by X-Gal method 8. Determination of molecular weight of proteins by SDSPAGE	
Total Teaching hours		18 hours
Course Material: • Practical Immunology. Franck C.Hay, Olwyn M.R. Westwood. Wiley-Blackwellpublications,2010. • Immunoassays:A Practical Approach. James P. Gosling (editor).Oxford university press,USA,2010. • Lab manual in biochemistry, immunology and biotechnology .Arti Nigam Archana ayyagari.McGraw-Hill education, 2008. • Practical immunology. Rabindra Narain, dom& wisdompublications,2012		

	P23BTE22A	SEMESTER II	Credits	L	T	P	Hrs
ELECTIVE III		DEVELOPMENTAL AND STEM CELL BIOLOGY	3	4	-	-	4

Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply	
Aim	To understand the recent advances and its applications to modern biotechnology	
Learning Objective	To study the basics of sperm, egg cell cycle and its various stages To teach the developmental concepts of drosophila and chick To teach the concepts of stem cell, embryonic and adult stem cell To study the types of stem cell and stem cell mediated antigen role different stem cell To understand the recent advances and its applications to modern biotechnology.	
Course outcome	After studied unit-1, the student will be able to know about basic knowledge of Developmental Biology After studied unit-2, the student will be able to understand mechanism of developmental morphogenesis andorganogenesis After studied unit-3, the student will be able to understand the stem cell and its importance After studied unit-4, the student will be able to know the different types of stem cell After studied unit-5, the student will be able to know various application of stem cell in medicine.	
Units	**Course Contents**	**Teaching hours**
Unit I	Introduction to Developmental Biology: Cells and morphogens gradients. Ultrastructure of sperm, egg, pollen and ovule. Production of gametes in animal and plant (Spermatogenesis, Oogenesis). Cell surface molecules in sperm - egg recognition in animals; zygote formation, cleavage, blastula formation, gastrulation and formation of germ layers in animals.	12 hours
Unit-II	Developmental Concepts: Morphogenesis and organogenesis in animals (Drosophila and Chick). Cell fate and cell lineages; genomic equivalence and the cytoplasmic determinants; imprinting. Role of in development. Cellular differentiation and Differential activation. Role of cell death in development. Terato genesis - Ageing, transgenic.	12 hours
Unit-III	Introduction to stem cell biology: Introduction to concepts in stem cell biology (renewal and potency)introduction to stem cells, Germ line stem cells and germ line derived pluripotent cell, Epigenetics, nuclear transfer and cloning, introduction to cell, tissues and organ. Introduction to embryonic and adult stem cell.	12 hours

Unit-IV	Basic and Types of Stem cell: Stem cell basic: Reprogramming and induced pluripotent cells (iPS cells), chromatin and stem cells, telomeres and stem cells, stem cell differentiation and characterization : CD antigens and its role in stem cell differentiation. Neuronal stem cell, mesenchymal stem cell,cardiac stem cells, hematopoietic stem cells	12 hours
Unit-V	Technique and Application Techniques used for stem cell isolation, enumeration and *in vivo* expansion, techniques used for stem cell characterization. Therapeutic applications of stem cell: fundamentals of regenerative medicine, autologous and allogenic stem cell transplantation, HLA typing, Stem cell banking – cryopreservation techniques, national and international guideline, recent advances in stem cell biology.	12 hours
Unit-VI	Internal Assessments, Seminars, and Guest Lecture	05 hours
	Total Teaching hours	65 hours

Textbook:

1. Essentials of stem cell biology 2009, (second ed)Robert Lanza, John Gearhart , Brigid Hogan, Douglass Melton, roger Pedersen, E. Donnall Thomas, James Thomson and sir Ian Wilmutt.
2. Ann a. Kiessling, human embryonic stem cells: an introduction to the science and therapeuticpotential, Jones andbartett,2003
3. Peter J ,Quesenberry, stem cell biology and gene therapy, 1st ed, willyless,1998
4. Developmental biology, (2018), 11th edition by Michael J. F. Barresi, Scott F. Gilbert.

Reference Book:

1. Human Embryology & Developmental Biology (2019), 6th edition by Bruce M. Carlson
2. Principles of Development (2019), 6th edition by Cheryll Tickle; Lewis Wolpert; AlfonsoMartinez Arias.
3. Freshney RI. 2016. Culture of animal cells: A manual of basic technique and SpecializedApplications. 7th Edn. Wiley- Blackwell.. United States of America.
4. Singh, B., Mal, G., Gautam, S.K., Mukesh, M.2019 Advances in animal biotechnology 1stEdnSpringer International Publishing. Switzerland

E-Reference

1. https://www.youtube.com/watch?v=dXknfffXeDM
   https://courseware.cutm.ac.in/courses/biochemistry-and-enzyme-technology/
2. https://freevideolectures.com/course/85/enzyme-science-and-engineering
3. E-Journals: Reproductive Biology, Stem cell biology, Fertility and Sterility, Urology

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S		S

PO – Programme Outcome, CO – Course outcome, S – Strong , M – Medium, L – Low

Course code	P23BTE22B	SEMESTER II	Credits	L	T	P	Hrs
ELECTIVE III		ENZYME TECHNOLOGY	3	4	-	-	4
Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply						
Aim	To provide knowledge of various enzymes and enzyme technology applied in the industries						
Learning Objective	To Learn about the classification and structure properties of enzymes To Understand the kinetics, catalysis and inhibitions activities of enzymes To understand physical properties, downstream process and purification of enzymes. To Expedite how enzymes are used as co-factors. To Enrich the students' knowledge with respect to different applications of Enzymes						
Course outcome	After studied unit-1, the student will be able to know about basic knowledge of enzymes After studied unit-2, the student will be able to understand mechanism of enzyme activities After studied unit-3, the student will be able to understand physical properties of enzyme. After studied unit-4, the student will be able to function of enzyme in different processes. After studied unit-5, the student will be able to know various application of enzyme technologies.						
Units	**Course Contents**						**Teaching hours**
Unit I	Introduction to enzymes: History of enzymes, nomenclature and classification of enzymes. Structural features of Enzymes: Chemical nature of Enzymes: amino acids, protein structure: Primary, secondary, tertiary and quartenery structure. Specificity of Enzymes: Types of specificity, the koshland "induced fit" hypothesis, strain or transition-state stabilization hypothesis.						10 hours
Unit-II	Enzyme Catalysis and Kinetics: Factors affecting the rate of chemical reactions, kinetics of un catalyzed chemical reactions, kinetics of enzymes catalyzed reaction, methods for investigating the kinetics of enzyme-catalyzed reaction, nature of enzyme catalysis, inhibition of enzyme activity.						8 hours
Unit-III	Extraction and purification of microbial enzymes: Importance of enzyme purification, different sources of enzymes. Extracellular an intracellular enzymes. Physical and Chemical methods used for cell disintegration. Enzyme fractionation by precipitation (using Temperature,salt, solvent pH, etc.),liquid-liquid extraction, ionic exchange, gel chromatography, affinity chromatography and other special purification methods, Enzyme						12 hours

	crystallization techniques. Criteria of purity of enzymes. Pitfalls in working with pure enzymes.	
Unit-IV	Enzymes inhibition and Co-factors: Irreversible, reversible, competitive, non-competitive and un-competitive inhibition with suitable examples and their kinetic studies. Allosteric inhibition, types of allosteric inhibition and their significance in metabolic regulation & their kinetic study Vitamins and their co-enzymes: Structure and functions with suitable examples ,Metallo enzymes and Metal ions as co-factors and enzymes activators.	9 hours
Unit-V	Immobilization of microbial enzymes and Enzyme Engineering: Methods viz. adsorption, covalent bonding, entrapment& membrane confinement and their analytical, therapeutic & industrial applications. Applications of microbial enzymes: Microbial enzymes in textile, leather, wood industries and detergents. Enzymes in clinical diagnostics. Enzyme sensors for clinical processes and environmental analyses. Enzymes as therapeutic agents.	9 hours
Unit-VI	Internal Assessment: Assignments, Seminars and Guest lecturers	5 hours
Total Teaching hours		53 hours

Textbook:

1. Introduction to proteins Structure by Branden and Tooze (1998): Garland Publishing Group.
2. Biotechnology . Volume 7 A- Enzymes in Biotechnology. 1983 Edited by H.J.Rehm and G.Reed. VerlagChemie.
3. Methods of Enzymatic analysis by Hans Ulrich, Bergmeyer, Academic Press.
4. Methods in Enzymology by W.A.Wood, AcdemicPress.
5. Topics in Enzyme and Fermentation Biotechnology by L.N. Wiseman ,John Wileyand sons.

Reference Book:

1. Enzymes by Palmer(2001): Horwood publishing series.
2. Fundamentals of Enzymology by price and Stevens (2002): Oxford University Press.
3. Enzyme Technology by Helmut Uling (1998): JohnWiley.
4. Methods in Enzymology. Volume 22-Enzyme purification and related techniques. Edited by William B.Jakoby. Academic press, NewYork.
5. Allosteric Enzymes-Kinetic Behaviour. 1982. By B.I .Kurganov ,John Wiley and Sons. Inc., NewYork.
6. Enzymes as Drugs Edited by John S. Holcenberg and Joseph Roberts, John Wiley& sons NewYork.
7. Advances in Enzmology by Alton Meister, Interscience Publishers.

Mapping with Programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome S – Strong, M – Medium, L – Low

Course code	P23BTS201	SEMESTER II	Credits	L	T	P	Hrs
SKILL ENHANCEMENT COURSE		PHARMACEUTICAL TECHNOLOGY	2	4	-	-	4
Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply						
Aim	To impart knowledge on the importance of drug during life span. To enlighten on the biotechnological modifications in drugs. To find mechanism of action of drugs used in therapy.						
Learning Objective	To learn drugs and its involved detoxification through phase 1 & 2 reactions2 To teach drug mechanism like passive and active phases To learn the drugs manufacture biotechnological pharmaceutical industry To understand the importance of drugs in treating various metabolic disorders5 To teach various applications of drugs in various fields.						
Course outcome	After studied unit-1, the student will be able to know about basic knowledge of drugs of phase I & II After studied unit-2, the student will be able to understand drug mechanism and its adverse effects. After studied unit-3, the student will be able to understand biotechnology in drug development, especiallyfor AIDS After studied unit-4, the student will be able to know drugs and its importance various treatment likediabetes, cancer, lipidemia and infertility After studied unit-5, the student will be able to know various application of drug dependence and abuse-management						
Units	**Course Contents**						**Teaching hours**
Unit I	Drug- structural feature and pharmacology activity, pro drug concept. Absorption – first – pass effect .distributor , metabolism- phase I, II reactions, action of cyto chrome p450 & elimination of drug receptor-localization, type and subtypes, models and their drug- receptor interaction, against & antagonist .						10 hours
Unit-II	Adverse response to drugs, drug tolerance, drug intolerance, Idio SYNERACY (pharmacogenesis), drug allergy. Tachyphylaxis, drug abuse, vaccination against infection						08 hours

Unit-III	Biotechnology and pharmacy: genetically engineered protein and peptide agents. novel drug delivery systems – non conventional routes of administration. Anti AIDS drug development, oncogenes target for drugs, multi- drugs resistance.	13 hours
Unit-IV	Mechanism of action of drugs used in therapy of :respiratory system-cough, bronchial- asthma, pulmonary tuberculosis .GIT– digestents , appetite suppressants. hypolipidemia agents,, vomiting, constipation and peptic ulcer. antimicrobial drugs- sulfonamide s,trimethoprim, cotrimoxazole, penicillin and macrolides . amino glycosides, cephalosporin and bacterial resistance .Insulin and oral diabetic drugs, anti fertility and ovulation inducing drugs.	08 hours
Unit-V	Drugs of plant origin: drug dependence and abuse- management of self poisoning cancer. Chemotherapy- cytotoxic drug. immuno suppressive drug therapy. New biological targets for drug development. Novel drug screening strategies.	08 hours
Total Teaching hours		50 hrs

Textbook:

1. The pharmacology Vol I and Vol II– Goodman and Gillman, Mc GrawHillprofessional;12 ed (2010)
2. Basic pharmacology – Foxter cox bulter worth‟s1980.
3. Pharmacology and pharmaco therapeutics – R.S.Satoskar. S.D.Bhandhhakar&S.S.Anilapure popular PrakasharBombay.

Reference Book:

1. Principles of medical chemistry – William O. Foge. B.I. Waverks Pvt Ltd, New Delhi.
2. Oxford text books of clinical pharmacology and drug therapy.D.G.Burges Medical chemistry & drug discovery.
3. Principles and practice – Manfred. E. Wolf John Wiley and sons.

Mapping with Programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome S – Strong, M – Medium, L – Low

Course code	P23BTT307	SEMESTER III	Credits	L	T	P	Hrs
CORE PAPER-7		PLANT BIOTECHNOLOGY	5	6	-	-	6

Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply	
Aim	This paper has been designed to give the students comprehensive knowledge about the applications of plant Molecular biotechnology for increasing agricultural production, environment improvement, human, nutrition and health. Help students to get a career in both industry/R & D	
Learning Objective	To Understand the role of plants nuclear, chloroplast and mitochondrial genomes and Equip students withknowledge on molecular markers and marker-aided breeding To Understanding the mechanism of gene transfer in plant and various methods of gene transfer To understand various Components of plant genetic engineering To Expedite the students to understand the techniques involved in plant tissue culture To Enrich the students' knowledge with respect to different applications of transgenic technology	
Course outcome	Unit-1, Able to know about genomic organization in plants and about theMarkers Unit-2, able to know methods of gene transfer in plan Unit-3, able to understand the plant genetic engineering aspect Unit-4, able to know plant cell and tissue culture techniques Unit-5, able to understand Applications of plant Biotechnology in variousfields.	
Units	**Course Contents**	**Teaching hours**
Unit I	**Genome organization in Plants** Nucleus, Chloroplast and Mitochondria, Molecular Marker-aided Breeding: RFLP maps, linkage analysis, RAPD markers, STS, Microsatellites, SCAR (Sequence Characterized Amplified Regions), SSCP (Single Strand Conformational Polymorphism), AFLP, QTL, map based cloning, molecular marker assisted Selection.	12 hours
Unit-II	**Methods of gene transfer in plants** Structure and function of Ti plasmid of Agrobacterium, Mechanism of T-DNA transfer to plants. Ti plasmid vectors for plant transformation. Transient and stable gene transformation. Physical method of gene transfer, Particle bombardment, electroporation,microinjection, chemical mediated transformation and floral dip method.	12 hours

Unit-III	**Plant Genetic Engineering :** Plant vectors: Co-integrate, binary vectors and viral vectors. Designing gene constructs - Promoters and polyA signals, Protein targeting signals, Plant selectable markers, Reporter genes. Positive selection, Selectable marker elimination, Transgene silencing. Transplastomics: Chloroplast transformation: advantages. Strategies for marker free transformation. Analysis of transgenic plants. Genome editing technology in Plant-CRISPR/Cas.	12 hours
Unit-IV	**Plant Cell and Tissue Culture:** Tissue culture media (composition and preparation), Callus and suspension culture; Somaclonal variation; Micropropagation; Organogenesis; Somatic embryogenesis. Embryo culture and embryo rescue. Artificial seeds. Protoplast fusion and somatic hybridization; cybrids; anther, pollen and ovary culture for production of haploid plants. Cryopreservation and DNA banking for germplasm conservation.	12 hours
Unit-V	Application of transgenesis for : crop improvement: Insect resistance, disease resistance, virus resistance, herbicide resistance, and resistance to biotic & abiotic stress. Transgenesis for male sterility and terminator seed. Transgenesis for quality improvement: Protein, lipids, carbohydrates, vitamins & mineral nutrients. Molecular pharming: Exploitation of Biotechnological techniques for plant therapeutic compounds - production of recombinant proteins in plants. Expression of antibodies in plants for immunotherapy. Expression of recombinant antibody fragments in plants.	12 hours
Total Teaching hours		50 hrs

Textbook:

1. **1**.PlantBiotechnology: The genetic manipulation of plants. Secondedition Slater, Scott,and Fowler, 2008, Oxford University Press, UK.
2. Plantcell culture.Apractical approach. Secondedition.Edited byR.A. Dixon and R.A. Gonzales.1994. Oxford University Press. UK.
3. An Introduction to Plant Tissue Culture,Third Edition,M.K. Razdan, Oxford an IBH Publishing Co., 2003.
4. Introductionto plant biotechnology,Third edition, HSChawla, 2009. Cassells, A. C and Peter B. Gahan. (2006).
5. Dictionary of Plant Tissue Culture.Food Products Press, an Imprint of the Haworth Press, Inc., New York-London-Oxford.
6. Adrian Slater, Nigel Scott and Mark Fowler. (2008). Plant Biotechnology – the Genetic Manipulation of Plants. SecondEdition.OxfordUniversity Press. Paul Christou and Harry Klee. (2004).
7. Handbook ofPlant Biotechnology,2ndvolumE set, Wiley publisher.
8. Bhojwani and Dantu, (2013). Plant Tissue Culture: an Introductory Text, Springer, New Delhi.
9. Bhojwani, S.S and Razdan. M.K. (2009). Plant Tissue Culture-Theory and Practice. Elsevier India Pvt. Ltd.

Reference Book:

1. Slater A, NW Scott, MR Fowler. Plant bio technology, Oxford University Press,2003.
2. Hans Walter Heldt. Plant Biotechnology & Molecular Biology, Oxford University Press, 1997.
3. Nigel W. Scott, Mark R. Fowler,Adrian Slater. Plant Biotechnology: The genetic manipulation ofplants 2nd Edition 2nd Edition, Oxford University Press,2008.
4. J. Hammond, P. McGarvey,V. Yusibov. Plant Biotechnology: New Products and Applications 1sted. Springer1999.
5. Bob Buchanan,Wilhelm Gruissem, Russell Jones. Biochemistry & Molecular Biology of Plants.
   I.k. International Pvt. Ltd,2007.
6. Robert J. Henry. Practical Applications of Plant Molecular Biology. Routledge Chapman & Hall,1997.
7. Introduction to Plant Biotechnology by H.S. Chawla, 2002. Oxford and IBH P Publishing Co.Pvt.Ltd. NewDelhi.
8. Plant molecular genetics by Monica. A. Hughes.1999. Pearson Education limited, England.
   An introduction to genetic engineering in plants, Mantel S.H, Mathews J.A. Mickee R.A.1985. Blackwell Scientific Publishers.London.
. Principles of medical chemistry – William O. Foge. B.I. Waverks Pvt Ltd, NewDelhi.
. Oxford text books of clinical pharmacology and drug therapy.D.G.Burger‟s Medicalchemistry & drugdiscovery.
. Principles and practice – Manfred. E. Wolf John Wiley andsons.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S		S

PO – Programme Outcome, CO – Course outcome, S – Strong, M – Medium, L – Low

Course code	P23BTT308	SEMESTER III	Credits	L	T	P	Hrs
CORE PAPER-8		ANIMAL BIOTECHNOLOGY	5	6	-	-	6

Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply	
Aim	To provide an overview and current developments in different areas of animal Biotechnologyand its application	
Learning Objective	To provide the basic knowledge on cloning methods, animal tissue culture techniques and applications of geneticengineering to the students. To obtain the knowledge of research related Various laboratory animals To know the advanced methods in animal handling according to CPCSEA guidelines To provide an overview and current developments in different areas of animal Biotechnology and its application. To obtain knowledge on difference between in vivo & in vitro for uses of animal modelling	
Course outcome	unit-1 -able to know about the genetic engineering tools, vectors, methodsof gene cloning. unit-2-able to know techniques and application of animal in rDNAtechnology unit-3- able to understand about the animal tissue culture unit-4-able to know how to conduct research in breeding, physiology, production, yield and management of crops and agricultural plants or trees, shrubs, and nursery stock, theirgrowth in soils, and control of pest unit-5- able to understand applications of animal	
Units	**Course Contents**	**Teaching hours**
Unit -I	Introduction to animal tissue culture. Mammalian cell culture, Tissues, Continuous cell lines, Suspension cultures, Cryopreservation and transport of Animal germplasm, (Embryo, Semen and ovum).	12 hours
Unit-II	Cell cultures media and Growth parameters of animal cell culture, Role of serum and essential supplements to medium and their applications. Cell Synchronization, Cell cloning Methods and Micromanipulation.	12 hours
Unit – III	Gene transfer in animal cells. Animal Germ cell and development, Valuable genes for Animal biotechnology, Transgenic Animals and Hybridization, and gene knockout, Somatic cell cloning Production of transgenic animals – mice, sheep and fish.	12 hours
Unit – IV	Testing of drugs, testing the toxicity of environmental pollutants in cell culture, Cytotoxicity, Apoptosis, Tissue, Diagnostic antigens	12 hours

Unit-V	Potential applications of transgenic animals – Animal models for diseases and disorders. Transgenic poultry, transgenic insects as bioreactor. Commercial scale production of animal cells, application of animal cell culture for in vitro, cultures technology in production of pharmaceutical proteins, and animal viral vaccines.	12 hours
Total Teaching hours		50 hrs

Textbook:

1.Culture of Animal cells, 2006, 3rd Edition, R. Ian Freshney . A John Wiley &Sons, Inc., publications.

2. Animal Cell Culture – Practical Approach, R.W. Masters, Oxford. AnimalCell Culture Techniques. Ed. MartinClynes, Springer.

Biotechnology by Kashav. T (Wiley EasternLtd).

3.Animal Cell Biotechnology; Methods and protocols, Nigel Jenkins, HumanaPress.

Biotechnology of Animal Tissue. P.R. Yadav & Rajiv Tyagi, 2006. Discovery 54 publishing House. New Delhi.

4.From Genes to Clones Introduction to Gene Technology – Winnacker, E.L.1987., Panima Educational BookAgency, New Delhi.

Gene VII – Benjamin Lewin, 2000. Oxford University Press, UK.

5.Principles of Gene Manipulation and Genomics – Primrose, S.B. and Twyman, R.M. 2006. 7th Edition. BlackwellPublishingCompany.

6.Recombinant DNA Second Edition – James D. Watson, Micheal Gilman, MarkZoller, 2001. W.H. Freeman andCompany, NewYork.

Biotechnology, Satyanarayanan .U, (2008), Books and Allied (p)Ltd.

Reference Book:

1. CPCSEA Guidelines for Laboratory Animal Facility, CPCSEA, 2003.
2. Kumar, H.D. Modern Concept of Biotechnology. Vikas Publishing House Pvt. Ltd., 2007
3. Animal Biotechnology: Models in Discovery and Translation, Second Edition (Elsevier)

Course Material:

Website links: https://www.sciencedirect.com/book/9780128117101/animal-biotechnology#book-description,E-Books: https://www.pdfdrive.com/animal-biotechnology-e41305678.html,
E- journals: https://www.tandfonline.com/toc/labt20/current,

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Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S		S

PO – Programme Outcome, CO – Course outcome, S – Strong, M – Medium, L – Low

Course code	P23BTT309	SEMESTER III	Credits	L	T	P	Hrs
CORE PAPER-9		MICROBIAL BIOTECHNOLOGY	5	6	-	-	6

Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply
Aim	The study of microbes helps us to understand our world and our place within it. It gives us insights into the complexity of nature and society, which in turn provide much different health, environmental, social, cultural, industrial, and economic benefits.
Learning Objective	To provide the basic knowledge on cloning methods, animal tissue culture techniques and applications of geneticengineering to the students. To obtain the knowledge of research related Various laboratory animals To know the advanced methods in animal handling according to CPCSEA guidelines To provide an overview and current developments in different areas of animal Biotechnology and its application. To obtain knowledge on difference between in vivo & in vitro for uses of animal modelling
Course outcome	unit-1 -able to identify the nature of bioprocess engineering technology unit-2-able to differentiate the fermentation technology and typthe es of the fermentation process unit-3- able to describe the downstream processing in cell disruption, precipitationmethods, etc. unit-4-able to explain the advantage of industrial application unit-5- able to analyze and can cross-examine the Production of industrial importance.

Units	Course Contents	Teaching hours
Unit-I	Scope and importance of bioprocess engineering technology, Development and strain improvement of industrially important microorganisms. Bioreactors: Typical structure of advanced bioreactor and their working mechanism; Design features - Heat transfer and Mass transfer; Specialized bioreactors- design and their functions; Airlift bioreactor, Tubular bioreactors, Membrane bioreactors, Tower bioreactors, Fluidized bed reactor, Packed bed reactors and Photo bioreactors.	12 hours
Unit-II	Fermentation technology: Natural and synthetic media; Strategies for media formulation, sources of carbon, nitrogen, vitamins, and minerals. Role of buffers, precursors, inhibitors, inducers, and antifoam agents. Types of fermentation process-submerged fermentation, the surface solid-state fermentation, batchfermentation, continuous fermentation, the	12 hours

	kinetics of fermentation process, bioprocess control, monitoring variables temperature, agitation, pH, and pressure.	
Unit-III	Downstream processing: cell disruption, precipitation methods, solid-liquid separation, liquid-liquid extraction, filtration, centrifugation, chromatography, drying devices (Lyophilization and spray dry technology), crystallization-biosensors-construction and applications	12 hours
Unit-IV	Immobilization and Biotransformation: Methods of immobilization - adsorption, crosslinking, ionic bonding, entrapment, encapsulation; Advantages and industrial applications of Immobilization of enzymes and whole cells. Biotransformation of antibiotics, steroids, and their applications.	12 hours
Unit-V	Production of Industrially important products: Alcohol- Ethanol, glycerol, butanol, Acetone; Organic acids- citric, acetic, and gluconic acid; Amino acids- lysine, glutamic acid; Antibiotics- penicillin, streptomycin, tetracycline; Vitamins- riboflavin; Enzymes- amylase, protease; biodegradable plastic- poly hydroxy alkanoates (butyrate, propionate).	12 hours
Total Teaching hours		50 hrs

Textbook:

1.Microbial Biotechnology: Principles And Applications (2nd Edition) by Yuan Kun Lee, August 24, 2006.

2.Microbial Biotechnology: Principles And Applications (Third Edition): Principles and Applications (3rdEdition) Paperback – Import, 15 April 2013 by Yuan Kun Lee (Editor)

3.Microbial Biotechnology: Principles And Applications (3rd Edition) 3rd Edition, Kindle Edition by Yuan KunLee (Editor) Format: Kindle Edition World Scientific; 3rd edition (30 January 2013)

3. Microbial biotechnology: principles and applications, Yuan Kun Lee. Edition 3rd ed. Imprint Singapore ;Hackensack, NJ : World Scientific, c2013.
4. Microbial Biotechnology, Principles and Applications, Yuan Kun Lee, Publisher- World Scientific PublishingCompany 2013.
5. Microbial Biotechnology ,Elsa Cooper, Syrawood Publishing House, 2016 M05 24 - 216 pages

7.Microb Biotechnol. 2016 Sep; 9(5): 529. Published online 2016 Aug 11. doi: 10.1111/1751 7915.12403

8.Microbial Biotechnology-2020 Kenneth Timmis, Juan Luis Ramos, Willem de Vos, Siegfried Vlaeminck, AuxiPrieto, Antoine Danchin, Willy Verstraete, and Victor de Lorenzo

9.Microbial Biotechnology: Methods and Applications by Elsa Cooper 06/11/2019 Publisher: ML Books International.

10.Microbial Biotechnology Hardcover – 23 March 2006 by A. R. Alagawadi (Editor), P.U. Krishnaraj (Editor), K. S. Jagadeesh (Editor), J.H. Kulkarni (Editor), & 1 More

Reference Book:

1. Basic Biotechnology 2nd Edition by Colin Ratledge (Editor), Bjorn Kristiansen (Editor) Cambridge University Press; 2nd edition (April 30, 2001)

2. Manual of Industrial Microbiology and Biotechnology 3rd Edition by Richard H. Baltz (Editor), Arnold L. Demain (Editor), Julian E. Davies (Editor) ASM Press; 3rd edition (March 25, 2010)

3. Microbial Biotechnology: Fundamentals of Applied Microbiology 2nd Edition by Glazer, Alexander N.; Nikaido, Hiroshi published by Cambridge University Press Hardcover Paperback – January 1, 1994 by aa (Author) Cambridge University Press; 13338th edition (January 1, 1994)

4. New and Future Developments in Microbial Biotechnology and Bioengineering: Trends of Microbial Biotechnology for Sustainable Agriculture and Biomedicine Systems: Perspectives for Human Health 1st Edition, Kindle Edition Elsevier; 1st edition (May 15, 2020)

5. Microbial Biotechnology: Principles And Applications (3rd Edition) 3rd Edition, Kindle Edition by Yuan Kun Lee (Editor) Format: Kindle Edition World Scientific; 3rd edition (January 30, 2013)

6. Microbial Biotechnology: Basic Research and Applications (Environmental and Microbial Biotechnology Book1) 1st ed. 2020 Edition, Kindle Edition Springer; 1st ed. 2020 edition (July 7, 2020)

7. Microbial Biotechnology by Elsa Cooper (Editor) Syrawood Publishing House (June 20, 2019)

8. Microbial Biotechnology Principles and Applications Third Edition https://doi.org/10.1142/8265 | April 2013

9. 2017 Microbial Biotechnology Volume 1. Applications in Agriculture and Environment

10. Microbial Biotechnology, Fundamentals of Applied Microbiology, 2nd Edition TEXTBOOK: AUTHORS: Alexander N. Glazer, University of California, Berkeley Hiroshi Nikaido, University of California, BerkeleyDATE PUBLISHED: October 2007

Course Material:

Website links: https://www.nifa.usda.gov/microbial-biotechnology

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	M	S	M	S	S
CO2	M	S	M	M	M	S	S	S	M	M
CO3	S	M	M	S	S	M	M	S	M	S
CO4	M	S	S	M	M	S	M	M	S	S
CO5	S	M	S	M	S	M	S	M	S	S

PO – Programme Outcome, CO – Course outcome, S – Strong, M – Medium, L – Low

Course code	P23BTP310	SEMESTER III	Credits	L	T	P	Hrs
CORE PRACTICAL -III		LAB IN PLANT, ANIMAL, MICROBIAL AND ENVIRONMENTAL BIOTECHNOLOGY	4	-	-	6	6

Units	Course Contents	Teaching hours
Plant Biotechnology	1. Introduction to plant tissue culture-induction of callus and suspension cultures. 2. Isolation and purify the protoplasts and check its viability. 3. Induction of somatic embryogenesis and analysis of different stages. 4. Extract the genomic DNA from plants by CTAB 5. Culture and selection of Agobacterium on Agar medium 6. Agrobacterium mediated gene transformation 7. Use of Agro infilteration for Transient Expression in Plant 8. Gus assay 9. Analysis of WT/ Transgenic plant by PCR 10. Isolation of Total RNA f 11. rom leavesGene gun method of transformation 12. Synthetic seed preparation	10 hours
Animal Biotechnology	1. Development of primary cell lines/maintenance of established cell lines. 2. Cell counting and cell viability. 3. Trypsinization of monolayer and subculturing. 4. Gene transfer by transfection 5. Preparation of metaphase chromosomes from cultured cells. 6. Isolation of DNA and demonstration of apoptosis of DNA laddering 7. MTT assay for cell viability and growth	08 hours
Microbial Technology	1.Study of fermentor-Demonstration. 2.Production and isolation of antibiotics (Penicillin and Streptomycin) 3.Production and analysis of Single cell protein (Spirullina and yeast) 4.Production of yoghurt and estimation of lacticacid. 5.Estimation of percentage of alcohol of given sample 6.Production and assay of α-amylase from Aspergillus niger by solid substrate fermentation. 7.Immobilization of given enzyme/wholecells 8.Estimation of amount of citric acid in the given sample.	13 hours

	Total hours	31hrs

Reference

1. Practical Applications of Plant Molecular Biology. Robert J. Henry .Routledge Chapman & Hall,2008.
2. Molecular Plant Biology: A practical approach (Vol. I and II). Gilmartin andBowler. Oxford Universitypress, UK,2002.
3. Plant Cell Culture: Essential Methods. Michael R. Davey, Paul Anthony.Wiley, 2010.
4. Plant Tissue Culture, Third Edition:Techniques andExperiments . Roberta H. Smith. AcademicPress,2012.
5. Plant cell culture Protocols (Methods in Molecular Biology, 3rd Ed). Victor M. Loyola-Vargas, NeftaliOchoa-Alejo. Humana Press,2012.
6. Plant Cell, Tissue and Organ Culture: Fudamental Methods (Springer Lab Manuals). Oluf L. Gamborg(Editor), Gregory Phillips (Editor), Springer,2013.

Mapping with Program me Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	M	M	S	S	S
CO2	M	M	M	S	S	M	S	S	M	M
CO3	S	M	M	S	S	S	S	M	M	M
CO4	S	S	S	M	S	M	S	S	S	S
CO5	M	M	S	S	M	S	M	S	S	S

PO – Programme Outcome, CO – Course outcome, S – Strong, M – Medium, L – Low

Course code	P23BTE33A	SEMESTER III	Credits	L	T	P	Hrs
ELECTIVE-V		GENOMICS AND PROTEOMICS	3	3	-	-	3

Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply
Aim	To enable us to explore many different components of living systems and the advent of proteomics will made itpossible to identify a broad spectrum of proteins in living systems. This elective subject will help to understand basic principles and applications in genomics and proteomics.
Learning Objective	To provide the basic knowledge of gene characteristic feature and mapping concepts To understand about the sequencing technologies To provide the basic concept for protein analysis To understand about protein sequencing To Enrich the students' knowledge with respect to metagenomic and applications
Course outcome	unit-1, able to know about genes functional properties. unit-2, able to understand how gene sequencing are done unit-3, able to understand Protein analysis. unit-4, able to protein sequencing methods. unit-5, able to know about metagenomics and its application .

Units	**Course Contents**	**Teaching hours**
UNIT I	Organization of genes across living systems, interrupted genes, overlapping genes, alternative genes , (RNA editing and RNA Splicing) etc. identification and characterization of insert DNAfragments, gene content and C value paradox – gene cluster andgene families .restriction mapping, chromosome walking and chromosomal localization of genes. RFLP and other uses of cloned sequences,cloning of microbial genes.	10 hours
UNIT-II	Methods of preparing genomic DNA, DNA sequence analysis methods, Sanger Di deoxy method, next generation sequencing, SNP – single nucleotide polymorphism, expressed sequenced Tags(ESTs),Gene disease association, site directed mutagenesis andmolecular chimeras , gungal genome and genomics.PCR based Analysis, DNA Fingerprinting.	08 hours
UNIT – III	Scope of proteomics, protein separation techniques – ion exchange chromatography, size – exclusion and affinity chromatography techniques, size – exclusion and affinity chromatography techniques , protein analysis (includes measurement of concentration , aminoacid composition, N-terminal sequencing); SDS-PAGE , two dimensional gel electrophoresis and image analysis.	13 hours

UNIT – IV	Introduction to mass spectrometry; strategies for protein identification ; protein sequencing ; protein modifications and proteomics ; applications of proteome analysis to drug; protein – protein interaction (Two hybrid interaction screening), analysis andsequencing individual spots by mass spectrometry (Maldi toff) and protein microarrays .	08 hours
UNIT-V	Meta genomics – construction, vector design and screening o f meta genomic libraries- biotechnological applications of meta genomics.	08 hours
	Total Hours	47 hours

Books

1.Introducing proteomics (2011) Josip lovric. John Wiley Publication
2.Principles of proteomics (2013). R. M Twyman. Taylor and Francis publishers

Reference Book

Expression Genetics: accelerated and High Throughput Methods (1999). Edited by M. McClelland and
A. Pardee, Eaton Publishing, MA.
Microbial Functional Genomics (2004). J. Zhou, D.K. Thomson, Y. Xu and J.M. Tiedje, Wiley Liss.
3. Reviews and articles from Journals such as Nature, Science, PNAS (USA), Nucleic Acids Research, Trends andCurrent Opinion Series.
4. Principles of Gene Manipulation and Genomics (2013) Sandy B. Primrose, Richard Twyman – BlackwellPublishing.
An Introduction to Genetic Engineering 3rd Edition DesmondS. T. Nicholl Cambridge University Press
6. Molecular Biotechnology: Principles and Applications of Recombinant DNA 4th Edition Bernard R. Glick, Jack J.Pasternak, Cheryl L. Patten ASM Press
Post-translational modifications in host cells during bacterial infection, D. Ribert, P. Cossart, FEBS letters, 2010.
7.Proteomics in practice: a laboratory manual of proteome analysis (2002).Westermeier, R., & Naven, T. John Wiley& Sons, Inc.
8.Proteomics for biological discovery. Veenstra, (2006). Timothy D. and John R. Yates John Wiley &
9.Plant proteomics: methods and protocols. (2007). Thiellement, H., Zivy, M., Damerval, C. and Méchin, V. eds. Totowa (NJ): Humana Press.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome S – Strong, M – Medium, L – Low

Course code	P23BTE33B	SEMESTER III	Credits	L	T	P	Hrs
ELECTIVE –V		FOOD AND NUTRITION	3	3	-	-	3

Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply
Aim	To enable students to gain a deeper understanding about principles of nutrition and also to develop competence to carry out investigation in nutrition
Learning Objective	To enable the students to learn the basic concepts of nutrition and different categories offoods. To enable the students to gain knowledge of different nutrient contents and their importance. To make them learn the basics of nutritive and calorific value. To enable the students to know food adulterants and food poisoning, disadvantages & health problems. To enable the students learn the food spoilage and preservation methods
Course outcome	The student will be able to differentiate the foods types and their nutritive value. The student will be able to develop competence to carry out investigation in nutrition The student will be able to measure and calculate calorific value of different types of foods The student will be able to identify the food adulterants and food poisoning The student will be able to practice food sterilization, preservation and processing.

Units	Course Contents	Teaching hours
UNIT I	Definition and basis of food and nutrition, Different Food groups and classification, Nutritional significance and physiological role of food groups, Protein Energy Malnutrition (PEM), definition and types, Treatment and preventive measures of PEM.	10 hours
UNIT-II	Introduction to Vitamins., Fat soluble vitamins, Water solublevitamins	08 hours
UNIT – III	Introduction to calorific value and nutritive value, Bomb calorimeter, Measurement of calorific value and nutritive of foods, RQ value, BMR and SDA of food stuffs, their measurements and influencing factors, Nutritive value of proteins and amino acids, Balanced diet, composition of balanced diet for pregnant woman, infants, old age.	13 hours
UNIT – IV	Definitions of food adulterations and food poisoning, Sources of foods and types of adulterants, advantages and disadvantages of adulteration, Constituents of foods, carbohydrates, proteins, fats, oils, Flavours, colours and natural toxicants, Sources causes and remedies for acidity, gastritis, indigestion and constipation.	08 hours

UNIT-V	Introduction to food spoilage, food preservation and food processing, Causes and types of food spoilage, types of food preservation and food processing, Food sterilization and pasteurization.	08 hours
Total Teaching hours		50 hrs

Text book:

1. Albanese, Anthony A Ed, Protein And Amino Acid Nutrition Academic Press New York 1959.
2. Devlin T.M., Biochemistry by Stryer Text book of Biochemistry with clinical correlations.
3. Lehninger, Principles of Biochemistry, by 4th Ed. By Nelson D.L. and Cox. M.M. 6
4. Murray R.K., Grammer, D.K., Mayer P.A., Rodwell V.W., Harpers Biochemistry, a lange medical book 26th Ed. Mc. Graw Hill, Health Professions Division.
5. West. E.S., Todal, W.R., Mason H.S. and Van Brygen J.T., Text Book of Biochemistry.
6. Mayer, J., Human Nutrition, Charles, C. Thomas, spring field.
7. Michael, J. Gibney, Barrie, M. Margetis, John, M. Kearney. Lenore Arab. Public Health Nutrition. Blackwell science, Blackwell Publishing Company (2004).
8. Frazier, We, Food Microbiology, Tata Mc Graw Hill 1978.
9. Meyer, Lilian H. Ed. (1987), Food chemistry. Indian Ed. CBS Publishers and Distributors

.

Reference Book:

1.Seema yadav: - Food Chemistry, anmol publishing (P) Ltd, NewDelhi
2.Car H.Synder: -the extraordinary chemistry for ordinary things, John Wiley & sonsinc, NewYork,1992.
3.B.Sivasankar – food processing and preservation – PHI learni9ng (P) LTD , New Delhi – 11001.

Course Material: website links, e-Books and e-journals
1. https://chico-primo.hosted.exlibrisgroup.com

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome, S – Strong , M – Mediumj

Course code	P23BTE33C	SEMESTER III	Credits	L	T	P	Hrs
ELECTIVE –V		Herbal Biotechnology	3	3	-	-	3

Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply
Aim	To give the details of plant-derived value-added compounds and their functions. To provide knowledge on biotech-based production of Herbal medicines
Learning Objective	6.To enable the students to learn about the biochemical parameters used in the identification and utilization of medicalplants 7.To enable the students to learn about the extraction of phytochemicals and procedures 8.To exploit and explore the medicinal values of plants 9.know the evaluation techniques for the herbal drugs 10. To provide knowledge on biotech-based production of Herbal medicines
Course outcome	1. After studied unit-1, the student will be able to – know the Study of on history and scope of herbals 2. After studied unit-2, the student will be able to – understand the Important medicinal herbs in treating diseases 3. After studied unit-3, the student will be able to –learn the Biotechnological methods of plant propagation 4. After studied unit-4, the student will be able to –explore methods Involved in secondary metabolite production 5. After studied unit-5, the student will be able to –know about pharmaceutical applications and Intellectual Property Rights

Units	Course Contents	Teaching hours
Unit I	Study of on history and scope of herbals - Introduction to the Indian system ofmedicine – Herbal drugs and importance- Herbal Cosmetic and Cosmeceuticals- Formulation Development of herbal preparations - Herbal Drug discovery andNovel drug delivery systems.	10 hours
Unit-II	Important medicinal herbs in treating diseases- Phytochemistry of medicinal plants- alkaloids- flavones- flavonoids and xanthones - furocoumarins - glycosides - naphthoquinones - phenols and acylphloroglucinols - resins, oleoresins and gum resins. Saponins - sterols and steroid-like compounds - tannins and terpenes.	08 hours
Unit-III	Biotechnological methods of plant propagation. - Micropropagation – Somatic Embryogenesis and somoclonal variation. Herbal gardening and maintenance- Standardization of cultivation protocols of selected medicinal plants; *in vitro* production of secondary metabolites. Polyhouse Technology- Important diseases of medicinal plants and their management.	13 hours

Unit-IV	Methods Involved in secondary metabolite production - Organ culture, Cellculture, Biotransformation (Microbial and Plant cells) - Scale up – Enhancement of product formation by elicitation-Immunodiagnostics and moleculardiagnostics in selection of elite plant species.	08 hours
Unit-V	Introduction to analysis and quality controls of herbal products (TLC, HPLC, IR, NMR, and mass spectroscopy). Pharmaceutical application of alkaloids, terpenoids, glycosides, volatile oils, tannins and resins. - Intellectual Property Rights - Regulatory Affair herbal pharmaceuticals – Entrepreneurship Management.	08 hours
Unit-VI	Internal Assessments, Seminars, and Guest lecture	5 hours

Reference & Text Books:

1. Harborne, J.B., 1998. Phytochemical methods to modern techniques of plant analysis. Chapman & Hall, London.
2. Trease G. E, M. C. Evans, 1979. Textbook of Pharmacognosy12th ed. Balliere-Tindal, London.
3. Irfan A. Khan and AtityaKhanum (Eds.). 2004. Role of Biotechnology in medicinal and Aromatic plants, Vols. I-X. Ukaaz Publications, Hyderabad. Analytical techniques in DNA sequencing edited by Brian K. Nunnally.
4. Agrawal S.S. and M. Paridhavi, Herbal Drug Technology, University press 2007.
5. Henry, R. J. 1997. Practical Applications of Plant Molecular Biology. Chapman &Hall, London, UK.
6. Bidlack, W.R., Omaye, S.T., Meskin, M.S.andTopham, D.K.W.," Phytochemicals as Bioactive Agents", 1St Edition, CRC Press, 2000.
7. Sharol Tilgner, N. D. 1999. Herbal medicine - From the heart of the earth. Edn. 1, Printed in the USA by MalloyLithographing Inc.
8. Balasubramanian, Bryce, Dharmalingam, Green and Jayaraman (ed), Concepts in Biotechnology, University,Press, 1996.
9. Anderson, F.J Illustrated History of the Herbals. New York: Columbia University press. 2009.
10. Callow, J. A., Ford-Lloyed, B. V. and Newbury, H. J. 1997. Biotechnology and Plant Genetic Resources:Conservation and Use, CAB International, Oxon UK.
11. Gokhale, S.S,C.K.Kokate and A.P.Purohit (1994). Pharmacognosy. Niraliprakashan, Pune.
12. Faroogi, A.A. and B.S.Sreeramu (2004), Cultivation of Medicinal and Aromatic crops. University Press (India) P.Ltd., Hyderabad.
13. Pal. D.C and S.K. Jain (1998), Tribal medicine, Naya Prakash, 206, Bidhan Sarani, Calcutta.
14. Thirugnanam, Akbarsha and Krishnamurthy(2010),Indian Medicinal plants and Home Reme

Course Material:

1.Rasheeduzzafar (2006), Medicinal plants of India, CBS publication.
2.International Journal of Herbal Medicine
3.Journal of Herbal medicine Elsevier
4.en.wikipedia.org/wiki/Herbal medicine

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

PO – Programme Outcome, CO – Course outcome, S – Strong , M – Medium, L –

Course code	P23BTN302	SEMESTER III	Credits	L	T	P	Hrs
NME-II		MUSHROOM CULTIVATION	2	3	-	-	3

Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply	
Learning Objective	• To have knowledge on general identification characteristics of mushroom • To know about the types of edible mushroom • To know about the mushroom cultivation techniques • To learn the skills of mushroom cultivation • To understand the medicinal value of mushroom	
Course outcome	• Differentiate edible and poisonous mushrooms • Know about the production methods of Spawn • Explain the culturing methods of Mushrooms • Know the value added products of mushrooms and mushroom recipes • Understand the medicinal values of mushrooms	
Units	**Course Contents**	**Teaching hours**
UNIT I	**Introduction to Mushrooms** History and Scope of mushroom cultivation - classification of mushrooms - Edible and Poisonous Mushrooms-Vegetative characters	5 hours
UNIT-II	**Nutritional Values of Mushroom** Nutritional and dietary values of mushrooms as source such as protein, carbohydrates, fibre, vitamins and minerals, therapeutic properties. Mushroom cultivation techniques- Spawn production - culture media preparation- production of pure culture, harvesting. Sterilization of substrates- composting technology, mushroom bed preparation.	5 hours
UNIT – III	**Cultivation of edible mushrooms** Substrate preparation, growth, packing, and maintenance of suitable environmental conditions for Button mushroom (Agaricus bisporus) and Oyster mushroom (Pleurotus sajorcaju). Factors influencing mushroom cultivation and harvesting.	5 hours
UNIT – IV	**Pest Management** Pest management and problems in cultivation - diseases, pests and nematodes, weed moulds and their management strategies. Post harvest technology- Preservation of mushrooms - freezing, dry freezing, drying, canning, quality assurance and entrepreneurship.	5 hours
UNIT-V	**Value added products** Value added products of mushrooms and mushrooms recipes- mushroom Soup, mushroom omelet, mushroom biryani, mushroom pickle. Medicinal values of mushrooms.	5 hours
Total Teaching hours		50 hrs

Text book:

1. C.D.Thapa Dr. V. Prakasam Sh. Mohinder Singh. Mushroom culture. College of Horticulture, YSPUH&F Nauni, Solan (HP). https://www.agrimoon.com/wpcontent/uploads/Mashroom-culture.pdf.2016.
2. Tripathi. Mushroom Cultivation, D.P Oxford & IBH Publishing Co. PVT.LTD, New Delhi. .2005
3. Pathak Yadav Gour. Mushroom Production and Processing Technology, Published by Agrobios (India). 2010
4. V.N. Pathak, Nagendra Yadav and Maneesha Gaur.Mushroom Production and Processing Technology/ Vedams Ebooks Pvt Ltd., New Delhi.• 2000.

Reference Book:

1.Singh, M., Vijay, B., and Kamal, S., and Wakchaure, G.C. Mushrooms:Cultivation, Marketing and Consumption. Directorate of Mushroom Research,Indian Council of Agricultural Research, Solan, India. 2011.
2.S.Kannaiyan and K.Ramasamy.A hand book of edible mushroom. Today &Tomorrows printers & publishers, New Delhi.1980

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

1.https://www.researchgate.net/publication/316967767_Mushroom_Cultivation_ Book_Preprint_version
2.https://content.kopykitab.com/ebooks/2013/11/2269/sample/sample_2269.pdf

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome, S – Strong , M – Medium, L – Low

Course code	P23BTT411	SEMESTER IV	Credits	L	T	P	Hrs
CORE PAPER-11		BIOINFORMATICS	5	6	-	-	6

Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply
Learning Objective	1.To provide information an understanding of the major computational problems in the field of molecular biology and to gain knowledge on molecular databases. 2.To enable to learn alignment of sequence, rapid similarity searching, phylogenies. 3.Comparative genomics, pattern search, classification of sequence and structure, 4.Automated pattern learning, representing and searching protein structure, gene expression profiling, clustering expressed genes, discovering transcription factor bindings sites, discovering common functions of co- expressed genes, 5.To make them translate metabolic pathways, signal transduction pathways and management.
Course outcome	1.The student will be able to use various biological databases. 2.The student will be able do alignment and compare the differences of local and global using BLAST and advanced alignment tools. 3.The student will be to understand the techniques used in genomics and proteomics and their applications. 4.The student will be able to comprehend basis of protein structure determination, identify domains and motifs in protein, usage of tools to predict the sites in protein, and learn the computational methods and application of bioinformatics techniques 5.The student will be able to interpret the biological metabolic pathways,

Units	Course Contents	Teaching hours
UNIT I	Biological data bases: gen bank: sequence data/ types ; - protein data bases – ESTs STSs – GSSs – HTGS; NCBI- PubMed- Entrez –BLAST – OMIM; Types Of Accession Numbers- Locus Link, Unigene, Entrez, EBI, and Expasy, Nucleic Acid Data Bank (NDB)	12 hours
UNIT-II	Sequence alignment: alignment algorithms – global and local – significance ; BLAST search steps –BLAST algorithm –BLASTsearch strategies ; advanced BLAST-alignment tools.	12 hours
UNIT – III	Gene expression analysis tools: the mRNA-c DNA-libraries; microarrays: experimental design – probe – hybridization – DNA fragment counting assembly and restriction enzyme mapping. image analysis – data analysis- biological confirmation – microarray database.	12 hours
UNIT – IV	Proteomic analysis tools: protein domains and motifs – bio informatic tools for high throughput protein analysis – protein structure – Sequence Similarty Basics: Similarty, Identity, Homology, Homology	12 hours

	Modelling and visulaization	
UNIT-V	Pathway bioinformatics : protein – carbohydrate metabolism – biochemical cycles – interconnection of pathways – metabolic regulation —KEGG: theory and practice.	12 hours
Total Teaching hours		50 hrs

Text book:

1.Bioinformatics: Sequence and genome analysis by David, W Mount, Cold Spring Harbur Press.
2.Bioinformatics Computing By Bryan Bergeron, Publisher: Prentice Hall PTR.
3.Bioinformatics a practical guide to analysis of genes and protein, Eds A D Baxevanis and B.F.Francis Ouellette, Wiley Interscience.
4.Discovering Genomics, Proteomics, and Bioinformatics, 2 nd Edition, Campbell AM & Heyer LJ, Pearson, 2007.
5.Bioinformatics: Sequence and Genome Analysis, 2 nd Edition, Mount D, CSHL Press, 2004.
6.Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition, Baxevanis AD & Francis BF, Wiley, 2004.
7.School of Biotechnology SYLLABUS of M. Sc. (Biotechnology) ODD SEMESTERS (2017 & 2018 Batches) Page 11 of 25 4. A Bioinformatics Guide for Molecular Biologists,
8.Aerni S & Sirota M, CSHL Press, 2014. 5. Genomes, 2nd Edition, Brown TA, Oxford, Wiley, 2002.

Reference Book:

1.Botkin, Daniel B. (2011). Environmental Science: Earth as a living Planet, John Wiley and Sons, New Delhi.
2.Chapman. J. L. and Reiss, M.J. (2005). Ecology, Principles ad Applictions, CambridgeUniversity Press, London.
3.Dash, M.C. (1994).Fundamentals of Ecology, Tata Mc Graw Hill, New Delhi.
4.Gunther, O. (1998) Environmental Information Systems. Berlin, New York, Springer.
5.Miller G. Taylor and Scot Spoolman. (2011). Essentials of Ecology, Books/ Cole Learning, sU.S.A.
6.Odum, E.P. (1971). Fundamentals of Ecology, W.B. Saunder Company, Philadelphia
7.Sharma P. D. (1996). Environmental Biology, Rastogi Publications, Meerut.
8.Verma P.S. and V.K. Agarwal. (1985). Principles of Ecology. S. Chand and Company (Pub.), New Delhi.
9.Strahler, A. V. and Strahler, A.A (1973). Environmental Geoscience, Wiley International.
10.PrimackR.B. 2014. Essentials of Conservation Biology, Oxford University Press, USA.

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

. https://www.pdfdrive.com/basics-of-bioinformatics-lecture-notes-
https://www.elsevier.com/books/bioinformatics/singh/978-0-323-89775-4.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome, S – Strong , M – Medium, L – Low

Course code	P23BTT412	SEMESTER IV	Credits	L	T	P	Hrs
CORE PAPER-12		RESEARCH METHODOLOGY	5	6	-	-	6

Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply
Aim	To enable the students to understand the importance of research, familiarize themselves with writing the project report, and learn about the various applications of statistics in the research.
Learning Objective	Understand some basic concepts of research and its methodologies Identify appropriate research topics Select and define the appropriate research problem and parameters Prepare a project proposal (to undertake a project) Organize and conduct research (advanced project) in a more appropriate manner
Course outcome	1.able to understand research concepts, issues and types andbasic knowledge of qualitative research 2.able to know read, comprehend, and explain researcharticles in their academic discipline. 3.able to develop an understanding of various kinds of research, objectives of doing research, research process, research designs, sampling, principles andresearch techniques. 4.able to detailed know the Observation and Collection ofdata and Generalization and Interpretation 5.able to Have adequate knowledge of ethics, plagiarism,citation and acknowledgment

Units	Course Contents	Teaching hours
Unit I	Objectives and types of research: Motivation and objectives – Research methods *vs* Methodology. Types of research – Descriptive *vs*. Analytical, Applied *vs*. Fundamental, Quantitative *vs*. Qualitative, Conceptual *vs*. Empirical.	12 hours
Unit-II	Research Formulation – Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs- patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.	12 hours
Unit-III	Research design and methods – Research design – Basic Principles- Need of research design — Features of good design – Important concepts relating to research design – Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan - Exploration, Description, Diagnosis, experimentation. Determining experimental and sample designs. Research techniques- microscopy, HPLC, HPTLC, GC-MS, FTIR, SEM/TEM, NMR and AAS.	12 hours
Unit-IV	Data Collection and analysis: Execution of the research - Observation and Collection of data - Methods of data collection – Sampling Methods- Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-testing - Generalization and Interpretation.	12 hours

Unit-V	Reporting and ethics – Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports. Environmental impacts - Ethical issues - ethical committees - Commercialization – Copy right – royalty - Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights – Reproduction of published material – Plagiarism - Citation and acknowledgement - Reproducibility and accountability.	12 hours
Total Teaching hours		50 hrs

Reference & Text Books:

1.Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2.Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International.418p.
3.Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
4.Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing.270p.
5.Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal LawPublishing.
6.Satarkar, S.V., 2000. *Intellectual property rights and Copy right.* EssEssPublication
7.Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS
8.Kothari, C.R.,1985, Research Methodology- Methods and Techniques, New Delhi
4. MS office, Sexena, S. 2001.Vikas Publishing House Pvt. Ltd., New Delhi
9.Authoring a PhD, thesis: how to plan, draft, write and finish a doctoral dissertation, Duncary, P.2003.
Macmillan, pp 256.
10.Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS

Course Material:

1. https://bbamantra.com/research-methodology/

2.https://www.researchgate.net/publication/329736173_Research_Methodology_

Msc_notes_of_Dr_J udu_illavarasusvyasa_univ

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

PO – Programme Outcome, CO – Course outcome, S – Strong, M – Medium, L – Low

Course code	P23BTE44A	SEMESTER IV	Credits	L	T	P	Hrs
ELECTIVE-VI		BIOETHICS, BIOSAFETY, AND IPR	3	4	-	-	4

Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply
Aim	Students get an idea about the advantages and disadvantages of biotechnological applications, ethical implications, and intellectual property rights.
Learning Objective	1. To provide basic knowledge on intellectual property rights and their implications inbiological research and product development 2. To become familiar with India's IPR Policy 3. To learn biosafety and risk assessment of products derived from biotechnology andregulation of such products 4. To become familiar with ethical issues in biological research. 5. This course will focus on consequences of biomedical research technologies such as cloning of whole organisms, genetic modifications, DNA testing.
Course outcome	After studied unit-1, the student will be able to Understand the rationale for and against IPR and especially patents. After studied unit-2, the student will be able to Understand why India has adopted anIPR Policy and be familiar with broad outline of patent regulations. After studied unit-3, the student will be able to Understand different types of intellectual property rights in general and protection of products derived frombiotechnology research and issues related to application and obtaining patents After studied unit-4, the student will be able to Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environmentalrelease of genetically modified organisms, national and international regulations After studied unit-5, the student will be able to Understand ethical aspects related to biological, biomedical, health care and biotechnology research

Units	Course Contents	Teaching hours
UNIT I	Introduction To Biodiversity Levels of biodiversity –values of biodiversity – loss of biodiversity – Species concept – Classification and systematics: biological nomenclature – biological classification; Biodiversity conservation: in situ and ex situ - Magnitude and distribution of biodiversity -wild life biology – conservation strategies – measures of biodiversity – biodiversity in India and global level – biodiversity hot spots. National Biodiversity Authority.(NBA)	12 hours
UNIT-II	Introduction To Ethics/Bioethics : Framework for ethical decision making; biotechnology and ethics – biotechnology in agriculture and environment: benefits and risks – benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and bio warfare	8 hours
UNIT – III	Ethical Implications Ethical implications of cloning: Reproductive cloning , therapeutic cloning ; Ethical, legal and socio- economic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research- GM crops– biotechnology and biopiracy – ELSI of human genome	8 hours

	project.	
UNIT – IV	Introduction To Biosafety Biosafety issues in biotechnology – risk assessment and risk management – safety protocols: risk groups – Biosafety levels – Biosafety guidelines and regulations (National and International) – operation of Biosafety guidelines and regulations – types of Biosafety containments - definition of GMOs & LMOs; principlesof safety assessment of transgenic plants.	9 hours
UNIT-V	Introduction To Intellectual Property And Intellectual Property Rights Types: patents, copyrights, trade-marks, design rights, geographical indications – importance of IPR – patentable and non-patentable – patenting life – legal protection of biotechnological inventions – patent databases - country-wise patent searches (USPTO, EPO, India) – History of world intellectual property rights organization (WIPO), GATT, WTO and TRIPS.	8 hours
Total Teaching hours		50 hrs

Text Book

1.IPR, Biosafety and Bioethics (2013), by DeepaGoel, ShominiParashar
2.Biodiversity and Biomedicine: Our Future (2020), 1st edition by MunirOzturk, DilfuzaEgamberdieva, MilicaPešić.
3.The basics of bioethics (2019), 4th edition by Guidry-Grimes, Laura; Veatch, Robert.

Reference book

Introduction to bioethics (2018), 2nd edition by J.A. Bryan

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://swayam.gov.in/nd1_noc20_hs18/preview2.
https://nptel.ac.in/courses/109/106/109106092/
3. https://onlinecourses.nptel.ac.in/noc20_hs18/preview4.
https://nptel.ac.in/courses/102/104/102104068/
5. https://www.futurelearn.com/courses/biosecurity

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

Course code	**P23BTE44B**	**SEMESTER IV**	**Credits**	**L**	**T**	**P**	**Hrs**
ELECTIVE-VI		**SYSTEM BIOLOGY**	**3**	**4**	**-**	**-**	**4**
Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply						
Aim	To gain basic knowledge of systems biology and understand some of the larger questionsand issues with systems biology and large-scale data collection and analysis						
Learning Objective	1. To provide basic knowledge on databases that are related with systems biology 2. To teach microarray tools to become familiar with system biology 3. To learn KEGG and biochemical neural networks to find protein and carbohydrate mechanism related to systems biology 4. To teach Integration of networks, data integration, modeling for metabolomics. 5. To learn the AI technology of systems biology						
Course outcome	1. After studied unit-1, the student will be able to understand the basic knowledge on databasesthat are related with systems biology 2. After studied unit-2, the student will be able to Understand microarray tools to become familiar with system biology 3. After studied unit-3, the student will be able to Understand KEGG and biochemical neuralnetworks to find protein and carbohydrate mechanism related to systems biology 4. After studied unit-4, the student will be able to Gain knowledge of Integration of networks,data integration, modeling for metabolomics 5. After studied unit-5, the student will be able to Understand AI technology of systems biology						
Units	**Course Contents**		**Teaching hours**				
UNIT I	Molecular databases: accessibility, compatibility, comprehensive database, portability, quality, and navigability. Systems Biology: Definition, Hypothesis-driven research in systems biology, Wet experiments-Dry experiments: predictions and simulations. Reductionist and Integrative approach.		10 hours				
UNIT-II	Interpreting expression data using Gene Ontology; Evolution of modularity and transcriptional networks, Riboswitches, metabolite sensing, and translational control; Microarrays-types and applications, Importance of non-coding sequence.		08 hours				
UNIT – III	Protein-carbohydrate metabolism; Biochemical cycles; Interconnection of pathways- metabolic regulation; Translating biochemical networks into linear algebra; KEGG: theory and practice		13 hours				
UNIT – IV	Genomics, Proteomics, Metabolomics, Transcriptomics, Interactomics, Phenomics, Localizomics; Gene networks -Integration of Networks. Combination of omics approaches:data integration, modeling;		08 hours				
UNIT-V	Synthetic biology, Artificial Intelligence (AI): Methodology, tools, and its application in agriculture, drug discovery, and biomedicine.		08 hours				

Total Teaching hours	50 hrs
Text Books & References 1. Kitano, Systems Biology: A Brief Overview. Science, 2002, 295: 1662-1664. 2. Ideker et al. A new approach to decoding life: Systems Biology. Annual Review onGenomics and Human Genetics 2001, 2: 343-372. 3. Ideker et al. Integrated Genomic and Proteomic Analyses of a Systematically PerturbedMetabolic Network. Science, 2001, 292: 929-934. 4. Ge et al. Integrating „omic" information: a bridge between genomics and systemsbiology. Trends in Genetics, 2003, 19, 10: 551-560. 5. Chong et al. Wholistic Biology, Science, 200820, 295:1661.	
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.] 1. https://swayam.gov.in/nd1_noc20_hs18/preview 2. https://www.tandfonline.com/toc/iaan20/current, 3. https://www.tandfonline.com/toc/iaan19/32/3, 4. https://chico-primo.hosted.exlibrisgroup.com	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome S – Strong , M – Medium, L – Low

Course code	P23BTE403B	SEMESTER IV	Credits	L	T	P	Hrs
SKILL ENHANCEMENT		NANO BIOTECHNOLOGY	2	4	-	-	4
Cognitive level	**K1:** Recall **K2:** Understand **K3:** Analyze **K4:** Apply						
Aim	To gain basic knowledge of systems biology and understand some of the larger questionsand issues with systems biology and large-scale data collection and analysis						
Learning Objective	To create Knowledge on Nano particle synthesis, characterization. To know the Nano particles importance in drug delivery To compare the analytical methods knowledge in nano particle characterization like SEM & TEM To apply the nano particles on various in vivo & in vitro for its applications To compare various nano particles on biomedical & environmental applications						
Course outcome	After studied unit-1, the student will be able to understand Nano technology on Cancer treatment After studied unit-2, the student will be able to know Nano Technology application in Diabetes After studied unit-3, the student will be able to develop an understanding Nano technology effecton target drug delivery After studied unit-4, the student will be able to detailed know the Nano technology uses in environmental remediation and recycling process After studied unit-5, the student will understanding the Nano technology uses in various biomedical & agriculture applications						
Units	**Course Contents**						**Teaching hours**
Unit I	Introduction to nanotechnology: characteristic scale for quantum phenomena, nano particles, nano-clusters, nano composite, nano tubes, nano wires emergence of bio nanotechnology. Characterization of nano particles- UV-Vis spectroscopy, electron Microscopy- HRTEM,SEM, AFM, EDS, XRD.						10 hours
Unit-II	Microbial nanotechnology –Microbial synthesis of nano drugs- metal nano particles and drug delivery vehicles- Nanoshels – Tectodentrimers Nanoparticle drug systems– diagnostic applications of nanotechnology.						08 hours
Unit-III	Preparation of nano materials by physical, chemical and Green methods: Polymeric scaffolds collagen, elastin's: Muco polysaccharides, Proteoglycans ,cellulose and derivate; dextran's ; alginates; Pectin's; Chitin. Nanoparticles – types, functions-Silver, Gold and Titanium. Physical and chemical properties of nanoparticles.						13 hours
Unit-IV	Nanoscale applications in biology and medicine: nanotechnology for biology and medicine – micro and nano-fluides- scanning probe microscopy in biology and medicine- self –assembly of biological molecules .drug delivery – protein mediated and nanoparticle mediated.						08 hours

	Hybrid conjugates of gold nano particles – DNA oligomers - use of DNA molecules in nanomechanics and computing	
Unit-V	Implications of nanotechnology : health and safety implications from nano particles: health issues- environmental issues- need for regulation – societal implications : possible military applications–potential benefits and risk for developing countries – intellectual property issues – criticism of Nanotechnology – studies on the implications of Nanotechnology.	08 hours
Total Teaching hours		50 hrs

Text book:

1. Parthasarathy, B.K (2007). Introduction to Nano technology, Isha publication.
2. Elisabeth Papazoglou and Aravind Parthasarathy (2007).Bio nanotechnology. Morgan & Claypoolpublishers.
3. Bernd Rehm (2006). Microbial bio nanotechnology: biological self-assembly78 systems and biopolymer – based nanostructures. Horizon scientificpress.
4. David E. Reisner ,Joseph D. Bronzino (2008). Bio nanotechnology: global prospects.CRC Press.
5. Ehud Gazit(2006).Plenty of room for biology at the bottom: An introduction to bionanotechnology. Imperial college press.
6. Hari Singh Nalwles , " Nano structured materials and nanotechnology ",2002academic press
7. M.H.Fulekar, 2010" Nanotechnology importance and applications."I.K. International publishinghousePvt.
8. Nanotechnology: Global strategies, Industry Trends and applications 2005John Wiley & sonsLtd.

Reference Book:

1.CPCSEA Guidelines for Laboratory Animal Facility, CPCSEA, 2003.
2.Kumar, H.D. Modern Concept of Biotechnology. Vikas Publishing House Pvt. Ltd., 2007
3.Animal Biotechnology: Models in Discovery and Translation, Second Edition (Elsevier)
4.Arun Bahl, B.S. Bahl and G.D. Tuli. Essentials of Physical Chemistry. Sultan Chand & Sons,2014.
5.P.L. Soni. Textbook of Inorganic Chemistry. Sultan Chand & Sons, 2013.
6.P.L. Soni and H.M. Chawla. Textbook of Organic Chemistry, Sultan Chand & Sons, 29th RevisedEdition, 2014
7.Subbiah Balaji. Nanobiotechnology, MJP Publishers, 2010.
8.W.J. Moore. Physical Chemistry, Longman, 5th Edition. 1972.
9.Robert R Crichton. Biological inorganic chemistry: a new introduction to molecular structure andfunction. Amsterdam: Academic Press, 3rd edition, 2018.

Course Material:

1. Website links: https://jnanobiotechnology.biomedcentral.com/,

2. E-Books: http://www.a-zshiksha.com/forum/viewtopic.php?f=148&t=61561E- journals: https://digital-library.theiet.org/content/journals/iet-nbt

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	M	S	M	S	S
CO2	M	S	M	M	M	S	S	S	M	M
CO3	S	M	M	S	S	M	M	S	M	S
CO4	M	S	S	M	M	S	M	M	S	S
CO5	S	M	S	M	S	M	S	M	S	S

PO – Programme Outcome, CO – Course outcome, S – Strong, M –