

A.V.V.M. Sri Pushpam College (Autonomous), Poondi – 613 503
PG DEPARTMENT OF BIOTECHNOLOGY
M.Sc. Programme in BIOTECHNOLOGY
OUTCOME BASED EDUCATION - CHOICE BASED CREDIT SYSTEM
SCHEME OF PROGRAMME AND SYLLABUS
(For the candidates admitted from 2023-2024 onwards)

Vision and Mission of the college

Vision

To provide quality academic programmes and value oriented higher education to the rural community, equip them to encounter current regional, national and global demands upholding moral standards and intellectual competency.

Mission

- To provide conducive environment for quality teaching-learning process and innovative research.
- To bestow substantial educational experience that is intellectually, socially, and personally transformative.
- To strive to bring out the latent potentiality and core competency of the learners
- To foster the culture of research-based learning, independent academic inquiry by encouraging the students to involve in research activities ranging from hands on training, student projects, publications etc.,
- To nurture essential skills, competent minds and compassionate hearts.
- To impart a practical, demanding and overall development of the personality generated by love, consideration and care for the society.
- To serve the society by extending needful outreach programmes to the rural populace.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

- Make the learners realise the transformative power of education.
- Acquire profound disciplinary, applied, integrative knowledge and intellectual competency and domain specific and generic skills.
- Pursue lifelong learning and generate innovative solutions for the problems at individual and social level.
- Create a collaborative and inclusive environment, and serve the betterment of the society with moral integrity.
- Motivate to become a committed professional with necessary ethics as a leader as well as a team player.

PROGRAMME OUTCOMES for M.Sc. BIOTECHNOLOGY PROGRAMME

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

PO1: Students learn about several aspects of biotechnology as part of the knowledge transfer process.

PO2: Improves Student's capacity to apply their knowledge of a subject to solve current issues on both a local and global scale is a function of their critical thinking abilities.

PO3: Students will apply their newly learned scientific knowledge for practical purposes in the workplace.

PO4: Instilling a passion for research and the skills to plan and carry out experiments can help students become more qualified to conduct research.

PO5: Acquiring technical proficiency to use a variety of sophisticated tools to apply biotechnology to solve complicated biological challenges.

- PO6:** Students get fundamental knowledge to evaluate the ethical concerns associated with biotechnology in relation to society, health, safety, legal, and cultural considerations.
- PO7:** Students design research problems and conduct individual research projects in specific fields of biotechnology.
- PO8:** Students integrate research findings into scientific papers by analyzing the results of their research.
- PO9:** Exhibit effective communication skills for interaction with personnel as well as presentation in appropriate forums
- PO10:** Demonstrate knowledge for in-depth analytical and critical thinking to identify, formulate and solve the issues related to Biotechnology Industry, Pharma industry, Medical or hospital related organizations, Regulatory Agencies, & Academia.

PROGRAMME SPECIFIC OUTCOMES for M.Sc BIOTECHNOLOGY PROGRAMME

On the completion of the **M.Sc., Biotechnology** programme, the learners will be able to

- PSO1:** To enhance student proficiency and encourage them to pursue higher education at reputable National and international levels
- PSO2:** The goal of the department is to produce competent, easily employable biotechnologists for the academic, service, healthcare, food, and agricultural sectors.
- PSO3:** To foster an innovative and creative mindset in the minds of the next generation in order to direct them towards entrepreneurship and research.
- PSO4:** To develop a sense of innovation, creativity and self-confidence to the students in order to help them address the skill gaps in the rapidly expanding field of biotechnology
- PSO5:** The student will be able to conduct research in breeding, physiology, production, yield and management of crops and agricultural plants or trees, shrubs, and nursery stock, their growth in soils, and control of pests
- PSO6:** The student will be aware of animal experimentation and intellectual property rights.
- PSO7:** The student can study the chemical, physical, biological, and mineralogical composition of soils as they relate to plant or crop growth.
- PSO8:** The student s can expect jobs at agricultural industries,
- PSO9:** The student can scope in manufacturing industries, public and private
- PSO10:** The student can be aware of environmental Pollution and its related research

Curriculum Structure for M.Sc. BIOTECHNOLOGY Programmes (OBE- CBCS) – 2023
Consolidated Table for Credits Distribution

	Category of Courses	Credits for each Course	Total Number of Courses	Total marks	Number of Credits in each Category of Courses	Total Credits	Total Credits for the Programme
PART A	Core	4	12	1200	48	83	90 (CGPA)
	Core Practical	3	6	600	18		
	Project with viva voce	5	1	100	5		
	Elective (Generic and Discipline Centric)	3	4	400	12		
PART B	Ability Enhancement Compulsory Course (i) Discipline – Centric / Generic Skill	1	4	400	4	7	
	(i) Open Elective (EDC)	3	1	100	3		
	(iii) *MOOC / *USRR	--		--	--		
			28	2800		90	

Part A component and Part B (i) will be taken into account for CGPA calculation for the postgraduate programme and the other components Part B and Part C have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the PG degree

Course Structure: M.Sc. Biotechnology (2023)

S. No.	Semester	Category	Course Code	Title of the Course	Maximum Marks			Minimum Marks for Pass			Hours/Week	Credits
					CIA	EE	Total	CIA	EE	Total		
1	I	Core	23P1BTC1	Biochemistry	25	75	100	10	30	50	6	4
2		Core	23P1BTC2	Cell and Molecular Biology	25	75	100	10	30	50	5	4
3		Core	23P1BTC3	Microbiology	25	75	100	10	30	50	5	4
4		Core	23P1BTCP1	PRACTICAL I: Biochemistry & Cell and Molecular Biology	25	75	100	10	30	50	4	3
5		Core	23P1BTCP2	PRACTICAL II: Microbiology	25	75	100	10	30	50	4	3
6		Elective	23P1BTEL1A/ 23P1BTEL1B	Basic Analytical Methods Virology	25	75	100	10	30	50	4	3
7		AECC	23P1BTAECC1	Communicative Skill and Personality Development	25	75	100	10	30	50	2	2
8	II	Core	23P2BTC4	Immunology	25	75	100	10	30	50	4	4
9		Core	23P2BTC5	Genetic Engineering	25	75	100	10	30	50	4	4
10		Core	23P2BTC6	Developmental and Stem Cell Biology	25	75	100	10	30	50	4	4
11		Core	23P2BTC7	Bioinformatics	25	75	100	10	30	50	4	4
12		Core	23P2BTCP3	PRACTICAL III: Immunology	25	75	100	10	30	50	4	3
13		Core	23P2BTCP4	PRACTICAL IV: Genetic Engineering and Bioinformatics	25	75	100	10	30	50	4	3
14		Elective	23P2BTEL2A/ 23P2BTEL2B	Enzyme Technology Pharmaceutical Technology	25	75	100	10	30	50	4	3
15		AECC	23P2BTAECC2	Language Lab	25	75	100	10	30	50	2	1

INTERNSHIP/ INDUSTRIAL ACTIVITY:

Students must complete in-plant training in any industry or organization where a programme-related procedure is being used, and this training must be done during the summer vacation at the end of I Year. A minimum of 30 hours should be spent on training. Students must submit a report on their training together with a certificate from the relevant industry or organization authority.

Ability Enhancement Compulsory Course (AECC – Soft Skill):

AECC 1: Communicative Skill and Personality Development

AECC 2: Language Lab

AECC 3: Research Methodology

AECC 4: Comprehensive Knowledge

Mode of Assessment for these courses is Viva-Voce examination.

Components of Evaluation:

Internal Marks	: 25
External Marks	: 75
Total	: 100

Field visit / Hands on Training:

In order to achieve experiential learning, these programmes with a minimum of 15 hours of contact time are offered as Extra Credit Courses in the I Semester.

Evaluation of visit report will be held at the end of II Semester.

Components of Evaluation:-

Internal Marks	: 25
External Marks	: 75
Total	: 100

MOOC:

Massive Open Online Course is offered in the III Semester as an Extra Credit Course. Students can avail any one or more of the courses available in MOOC to equip their skill and knowledge themselves. To receive the extra credit, students must provide their MOOC course completion certificate at the end of the second year.

OPTIONAL PAPER: compulsory Optional paper “**Human Rights**” included as per the direction given by TANSCHÉ in the II semester

EXTRA DISCIPLINARY COURSE (EDC) OFFERED BY THE DEPARTMENT OF ZOOLOGY & BIOTECHNOLOGY:

Medical Laboratory Technology, Agricultural Biotechnology

VALUE ADDED COURSE OFFERED BY THE DEPARTMENT OF ZOOLOGY & BIOTECHNOLOGY:

“**VERMICULTURE TECHNOLOGY**” will be conducted for I PG students as a certificate Course.

M.Sc., Biotechnology

Semester	Course code	Title of the course	Hours of teaching / week	No. of Credits
I	23P1BTC1	BIOCHEMISTRY	6	4

Nature of the course

Relevant to Local need		Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need	√	Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need		Skill development Oriented		Addresses Environment and Sustainability	
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

- To learn the physical and chemical nature of Biomolecules
- To learn various types of biomolecules
- To develop knowledge on intermediary metabolism of CHO, Proteins, and Lipids
- To teach the basics and advance of enzymes and their classifications
- To develop a piece of knowledge in clinical biochemistry.

Unit	Content	No. of Hours
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's bonds)	15
II	Bio molecules: 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,	15
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, Photo phosphorylation	15
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 (Co-enzymes).	15

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.	15
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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 ,7thEdition, jermy M.BergJohn,L. Tymoczko, Lubertstryer 2012.W.H,freeman&company,newYork2.
5. Molecular Biomethodsh and book, 2nd edition R.Rapley& J.MWalker, 2008, Humanapress.
6. Principles of Biochemistry, 5th Edition AL.Lehninger, D.L.Nelson and M.MCox. , 2008. Worth publishers, New York.
7. Biochemistry 4TH Edition, G.Zubay, 1998.McMillan publishing Co. New York.
8. Harper's Biochemistry, 29th Edition-Rober K.Murray, Dary IK.Grammer, 2012 Mc Graw Hill, lange Medical Books
9. Understanding enzymes -5th edition Trevorpalmer, Prentice Hall/Ellias Horwood 1995
10. Text Book Medical Biochemistry M.N.Chatterjee 8th edition Jaypee brothers Medical publishers2013

References books:

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. Mc Graw Hill,2015.
3. Wilson and Walker. Principles and Techniques of Practical Biochemistry, 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/CUMMING Spubl.Co.,Inc.,California,2013
7. GenesVI(9thEd).Benjamin Lewin, oxford university press, uk.,200710. Molecular biology of cell (5th edition)
8. Bruce alberts, alex ander johnson, Julianlewis, martinraff, keith Roberts, peter walter, garland science publications.2008
9. Molecular Biology (5th edition).weaver .R.F, McGraw Hill publications, 2011. Cell and
10. Molecular biology: concepts and experiments (5th edition). geraldkarp, wiley publications,2013

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

- <https://nptel.ac.in/courses/104105076>,
- <https://oli.cmu.edu/courses/biochemistry-open-free/>,
- https://onlinecourses.nptel.ac.in/noc20_cy10/preview,
- E-Books: <https://www.pdfdrive.com/biochemistry-books.html>,

- E-journals: Process Biochemistry (Elsevier), Journal of Cellular Biochemistry (Wiley)

Pedagogy: Teaching / Learning methods: Lecture, PPT presentation, Group Discussion

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	After studied unit 1, the students will be able to identify the nature of solvents and solutions concerning Handits important	K1
CO2	After studied unit 2, the students will be able to classify carbohydrates, proteins, lipids, and nucleic acids of bio molecules	K2
CO3	After studied unit 3, the students will be able to describe the biomolecules involved in intermediary metabolism	K2 & K4
CO4	After studied unit -4, the student will be able to explain enzyme and enzyme kinetics.	K2 & K5
CO5	After studied unit -5, the student will be able to apply biochemistry in clinical biochemistry procedures.	K2

Cognitive Level : K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	2	3
CO2	3	3	2	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	3	3	3	3
CO4	3	2	3	3	2	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3

3 - Strongly Correlated; **2**- Moderately Correlated; **1** - Weakly Correlated; **0** – No correlation

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
I	23P1BTC2	CELL AND MOLECULAR BIOLOGY	5	4

Nature of the course

Relevant to Local need		Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need	√	Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need		Skill development Oriented		Addresses Environment and Sustainability	
Relevant to Global need	√		Addresses Human Values	√	

Course Objectives

The main objectives of this course are to

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

SYLLABUS

Unit	Content	No. of Hours
I	Cell Biology: Structure and function of cells in prokaryotes and eukaryotes; Structure and organization of Plasma membrane – Membrane Model, active and passive transport channels and pumps. Structure and biogenesis of Mitochondria and Chloroplast. Structure and functions of Endoplasmic reticulum, Golgi complex, Lysosomes.	12
II	Cell division: Mitosis, Meiosis, regulation of cell cycle; factors regulating cell cycle. Nucleic acid structure, Genome Organization. DNA replication: Enzymes and mechanisms of DNA replication in prokaryotes and eukaryotes, Telomeres, telomerase and endreplication, role of telomere aseinaging and cancer. DNA replication models, DNA damage, Mutations, DNA repair and recombination.	12

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
IV	Gene regulation: Prokaryotic gene regulation- Operon concept; Lacoperon and tryptophanoperon. Eukaryotic gene regulation: Chromatin Structure, Regulation at transcriptional Level: DNA binding domains of these regulatory proteins. Biochemistry and applications of ribozyme technologies. Transposable genetic elements.	12
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, BRCA1. Oncogenes as transcriptional activators.	12

Textbook:

1. Molecular cell Biology, by Darnell, Lodish, Baltimore, Scientific American Books, Inc., 1994.
2. Molecular and cellular Biology, Stephen L.Wolfe, Wadsworth Publishing Company, 1993.
3. Cell and Molecular Biology: Concepts and Experiments 5th Ed, Gerald Karp. Wiley publications, 2013.

References:

1. Molecular and cellular Biology, Stephen L.Wolfe, Wadsworth Publishing Company, 1993
2. Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxford, 1991
3. Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxford, 1991.
4. Molecular Biology of the Gene (4th Edition), J.D.Watson, N.H.Hopkins, J.W.Roberts,
5. J.A. Steitz and A.M.Weiner, The Benjamin/Cummings Publ. Co., Inc., California, 1987.
6. Genes VI (6th Edition) Benjamin Lewin, Oxford University Press, U.K., 1998
7. Molecular biology of cell – Albert Bruce et al., 1994 3rd Ed
8. Molecular Biology-Weaver. R. F. 3rd ed. Mc Graw Hill publication ,2005
9. The Molecular Biology of Cancer: S. Pelengaris, M. Khan. Blackwell Publication. 2002

Web resources:

1. Swayam- MolecularbiologycoursebyDr.NayanK.Jain,GujaratUniversity
2. Swayam- CellBiologybyDrK.Sanatombi
3. NPTEL-MolecularCellBiologybyProf.D.Karunakaran
4. <https://www.coursera.org/courses?query=molecular%20biology>
5. <https://www.cdc.gov/labtraining/training-courses/basic-molecular-biology/index.html>

Pedagogy: Teaching / Learning methods

Lecture, PPT presentation, Group Discussion

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	After studied unit-1, the student will be able to equip with a basic knowledge of the structural and functional properties of cells.	K1, K2, K3, K4, K5& K6
CO2	After studied unit - 2, the student will be able to understand process of cell division and replication process.	K1, K3, K4&K5
CO3	After studied unit-3, the student will be able to understand the occurrence of central dogma of life in the cell and them a chineries involved to initiate and inhibit RNA and protein synthesis.	K2, K4, K5& K6
CO4	After studied unit-4, the student will be able to control of gene expressions in prokaryotes and eukaryotes and transposable elements.	K2, K3, K4, K5& K6
CO5	After studied unit-5, the student will be able to understand mechanism of epigenetic controls and cancer biology.	K1, K2, K3, K4, K5& K6

Cognitive Level :K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	2	3
CO2	3	3	2	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	3	3	3	3
CO4	3	2	3	3	2	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3

3 - Strongly Correlated; 2 - Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course code	Title of the course	Hours of teaching / week	No. of Credits
I	23P1BTC3	MICROBIOLOGY	5	4

Nature of the Course

Relevant to Local need	√	Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need	√	Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need	√	Skill development Oriented	√	Addresses Environment and Sustainability	
Relevant to Global need	√			Addresses Human Values	

Course Objectives

The main objectives of this course are to:

- To understand the History of Microbiology.
- To well understand the Nutritional classification of bacteria, etc.
- To obtain knowledge about Sterilization and Disinfection.
- To obtain knowledge of Microbial diversity.
- To know the basic Microbial community in natural habitats.

Unit	Content	No. of Hours
I	History of Microbiology - Classification of microorganism –Kingdom - Prokaryotic and eukaryotic microorganisms, Five kingdom concept of classification, Archaeobacteria, Eubacteria, and eukaryotes. Microscope-Light field, Dark field, Fluorescent and Electron microscope, Prokaryotic and Eukaryotic cell structure. Staining techniques -Simple and Differential staining.	15
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.	15
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.	15
IV	Microbial diversity-methods to assess microbial diversity, Culture dependent, and culture-independent methods. Molecular analysis of bacterial community; Denaturing Gradient Gel Electrophoresis (DGGE), Terminal Restriction Fragment Length(TRFL) Polymorphism (T-RFLP), Amplified Ribosomal DNA and Restriction Analysis (ARDRA) (16sRNA).	15

V	Microbial community in natural habitats –air, water, soil, food, and milk. Food and milk-borne diseases, Extremophiles - habitant & Classification, Halophiles, The rmophiles, Alkaliphiles, Acidophiles, Biotechnological applications of Extremophiles.	15
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Textbook:

1. Microbiology 3rd Edition by [Dave Wessner](#)(Author), [Christine Dupont](#) (Author), [TrevorCharles](#)(Author), [Josh Neufeld](#) (Author) 3rd edition (December3,2020)
2. Fundamentals of Microbiology 12th Editionby[Jeffrey C.Pommerville](#)(Author)12 th edition (March29,2021)
3. Burton's Microbiology for the Health Sciences 11th Edition by [PaulG. Engelkirk](#)(Author)11th edition (October10,2018)
4. Brock Biology of Microorganisms plus Pearson Mastering Microbiology with Pearson e Text, Global Edition15th Edition (March27,2018)
5. Microbiology: An Evolving Science Fifth Edition by [JoanL.Slonczewski](#)(Author), [John W. Foster](#)(Author), [Erik R. Zinser](#)(Author)Fifth edition(July1,2020)
6. Microbiology with Diseases by Taxonomy, Loose-Leaf Plus Mastering Microbiology with Pearsons Text—Access Card Package (6thEdition) (January14,2019)

Reference Book:

1. Medical Microbiology: A Guide to Microbial Infections: Pathogenesis, Immunity, LaboratoryDiagnosisandControl.WithSTUDENTCONSULTOnlineAccess(Greenwood,M edicalMicrobiology) 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 MDFRCPathFRCPE (Author), & [1more](#) Churchill Livingstone; 17th edition (June6, 2007)
2. MicrobiologyExperiments:AHealthSciencePerspectivePaperback– InternationalEdition,January1,2018MCGRAWHILL;9thedition(January1,2018)
3. HugoandRussell'sPharmaceuticalMicrobiology,8thEdition8thEditionby[Denyer](#)(Author)Wi ley-Blackwell;8thedition(August12,2011)
4. Clinical Bacteriology Hardcover–August 1, 1980 by [EJoanStokes](#) EArnold; Fifth Edition (August1, 1980)
5. Review of Medical Microbiology and Immunology (Medical Microbiology & Immunology (Levinson)) 9th Edition (March10, 2006)

Web Link:

- https://water.mecc.edu/courses/Env108/Lesson2_print.htm
- <https://www2.nau.edu/~fpm/bio205/Sp-10/Chapter-03.pdf>
- <https://www.colorado.edu/ehs/resources/disinfectants-sterilization-methods>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4852739/>

Pedagogy: Teaching / Learning methods

Lecture, PPT presentation, Quiz, Group Discussion, e-content Seminar

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Identify the Classification of microorganisms practical's.	K2
CO2	Identify and differentiate the pure culture technique.	K3
CO3	Identify and describe the chemo therapeutic agent	K4
CO4	Identify and explain enzymes and their regulations by kinetic parameters	K5
CO5	Identify and cross-examine the Biotechnological applications of Extremophiles.	K5

Cognitive Level :K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	2	3	1	1	3	2
CO2	2	2	2	2	3	2	3	2	2	3
CO3	2	3	3	3	3	2	2	3	2	2
CO4	3	1	2	1	1	3	2	3	1	2
CO5	3	3	3	3	0	1	2	2	3	1

3 - Strongly Correlated; 2- Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course code	Title of the course	Hours of teaching / week	No. of Credits
I	23P1BTCP1	Core - Practical I Biochemistry and Cell & Molecular Biology	4	3

Nature of the Course

Relevant to Local need	√	Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need	√	Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need	√	Skill development Oriented	√	Addresses Environment and Sustainability	√
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

- To learn the physical and chemical nature of Biomolecules
- To learn various types of biomolecules
- To prepare the students to accept the challenges in life sciences.
- To develop skills required in various industries, research labs and in the field of human health

Lab in biochemistry

1. Determination of Chlorophyll-a, Chlorophyll-b & total Chlorophyll by Arnon method.
2. Estimation of Carbohydrates in plant and animal tissues
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 separation of amino acids

Lab in Cell and Molecular biology

9. Isolation of Genomic DNA from *E.coli*
10. Isolation of plasmid DNA from *E.coli*
11. Elution & quantification of DNA from agarose gel.
12. Separation of Peripheral Blood Mononuclear Cells from blood
13. Wright and Giemsa stain based blood cells staining.
14. Preparation of competent cells and transformation
15. Isolation of Total RNA from bacteria
16. Synthesis of cDNA by Reverse transcription polymerase chain reaction

Reference

1. Introduction to Practical Biochemistry, E.F.Plummer Mu, Plummer Tata McGraw-Hill Education, 1998.
2. Molecularcloning:alaboratorymanual,4thed.J.Sambrook, Fritsch and T.Maniatis. colds pringharb orlaboratory press, NewYork, 2012
3. Essential cell biology : a practical approach volume 1: cell structure. John Davey, J.Michaellord. Oxforduniversity press, USA, 2003
4. Principles and techniques of biochemistry and molecular biology (7thed). Keith Wilson (editor), john walker (editor), Cambridge university press, 2010.

Web Link:

1. <https://www.cdc.gov/labtraining/training-courses/basic-molecular-biology/index.html>
2. <https://sites.google.com/site/igcascellbiology/practicals>

Pedagogy: Teaching / Learning methods

Lecture, PPT presentation Group Discussion

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Learn about the chemical structures of carbohydrate, and their structural and metabolic role in cellular system.	K1 & K2
CO2	Understand about the structure and function of nucleosides and nucleotides.	K2
CO3	Get detailed and comprehensive knowledge on the various practical aspects of microscopy, microbial taxonomy, and basic microbial culture techniques.	K2 & K4
CO4	Analyze biochemically different biological samples.	K3 & K4
CO5	Get practical knowledge regarding preparation of biochemically important buffers	K3 & K6

Cognitive Level :K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	3	3	2	2	2	2
CO2	2	2	3	3	3	3	3	3	3	2
CO3	2	3	3	3	3	3	3	3	3	2
CO4	2	3	3	3	3	3	3	3	3	2
CO5	2	3	2	3	3	3	2	2	2	2

3 - Strongly Correlated; 2- Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course code	Title of the course	Hours of teaching / week	No. of Credits
I	23P1BTCP2	Practical II Microbiology	4	3

Nature of the Course

Relevant to Local need	√	Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need	√	Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need	√	Skill development Oriented	√	Addresses Environment and Sustainability	√
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

- To obtain knowledge about Sterilization and Disinfection.
- To obtain knowledge of Microbial diversity.
- To know the basic Microbial community in natural habitats

Syllabus:

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

References:

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, 2nd Edition. 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.

M.Sc., Biotechnology

6. Laboratory manual in General Microbiology, N.Kannan, Panima publishers.
7. Bergey's Manual of Determinative Bacteriology. Ninth Edition J.G.Holt, N.R.Krieg., Lippincott Williams, Wilkin publishers, 2000.

Web Link:

1. <https://microbiologysociety.org/static/uploaded/23cbf9c5-f8c8-4f91-b092a4ad819e6357.pdf>
2. <https://faculty.washington.edu/korshin/Class-486/MicrobiolTechniques.pdf>

Pedagogy: Teaching / Learning methods

Lecture, PPT presentation Group Discussion

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Gain knowledge about the different cell organelles of microorganisms and their detailed functions.	K1 & K2
CO2	Study the growth and control of microbes as well as different bacteriological techniques involved in microbiology.	K2
CO3	Learn about the bio molecules by studying their structures and types.	K2 & K4
CO4	Students will learn about the different fields in microbiology.	K3 & K4
CO5	Gain knowledge about the different types of microorganisms and their significance	K3 & K6

Cognitive Level : K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	3	3	2	2	2	2
CO2	2	2	3	3	3	3	3	3	3	2
CO3	2	3	3	3	3	3	3	3	3	2
CO4	2	3	3	3	3	3	3	3	3	2
CO5	2	3	2	3	3	3	2	2	2	2

3 - Strongly Correlated; 2- Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course Code	Title of the Paper	Hours of Teaching / Week	No. of Credits
I	23P1BTEL1A	Major Elective – II BASIC ANALYTICAL METHODS	4	3

Nature of the Course

Relevant to Local need		Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need	√	Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need		Skill development Oriented	√	Addresses Environment and Sustainability	√
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

- 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

SYLLABUS

Unit	Content	No. of Hours
I	Electrochemical techniques The pH electrode- Ion-selective gas- sensing and oxygen electrodes. Beer-Lambert law, light absorption, and its transmittance. Principles and applications: UV- Visible Spectroscopy, Infrared Spectroscopy, NMR, Mass Spectrometry, Spectrofluorometric, Flame photometry, Atomic Absorption Spectrophotometry. Elementary details of biosensors.	12
II	Introduction and classification of chromatography Principles and applications of Column chromatography, Paper chromatography, TLC, GC, HPLC, HPTLC – Detection methods, qualitative and quantitative applications.	12
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 ultra centrifugation techniques. Isoelectric focusing, Blotting methods: Western, Southern and Northern-applications	12

IV	Electrophoresis Factors affecting the migration rate, electric field, buffer and supporting medium. Tiselius moving boundary electrophoresis. Agarose gel electrophoresis, PAGE, SDS-PAGE, Pulse-field gel electrophoresis, Cellulose acetate membrane electrophoresis.	12
V	Radio isotopic and imaging techniques Introduction to radio isotopes, detection. Measurement and uses of radio isotopes, Counting efficiency and autoradiography. Principles of microscopy, Fluorescent, Transmission and Scanning electron microscopy, confocal microscopy. Microtome analysis and measurement of images	12

Text Book

1. Keith Wilson, John M Walker. Principles and techniques of biochemistry and molecular biology. 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, 3rd Edition. Himalayan publications, 2009.
4. D. 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, 2nd Edition, 2007

Reference Book

1. Principles and Techniques of Practical Biochemistry (Paperback) by Keith Wilson (Editor), John Walker (Editor), John M. Walker (Author) "Fifth Edition 2000
2. Introductory Practical Biochemistry (Hardcover). By S.K. Sawhney; Randhir Singh (Editor) 2005
3. Principles of Physical Biochemistry (2nd Edition) by Kensal Evan Holde, Curtis Johnson, and Pui Shing Ho (Hardcover - April 16, 2005)
4. Physical Biochemistry: Applications to Biochemistry and Molecular Biology by David M. Freifelder (Paperback - Aug 15, 1982)
5. Instrumental Methods of Chemical Analysis by GR Chatwal and SK Anand (Hardcover - Jun 1980).

Web Link:

- <https://www.edx.org/course/basic-analytical-chemistry>,
- E-Books: <http://shvaiko.ru/wp-content/uploads/2010/02/Analytical-Techniques-Julia-C.-Drees-Alan-H.-B.-Wu.pdf>, <https://www.uvm.edu/~gpetrucc/courses/chem196/Textbooks/Manahan%20-%20Fundamentals%20of%20Environmental%20Chemistry/1491Ch25.pdf>, E-journals:
- <https://onlinelibrary.wiley.com/series/8247>,
- https://link.springer.com/chapter/10.1007/978-3-642-75490-6_15, Mapping with Programme

Pedagogy: Teaching / Learning methods

Lecture, Tutorial, Group Discussion, e-content

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Know the significance of instruments concerning diagnostic procedures.	K1, K2, K3, K4, K5 & K6
CO2	Handle qualitative and quantitative chroma to graphic techniques	K1, K3, K4 & K5
CO3	Handle centrifugation and separate samples For further practical's / research	K1, K2, K4, & K5
CO4	Handle different qualitative and quantitative electrophoresis techniques	K1, K2, K3, K4 & K5
CO5	Handle microscopes and Validate microscopical images	K1, K2, K3, K4, K5 & K6

Cognitive Level: K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Mapping of Course Outcomes with Programme Outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	3	2	2	2	3	2	3	3
CO2	2	3	2	2	2	3	3	3	2	2
CO3	3	2	2	3	3	2	2	3	2	3
CO4	2	3	3	2	2	3	2	2	3	3
CO5	3	2	3	2	3	2	3	2	3	3

3 - Strongly Correlated; 2 - Moderately Correlated; 1 - Weakly Correlated; 0 - No correlation

Semester	Course Code	Title of the Paper	Hours of Teaching / Week	No. of Credits
I	23P1BTEL1B	Major Elective – II VIROLOGY	4	3

Nature of the Course

Relevant to Local need		Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need	√	Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need		Skill development Oriented		Addresses Environment and Sustainability	√
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

- Contrast differences in virus architecture and classification.
- 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 anti viral strategies and social stigmas against infected individuals.

SYLLABUS

Unit	Content	No. of Hours
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: In vivo, In vivo, Ex vivo/Invitro. Cytopathic effect - pock forming unit.	12
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, micro array and nucleotide sequencing, LINE probe assay.	12
III	Bacterio phages and plant viruses: Bacteriophage: Morphology, genome organization, classification-Lifecycle-Lytic and Lysogenic Cycle, Head and tail phages-T4 phage- phage-	12

	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.	
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, Retro virus mediated oncogenesis.	12
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, immune modulators (cytokines), adjuvants to increase immunogenicity of vaccines. Antivirals: Interferons, 21 designing and screening for antivirals, mechanisms of action, antiretrovirals –mechanism of action and drug resistance.	12

Text Book

1. Virology principles and application John Carter and Venetia Saunders (2007) John Wiley and Sons publishers.
2. Analytical techniques in DNA sequencing edited by Brian K.Nunnally
3. Medical Microbiology: with student consult by Patrick R. Murray Ph.D. (Author), Ken S.RosenthalPhDSaunders;7thedition.

Reference Book

1. PrinciplesofVirology4theditionJaneFlint.
2. Real –Time PCR: Current technology and applications 1st edition (2009) edited by JulieLogan*et al.*,
3. Antiviral Agents, Vaccines and Immuno therapies. Stephen K. Trying. October 2004.MarcelDekker.

Web Link:

- InternationalCongressonTaxonomyofViruses;http://WWW.ncbi.nlm.nih.gov/ICTV
- KnipeDavidM.,PeterM.Howley,DianeE.Griffin,RobertA.Lamb,MalcolmA.Martin,BernardRoizman,StephenE.Straus,(2007),Field’sVirology,5thEd.LippincottWilliams&Wilkins
- CannAlanj, (2000), DNA virus Replication, Oxford University press
- <https://www.yourgenome.org/facts/what-is-PCR-polymerase-chain-reaction>.

Pedagogy: Teaching / Learning methods

Lecture, Tutorial, Group Discussion, e-content

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	describe and review the General Virology and cultivation of viruses	K1&K2
CO2	know the Viral diagnostic and detection methods	K1&K2
CO3	explain viral replication strategies; and compare and contrast replication mechanisms used by viruses relevant to human disease	K1&K2
CO4	discuss principles of virus pathogenesis	K1&K2
CO5	explain host antiviral immune mechanisms at a cellular and molecular level and vaccine strategies and mechanism of anti viral drugs	K1&K2

Cognitive Level: **K1** - Remember; **K2** - Understanding; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Mapping of Course Outcomes with Programme Outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

3 - Strongly Correlated; 2 - Moderately Correlated; 1 - Weakly Correlated; 0 - No correlation

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
I	23P1BTAECC1	Ability Enhancement Compulsory Course - Communicative Skill And Personality Development	2	2

Nature of the course

Employability Oriented	√	Relevant to Local need	√	Addresses Gender Sensitization	
Entrepreneurship Oriented	√	Relevant to national need	√	Addresses Environment and Sustainability	
Skill development Oriented	√	Relevant to regional need	√	Addresses Human Values	√
		Relevant to Global development need	√	Addresses Professional Ethics	√

Course Objectives

The main objectives of this course are to:

1. Cultivate positive personality traits for successful life.
2. Groom Winning Attitude among the learners.
3. Assist the learners to identify their own potential and realize their aspirations.
4. Enable a holistic development.
5. Facilitate optimum means of improving personal performance.

SYLLABUS

Unit	Content	No. of Hours
I	<ol style="list-style-type: none"> 1. Personality- Definition. 2. Determinants of Personality. 3. Perceptual Process. 4. Personality Traits. 5. Developing Effective Habits. 6. Self Esteem (Freud and Erikson). 7. Self Appraisal and Self Development. 8. Dos and Don'ts to develop positive self esteem. 9. Interpersonal Relationship. 10. Difference between Aggressive, Submissive and Assertive behaviour. 11. Mind Mapping, Competency Mapping, 360 degree assessment. 12. Presentation Skills – Opening, ending, Handling nerves, Handling audience, Power Storytelling, Visual aids, Question and answer session 	15

II	<ol style="list-style-type: none">1. Projecting Positive Body Language.2. Conflict Management.3. Change Management.4. Stress Management.5. Time Management.6. Goal Setting.7. Assertiveness and Negotiating Skill.8. Problem Solving Skill.9. Decision Making Skills.10. Leadership Qualities of a Successful Leader.11. Attitudes – Positive Attitudes.12. Public Speaking – Engaging, Connecting, and Influencing the audiences.13. Employability Skill – Group Discussion, Interview Questions, Psychometric analysis.	15
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Textbook:

1. Andrews, Sudhir. *How to Succeed at Interviews*. 21st (rep) New Delhi:Tata McGrew Hill 1988.
2. Hurlock.E.B (2006) :*Personality Development*, 28th Reprint. New Delhi: Tata McCraw Hill.
3. Kumar, Pravesh. *All about Self Motivation*. New Delhi:Goodwill Publication House. 2005.
4. Preston, David Lawrence.*365 Steps to Self-Confidence*. Mumbai: Jaico Publishers, 2007
5. Stephen.P.Robbins and Timothy. A.Judge: *Organisation Behaviour*. 16thEdition.Prentice Hall. 2014

References:

1. Grellet ,Françoise. *Developing Reading Skills*. Cambridge: Cambridge University Press, 2007.
2. Kristine, Brown and Susan Hood.*Academic Encounters Life in Society Reading, Study Skills, Writing*. , New Delhi:Cambridge University Press,2010.
3. Little ,Graham R .*Operations Team Leadership*. Mumbai :Jaico Publishers, 2006.
4. Nurnberg ,Maxwell and Morris Rosenblum *How to Build a Better Vocabulary*. New York :Warner Books, 1989.
5. O' Connell ,Sue with LousieHashemi.*Cambridge First Certificate: Listening and Speaking –*, Cambridge University Press, Cambridge, 2000.
6. Pfeifer , William Sanborn and T.V.S.Padmaja*Technical Communication : A Practical Approach*, (Sixth edition) New Delhi: Pearson, 2006.
7. Withrow, Jean, Gay Brookers and Martha Cumings .*Inspired to Write*. New York: Cambridge University Press, 2004.

Web resources:

- <https://www.managementstudyguide.com/personality-development.htm>
<https://www.artofliving.org/in-en/personality-development>
<https://study.com/academy/lesson/what-is-conflict-management-definition-styles-strategies.html>

<https://www.hays.com.au/career-advice/upskilling/soft-skills>

<https://www.skillsyouneed.com/presentation-skills.html>

Pedagogy: Teaching / Learning methods

Lecture, Tutorial, Assignment, PPT presentation, Group Discussion, e-content, Seminar, Tasks, Role play, Debate, Group Activities etc.

Course Out comes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Understand the significance of developing progressive and positive personality	K1,K2
CO2	Gain self-confidence and broaden perception of life.	K3
CO3	Maximize their potential and steer that into their career choice.	K4
CO4	Enhance one's self image and self-esteem.	K3, K5
CO5	Find a means to achieve excellence and derive fulfillment.	K6

Cognitive Level: K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Specific Outcomes

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

3 - Strongly Correlated; 2 - Moderately Correlated;
1 - Weakly Correlated; 0 – No correlation

Semester	Course code	Title of the course	Hours of teaching / week	No. of Credits
II	23P2BTC4	IMMUNOLOGY	4	4

Nature of the Course

Relevant to Local need		Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need		Entrepreneurship Oriented	√	Addresses Gender Sensitization	
Relevant to regional need		Skill development Oriented		Addresses Environment and Sustainability	
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

- Learn the basic components and principles of defense mechanism against infections
- Understand the properties of antigens and structure and types of Immunoglobulin
- understand the principle behind Antigen-Antibody reactions.
- Expedite how the immune system recognizes foreign antigen and the significance of self/non-self-discrimination
- Enrich the students' knowledge with respect to different applications of Immunology

Unit	Content	No. of Hours
I	Introduction to Immunology: History and scope of immunology. Immunity: Innate and Adaptive immunity – Humoral and cellular – Mediated Immune responses – Cells involved in the Immune response: Macrophages, B and T lymphocytes, Dendritic cells, Natural killer cells and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast cells. Lymphoid organs: Thymus, Bone marrow, Spleen, lymph nodes and MALT, GALT	12
II	Properties of Antigens and Antibody Antigens and Immunogenicity. Nature of Antigens and antibodies. Theories of Antibody formation. Antibody structure, structural basis of Antibody diversity: Properties of immunoglobulin and types of immunoglobulin, Immunoglobulin as Antigen, Complement and its role in Immune Responses.	12
III	Antigen - Antibody Reaction Strength of Antigen and Antibody reaction – Cross reactivity, Precipitation	12

	and Agglutination reactions – Radioimmunoassay (RIA) and ELISA. B-cell generation, activation and differentiation. Antibody production, Regulation and Diversity.	
IV	Cytokines, Hypersensitivity and Transplantation Structure of Cytokines; function of Cytokines. Complement fixation. Structure and function of Major Histocompatibility Complex (MHC) class I and II molecules - antigen recognition and presentation, HLA typing and Cellular Immunity. Hypersensitivity Reactions, Types of Hypersensitivity, Immune tolerance, Autoimmune diseases - Transplantation and Types of grafts.	18
V	Hybridoma Technology and Immuno techniques 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 (immuno blot) – flow cytometry and immuno-fluorescence microscopy including <i>in-situ</i> localization techniques such as FISH and GISH.	12

Text Books:

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

References:

1. Immunology (7th ed) J. Kuby, W. H. Freeman and Company, New York, 2013
2. Basic Immunology updated: functions and disorders of the immune system (3rd ed). Abbas, Andrew H. Lichtman, Saunders Publishers, New York, 2010
3. Immunology: an introduction (4th ed) I. R. Tizard, Saunders College Publishers, New York.
4. Essential Immunology (1st ed). Peter Delves, Seamus Martin, Dennis Burton, Ivan Roitt, Wiley-Blackwell Publication, Singapore, 2006
5. Immunology (Lippincott's illustrated review series) Thadoan, Roger Melvold, Susan Viselli, Carl Waltenbaugh, Lippincott Williams & Wilkins Publications, 2012
6. Fundamental Immunology (7th ed) Williams Paul, Lippincott Williams & Wilkins Publications, 2012
7. Essentials of Clinical Immunology (6th ed) Helen Chapel, Mansel Haeny, Siraj Misbah, Neil Snowden, Wiley-Blackwell Publications, 2014
8. Monoclonal Antibodies: Principles and Practice (3rd ed) W. Gooding, Academic Press, 2010
9. Monoclonal Antibodies: Methods and Protocols (2nd ed). Vincent Siso, Nicola Fisher, Human Press, 2014
10. Rastogi, S.C. (2002), Elements of Immunology, CBS Publishers and Distributors, 4596/1-A, 11 Darya Ganj, New Delhi.
11. Shetty, N. (2006), Immunology. New Age International (P) Limited, Publishers, New Delhi
12. Gupta S.K. (1999) Immunology, Narosa Publishing House, New Delhi.

Web resources :

1. <https://nptel.ac.in/courses/102/105/102105083/>
2. <https://www.coursera.org/specializations/immunolog>
3. <https://www.mdpi.com/2076-0817/11/4/390/htm>
4. <https://www.ncbi.nlm.nih.gov/books/NBK27169/>
5. <https://pubmed.ncbi.nlm.nih.gov/12720278/>

Pedagogy: Lecture, Assignment, PPT presentation, Quiz, Demonstration

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Know about the basics of Immunity and various components of Immune system	K1, K2, K3, K4, K5 & K6
CO2	Understand about the Antigens and structural properties of Immunoglobulin	K1, K3, K4 & K5
CO3	Understand principle of antigen-antibody reaction and their types	K1, K2, K3, K4, K5 & K6
CO4	Evaluate the immune cells are signaled, processed and destroyed	K1, K2, K3, & K4
CO5	Know about the various immunological technologies.	K1, K2, K3, K5 & K6

Cognitive Level : K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	2	3
CO2	3	3	2	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	3	3	3	3
CO4	3	2	3	3	2	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3		3

3 - Strongly Correlated; **2**- Moderately Correlated; **1** - Weakly Correlated; **0** – No correlation

Semester	Course code	Title of the course	Hours of teaching / week	No. of Credits
II	23P2BTC5	GENETIC ENGINEERING	4	4

Nature of the Course

Relevant to Local need		Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need	√	Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need		Skill development Oriented	√	Addresses Environment and Sustainability	
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

- Understand the basics of Enzyme, Ligases in Genetic Engineering Tools.
- Well understand the Cloning Vectors.
- Obtain knowledge about Genecloning strategies and transformation techniques.
- Obtain the knowledge of Selection, Screening, and analysis of recombinants.
- Know the basic Genetic Engineering Techniques-Application of rDNA technology.

Unit	Content	No. of Hours
I	Tools of Genetic Engineering: Nomenclature of Enzymes, Types-endo and exonucleases, Restriction endonucleases. Recognition sequences and mechanism of action; Isochizomers, Isozymes -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
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, pUC18 & 19 vectors, and Expression vectors, Bacteriophage vectors, Lambda phage, Insertion vectors, Replacement vectors, Cosmids, Phagemids, Mini chromosomes, BAC's, YAC's, Shuttle vectors, Tiplasmids, Vectors for animals -SV40 and Bovine papilloma virus.	12

III	<p>Gene cloning strategies and transformation techniques: Chimeric DNA, Cloning strategies- ligation, Transformation and selection, use of adaptors and linkers, Homo polymer 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,CaCl₂,calcium phosphate precipitation method, liposome – mediated method</p>	12
IV	<p>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 – radio labelled probes and its applications.</p>	12
V	<p>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.</p>	12

Textbook:

1. Concepts of Genetics(Mastering genetics) 12th Edition by William Klug (Author), MichaelCummings(Author),CharlotteSpencer(Author),MichaelPalladino(Author),Darre lKillian(Author)
2. Genetics: A Conceptual Approach Sixth Edition by Benjamin A. Pierce (Author)W. H. Freeman; Sixthedition(December19,2016)
3. Genetics:FromGenestoGenomes,5thedition 5thEditionbyLelandH.Hartwell (Author), MichaelL.Goldberg (Author), JaniceA.Fischer (Author), LeroyHood (Author), CharlesF.Aquadro (Author)McGraw-HillEducation;5thedition(September5,2014)
4. Genetics:AnalysisofGenesandGenomes:AnalysisofGenesandGenomes 9thEditionbyDanielL.Hartl(Author),BruceCochrane (Author)Jones&BartlettLearning;9thedition(December14,2017)
5. Principles of Genetics 6th Edition by D. Peter Snustad(Author), Michael J. Simmons (Author) John WileyandSons;6thedition(August23,2011)
6. An Introduction to Genetic Engineering 3rd Edition, author :Desmonds S.T. Nicholl, University of PaisleyMay2008.
7. Gene Cloning and DNA Analysis: An Introduction 7th EditionbyT. A. BrownWiley-Blackwell; 7th edition(January19,2016)
8. Biotechnology: Applying the Genetic Revolution 1st EditionbyDavid P. Clark BA (honors)Christ's CollegeCambridge 1973
PhD University of Brsitol (England) 1977 (Author), Nanette Pazdernik Academic Cell;1stedition(September19,2008)

Reference Book:

1. An Introductionto Genetic Engineering (Studiesin Biology) 2nd Edition by DesmondsS.T.Nicholl
2. GeneticallyEngineeredFoods(Volume6)(HandbookofFood

M.Sc., Biotechnology

Bioengineering, Volume 6) 1st Edition by Alexandru Mihai Grumezescu (Editor), Alina Maria Holban (Editor) 2017.

3. Genetically Engineered Foods Hard cover – January 1, 2021 by Armando Mills (Author) ED-Tech Press; 1st edition
4. Genetic Engineering: A Christian Perspective Paperback – December 27, 2019 by Michael Scaife

Web Link:

- https://www.amazon.in/s?k=genetic+engineering+book&hvadid=82669701180826&hvmt=bp&hvdev=c&hvqmt=p&tag=msndeskstdin-21&ref=pd_sl_3hztgcyjhj_p
- E-journals: Process Biochemistry (Elsevier), Journal of Cellular Biochemistry (Wiley)

Pedagogy: Teaching / Learning methods

Lecture, PPT presentation, Quiz, Group Discussion, e-content Seminar

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Identify the tools which are used in Genetic Engineering and exhibit their practical's.	K1 K2
CO2	differentiate the Cloning Vectors and their roles in gene cloning.	K2 K4
CO3	Describe the Techniques in Gene cloning – Physical and chemical methods.	K4
CO4	Explain the screening techniques to identify recombinants like PCR, DNA sequencing, etc	K3 K5
CO5	Analyze and cross – examine the Genetic Engineering of patients who visit the Lab.	K4 K5

Cognitive Level : K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	2	2	3	3	3	2	3	3	2	2
CO3	2	2	3	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	2	3	3
CO5	2	2	2	3	3	3	2	2	3	2

3 - Strongly Correlated; 2 - Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course code	Title of the course	Hours of teaching / week	No. of Credits
II	23P2BTC6	DEVELOPMENTAL AND STEM CELL BIOLOGY	4	4

Nature of the Course

Relevant to Local need		Employability Oriented	√	Addresses Professional Ethics	√
Relevant to national need		Entrepreneurship Oriented	√	Addresses Gender Sensitization	
Relevant to regional need		Skill development Oriented		Addresses Environment and Sustainability	√
Relevant to Global need	√		Addresses Human Values	√	

Course Objectives

The main objectives of this course are to:

1. Study the basics of sperm, egg cell cycle and its various stages
2. Teach the developmental concepts of drosophila and chick
3. Teach the concepts of stem cell, embryonic and adult stem cell
4. Study the types of stem cell and stem cell mediated antigen role different tem cell
5. Understand the recent advances and its applications to modern biotechnology

Unit	Content	No. of Hours
I	DEVELOPMENTAL BIOLOGY Introduction to Developmental Biology: Cells and morpho gens gradients. Ultra structure 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
II	MORPHOGENESIS AND ORGANOGENESIS Developmental Concepts: Morpho genesis and organ ogenesis 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. Teratogenesis-Ageing.	12
III	INTRODUCTIONTOSTEMCELLBIOLOGY Concepts in stem cell biology (renewal and potency) introduction to stem cells, Germ line stem cells and germ line derived pluri potent cell, Epi genetics, nuclear transfer and cloning. Introduction to embryonic and adult stem cell.	12

IV	TYPES OF STEM CELL Types of Stem cell: 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	18
V	THERAPEUTIC APPLICATIONS OF STEM CELL Technique and Application Techniques used for stem cell isolation, enumeration and <i>in vivo</i> 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 – cryo preservation techniques, national and International guide line, recent advances in stem cell biology.	12

Textbook:

1. Essentials of stem cell biology 2009, (seconded) Robert Lanza, John Gearhart, Brigid Hogan, Douglass Melton, Roger Pedersen, E. Donnall Thomas, James Thomson and Sir Ian Wilmutt.
2. Anna. Kiessling, human embryonic stem cells: an introduction to the science and therapeutic potential, Jones and Bartlett, 2003
3. Peter J. Quesenberry, stem cell biology and gene therapy, 1st ed, Wiley, 1998
4. Developmental biology, (2018), 11th edition by Michael J.F. Barresi, Scott F. Gilbert.

References:

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

Web resources:

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

Pedagogy: Teaching/Learning methods

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Know about basic knowledge of Developmental Biology	K1, K2, K3, K4, K5 & K6
CO2	Understand mechanism of developmental morphogenesis and organogenesis	K1, K3, K4 & K5
CO3	Understand the stem cell and its importance	K1, K2, K3, K4, K5 & K6
CO4	Know the different types of stem cell	K1, K2, K3, K4 & K5
CO5	Realise the various application of stem cell in medicine.	K1, K2, K3, K4, K5 & K6

Cognitive Level :K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	2	3
CO2	3	3	2	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	3	3	3	3
CO4	3	2	3	3	2	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3

3 - Strongly Correlated; 2- Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
II	23P2BTC7	BIOINFORMATICS	4	4

Nature of the course

Relevant to Local need		Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need	√	Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need		Skill development Oriented		Addresses Environment and Sustainability	
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

1. Provide information an understanding of the major computational problems in the field of molecular biology and to gain knowledge on molecular databases.
2. Enable to learn alignment of sequence, rapid similarity searching, phylogenies.
3. Comparative genomics, patternsearch, classification of sequence and structure,
4. Automatedpatternlearning,representingandsearchingproteinstructure, geneexpressionprofiling,clustering expressed genes, discovering transcription factor bindings sites, discovering common functions of co-express edgenes,
5. Make them translate metabolic pathways, signaltransductionpathways and management.

Unit	Content	No. of Hours
I	Biological data bases Gen bank: sequence data/ types;- protein data bases – ESTs STSs – GSSs – HTGS; NCBI- Pub Med- Entrez –BLAST–OMIM; Types of Accession Numbers – Locus Link, Unigene, Entrez, EBI, and Expasy, Nucleic Acid Data Bank(NDB)	12
II	Sequence alignment Alignment algorithms – global and local –significance; BLAST search steps – BLAST algorithm – BLAST search strategies; advanced BLAST – alignment tools.	12
III	Gene expression analysis tools Them RNA- cDNA - libraries; microarrays: experimental design – probe – hybridization – DNA fragment counting assembly and restriction enzyme mapping. Image analysis – data analysis – biological confirmation – microarray database.	12

IV	Proteomic analysis tools Protein domains and motifs –bio informatic tools for high through put protein analysis – protein structure –Sequence Similarity Basics: Similarity, Identity, Homology, Homology Modelling and visualization	12
V	Pathway bioinformatics: Protein – carbohydrate metabolism – biochemical cycles –inter connection of path ways – metabolic regulation - KEGG: theory and practice.	12

Textbook:

1. Bioinformatics: Sequence and genome analysis by David, W Mount, Cold Spring Harbor 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, 2nd Edition, Campbell AM & Heyer LJ, Pearson, 2007.
5. Bioinformatics: Sequence and Genome Analysis, 2nd Edition, Mount D, CSHL Press, 2004.
6. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition, Baxevanis A D & Francis BF, Wiley, 2004.
7. School of Biotechnology SYLLABUS of M.Sc. (Biotechnology) ODD SEMESTERS (2017 & 2018 Batches) Page 11 of 254. A Bioinformatics Guide for Molecular Biologists,
8. Aerni S & Sirota M, CSHL Press, 2014. 5. Genomes, 2nd Edition, Brown TA, Oxford, Wiley, 2002.
9. S.C. Rastogi et al. Bioinformatics: Methods and Applications: (Genomics, Proteomics and Drug Discovery) Kindle Edition.

Reference books

1. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory Press, New York. 2004.
2. Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellette, B.F., Wiley India Pvt Ltd. 2009
3. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith. Pearson Education. 1999
4. Stuart Russel and Peter Norvig, “Artificial Intelligence- A Modern Approach”, Prentice Hall, 1995.
5. Understanding Bioinformatics, Jeremy O. Baum, Marketa J. Zvelebil. 2007, Garland Science, USA 2
6. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Andreas D.
7. Baxevanis, B. F. Francis Ouellette, 1998, Wiley Publishers.

WEB Link:

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

Pedagogy: Teaching / Learning methods

Lecture, PPT presentation, Group Discussion

Lecture, PPT presentation, Quiz, Group Discussion, e-content Seminar

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Use various biological software databases.	K1
CO2	Do alignment and compare the differences of local and global using BLAST and advanced alignment tools.	K2
CO3	Underst and the techniques using enomics and proteomics and their applications	K2 & K4
CO4	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	K2 & K5
CO5	Interpret the biological metabolic pathways	K2

Cognitive Level :K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	2	3
CO2	3	3	2	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	3	3	3	3
CO4	3	2	3	3	2	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3

3 - Strongly Correlated; 2 - Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course Code	Title of the Paper	Hours of Teaching / Week	No. of Credits
II	23P2BTCP3	Practical – III IMMUNOLOGY	4	3

Nature of the Course

Relevant to Local need	√	Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need	√	Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need	√	Skill development Oriented	√	Addresses Environment and Sustainability	√
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

1. Acquire the knowledge on Immunological techniques.
2. Understand the genetics in various fields of science and its medical applications.

1. IMMUNOLOGY

1. Blood grouping
2. Identification and enumeration of Lymphocyte.
3. Radial immuno-diffusion test.
4. Ouchterlony double diffusion.
5. Immuno electrophoresis
6. Rocket Immuno electrophoresis
7. Latex Agglutination
8. Quantitative Precipitin assay
9. ELISA
10. Western Blotting

Text Book

1. A text book of Experimental Procedures in Life Sciences; Rajan. S First edition; 2018.

Reference Book

1. Practical Immunology. Franck C.Hay, Olwyn M.R.Westwood. Wiley-Black well publications, 2010.
2. immunoassays:
A Practical Approach. James P. Gosling (editor). Oxford university press, USA, 2010.
3. Lab manual in
biochemistry, immunology and biotechnology. Arti Nigam Archana ayyagari. McGraw-Hill education, 2008.

4. Practical immunology. Rabindra Narain, dom & wisdom publications, 2012

Web Link:

1. <http://www.fao.org/3/t0551e/t0551e05.htm>
2. <http://www.fao.org/fcit/environment-health/solid-waste/en/>

Pedagogy: Teaching / Learning methods

Lecture, Tutorial, Group Discussion, e-content Seminar etc.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Understand and assimilate the specific concepts Immunology.	K1 & K2
CO2	Describe the potential application of immune diffusion techniques	K2
CO3	Explain tools and techniques in the field of Immunology.	K2 & K4
CO4	Know the role and application of blotting techniques in biotechnological.	K3 & K4
CO5	Gain knowledge about ELISA	K3 & K6

Cognitive Level: K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	3	3	2	2	2	2
CO2	2	2	3	3	3	3	3	3	3	2
CO3	2	3	3	3	3	3	3	3	3	2
CO4	2	3	3	3	3	3	3	3	3	2
CO5	2	3	2	3	3	3	2	2	2	2

3 - Strongly Correlated; 2 - Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course Code	Title of the Paper	Hours of Teaching / Week	No. of Credits
II	23P2BTCP4 (SEC IV)	Practical – IV GENETIC ENGINEERING AND BIOINFORMATICS	4	3

Course Objectives

The main objectives of this course are to:

3. To study the isolation of DNA , Electrophoresis techniques
4. Understand the genetics in various fields of science and its medical applications.
5. Gain knowledge about amplification technique.
6. Know about Software tools for modeling of bio-molecules.

1. GENETICENGINEERING

1. Isolation of genomic DNA from the given sample and its molecular weight determination.
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 Lambdaphage DNA.
5. Ligation of DNAandanalysisby electrophoresis.
6. DNA amplification by PCR.
7. Preparation of competent cellsandtransformationbyCaCl₂methodand Selection of transformed colony by X-Gal method.
8. Determination of molecular weight of proteins by SDSPAGE.

2. BIOINFORMATICS

1. PCR Primer design
2. Homology search
3. Multiple Sequence alignment
4. Sequence retrieval from biological databases- NCBI, EMBL, DDBJ, SWISSPROT.
5. Protein structure visualization- Rasmol.

Text Book

1. A text book of Experimental Procedures in Life Sciences; Rajan. S First edition; 2018.

Reference Book

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2017) 5 th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC).
2. Molecular cloning,M.R.Green and J. Sambrook (2012) A Laboratory Manual Vol. III. (Fourth edition) Cold Spring Harbor Laboratory Press.
3. Nucleic acid and protein sequence analysis, A practical approach by MJ Bishop and C.J. Ramslings (1987) IRL Press.
4. Sequence Analysis primer by M Gribskov, J. Devercux (1989) Stockton Press.

5. Molecular databases for protein and structure studies by Sillince, J.A. and Sillince M (1991) Springer Verlag.

Web Link:

1. <https://myplan.uw.edu/course/#/courses/BIOL302?states=N4Ig7gDgziBcLADrgJYDsAmB7MAJApigOYAWALsrAJxUAMANMmOtmAApZQpkpZqW0AviEFA-> (University of Washington)- Unit III
2. http://courses.cornell.edu/preview_program.php?catoid=31&poid=15391#-(Cornell University) Unit IV - cutting-edge technologies of recombinant DNA, next-generation DNA sequencing.
3. <https://bee.cals.cornell.edu/research/biological-engineering/> - Unit V – Cell free protein Production, protein engineering
4. <http://www.nus.edu.sg/nusbulletin/faculty-of-science/undergraduate-education/degree-requirements/bachelor-of-sciencebachelor-of-science-hons-programme-requirements-b-sc-b-sc-hons/computational-biology/>(NUS)

Pedagogy: Teaching / Learning methods

Lecture, Tutorial, Group Discussion, e-content

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Knowledge in fundamental steps of genetic engineering procedure.	K1 & K2
CO2	Gain Skills in bacterial transformation	K2 & K5
CO3	Gain Skills in DNA and RNA isolation techniques.	K2 & K4
CO4	Develop skill about electrophoresis and PCR technique	K3 & K4
CO5	Know the principle and application of bioinformatics	K3 & K6

Cognitive Level: K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	3	3	2	2	2	1
CO2	2	2	3	3	2	3	3	3	3	2
CO3	2	3	2	3	3	2	3	2	3	1
CO4	2	3	3	3	2	3	3	3	3	2
CO5	2	3	2	3	3	3	2	2	2	2

3 - Strongly Correlated; 2 - Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course code	Title of the course	Hours of teaching/ week	No. of Credits
II	23P2BTEL2A	Major Elective – II ENZYME TECHNOLOGY	4	3

Nature of the Course

Relevant to Local need	√	Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need	√	Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need	√	Skill development Oriented	√	Addresses Environment and Sustainability	√
Relevant to Global need	√			Addresses Human Values	√

Course Objectives The main objectives of this course are to

1. Learn about the classification and structure properties of enzymes
2. Understand the kinetics, catalysis and inhibitions activities of enzymes
3. Understand physical properties, downstream process and purification of enzymes.
4. Expedite how enzymes are used as co-factors.
5. Enrich the students' knowledge with respect to different applications of Enzymes

Unit	Content	No. of Hours
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 quaternary structure. Specificity of Enzymes: Types of specificity, the Koshl and “induced fit” hypothesis, strain or transition - state stabilization hypothesis.	12
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.	12
III	Extraction and purification of microbial enzymes : Importance of enzyme purification, different sources of enzymes. Extracellular an intra cellular 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 crystallization techniques. Criteria of purity of enzymes. Pit falls in working with pure enzymes.	12

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 all ostericinhibition 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.	12
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. Enzymes sensors for clinical processes and environmental analyses. Enzymes as therapeutic agents	12

Textbook

1. Trevor Palmer, Enzymes IInd Horwood Publishing Ltd 2007
2. Wiseman, Enzyme Biotechnology, Ellis Horwood Pub.1995
3. Introduction to proteins Structure by Branden and Tooze (1998): Garland Publishing Group.
4. Biotechnology. Volume 7A - Enzymes in Biotechnology. 1983 Edited by H.J. Rehm and G. Reed. Verlag Chemie.
5. Methods of Enzymatic analysis by Hans Ulrich, Bergmeyer, Academic Press.
6. Methods in Enzymology by W.A. Wood, Academic Press.
7. Topics in Enzyme and Fermentation Biotechnology by L.N. Wiseman, John Wiley and sons.

Reference:

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): John Wiley.
4. Methods in Enzymology. Volume 22- Enzyme purification and related techniques. Edited by William B. Jakoby. Academic press, New York.
5. Allosteric Enzymes- Kinetic Behaviour. 1982. By B.I. Kurganov, John Wiley and Sons. Inc., New York.
6. Enzymes as Drugs Edited by John S. Holcenberg and Joseph Roberts, John Wiley & sons New York.
7. Advances in Enzymology by Alton Meister, Interscience Publishers.

Web link

1. <https://www.slideshare.net/neutromec/introduction-to-enzymes-11298338>
2. <https://www.worthington-biochem.com/sites/default/files/2022-03/Enzymes.pdf>
3. <https://www.slideshare.net/KamalKishor31/enzyme-kinetics-57408548>
4. http://www.columbia.edu/itc/chemistry/chem-c2407/hw/ENZYME_KINETICS.pdf
5. http://www.columbia.edu/itc/chemistry/chem-c2407/hw/ENZYME_KINETICS.pdf
6. <https://www.slideshare.net/DipeshTamrakar2/enzyme-inhibition-79640392>
7. <https://www.slideshare.net/kamblesai2611/immobilization-of-enzymes-87581165>

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Know about basic knowledge of enzymes	K1 & K2
CO2	understand the mechanis mofenzyme activities	K2
CO3	Understand physical properties of enzyme.	K3
CO4	Understand the function of enzyme in different processes.	K4 & K5
CO5	Know various application of enzyme technologies.	K3 & K6

Cognitive Level :K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	2	3	3	2	3
CO2	3	3	3	3	3	2	3	3	2	3
CO3	3	3	3	3	3	3	2	3	3	2
CO4	3	3	3	3	2	3	3	2	3	3
CO5	3	3	3	3	2	3	2	2	3	2

3 - Strongly Correlated; **2**- Moderately Correlated; **1** - Weakly Correlated; **0** – No correlation

Semester	Course code	Title of the course	Hours of teaching / week	No. of Credits
II	23P2BTEL2B	Major Elective – II PHARMACEUTICAL TECHNOLOGY	4	4

Nature of the Course

Relevant to Local need	√	Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need	√	Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need	√	Skill development Oriented	√	Addresses Environment and Sustainability	
Relevant to Global need	√			Addresses Human Values	

Course Objectives

The main objectives of this course are to:

- Learn drugs and its involved detoxification through phase I & II reactions
- Teach drug mechanism like passive and active phases
- Learn the drugs manufacture bio technological pharmaceutical industry
- Understand the importance of drugs in treating various metabolic disorders
- Teach various applications of drugs in various fields.

Unit	Content	No. of Hours
I	Introduction to Pharmacology Drug - structural feature and pharmacology activity, pro drug concept. Absorption – first –pass effect. distributor, metabolism- phase I, II reactions, action of cytochrome p450 & elimination of drug receptor-localization, type and sub types, models and their drug-receptor interaction, agonist & antagonist.	18
II	Drug and Vaccination: Routes and principles of administration of drugs - Indian pharmacopoeia: Legal issues; Storage of various drugs; Calculation of drug dosage - Rational use of drugs - Principles of therapeutics Adverse response to drugs, drug tolerance, drug intolerance, Idiosyncrasy (pharmacogenesis), drug allergy. Tachyphylaxis, drug abuse, vaccination against infection	18
III	Biotechnology and pharmacy: Pharmacology of commonly used; Penicillin - Cephalosporins – Amino glycosides - Macrolide & Broad Spectrum Antibiotics - genetically engineered protein and peptide agents. Novel drug delivery systems –non conventional routes of administration. Anti AIDS drug development, oncogene target for drugs, multi-drugs resistance.	18

IV	Pulmonary and Gastro intestinal drugs: 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 - sulfonamides, trimethoprim, cotrimoxazole, penicillin and macrolides. Amino glycosides, cephalosporin and bacterial resistance. Insulin and oral diabetic drugs, anti fertility and ovulation inducing drugs.	18
V	Origin of Drugs and Chemotherapy: Drugs of plant origin: drug dependence and abuse- management of self – poisoning cancer. Chemotherapy - cyto toxic drug. Immune suppressive drug therapy. New biological targets for drug development. Novel drug screening strategies.	18

Textbook:

1. S.D Seth, Text book of Pharmacology, 3rd edn. Published by Elsevier, 1998.
2. Bertran G Katzung, Susan B Masters Anthony J.Treanor Basic & Clinical Pharmacology 12th 2015
3. George M Brenner Craig M Stevens Pharmacology 4th edn. 2013
4. Harshmohan, Basic Text Book Pathology Harshmohan 7 th 2015

Reference Book:

1. Satoskar, Bhandarkar, Ainapure: Pharmacology and pharmacotherapeutics, 18 Edition Popular Prakashan Mumbai.
2. M M Das: Pharmacology, Books & Allied (p) Ltd, 4 Edition 2001.
3. Linda, Skidmore Roth: Mosby's 2000 Nursing Drug Reference, Mosby Inc, Harcourt Health Sciences Company, Missouri 2000.
4. Ramesh Karmegan: First aid to Pharmacology for undergraduates, Paras Medical publishers, Hyderabad, India, 1 Edition 2003.
5. K D Tripathi: Essentials of medical pharmacology, 4 Edition, Jaypee Brothers, Bangalore.
6. Govoni & Hayes: Drugs and nursing implications, 8 Edition, Appleton & Lange Newyork.
7. Rodman & Smith: Clinical pharmacology in nursing, 2 Edition, J B Lippincott company, Philadelphia.
8. Richard A Lehne : Pharmacology for nursing care , 3 Edition ,W B S aunderers company Philadelphia, 1990.
9. Lalit Mishra: Drug Today, Vol 12, No 12, Lorina publications Inc. Delhi 2004..

Web Link:

1. <https://books.google.co.in/books?id=51ozlZRBvQwC&printsec=copyright#v=onepage&q&f=false>
2. https://pharmacomedicale.org/images/cnpm/CNPM_2016/katzung-pharmacology.pdf
3. <https://www.slideshare.net/AbhayRajpoot3/introduction-to-pharmacology-232361155>
4. https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/health_science_students/pharmacology.pdf
5. <https://www.slideshare.net/diptisorte/chemotherapy-111124533>
6. <https://www.slideshare.net/diptisorte/drugs-used-in-nervous-system>
7. <https://www.slideshare.net/diptisorte/unit-10-cardiovascular-drugs>
8. <https://www.slideshare.net/diptisorte/drug-used-in-skin-and-mucus-membrane>

9. <https://www.slideshare.net/USrinivasa/ayurveda-homeopathy-unani-medicine-by-drusrinivasa-professor-and-head-srinivas-college-of-pharmacy-mangalore>

Pedagogy: Teaching / Learning methods

Lecture, PPT presentation, Quiz, Group Discussion, e-content Seminar

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Know about basic knowledge of drugs of phase I & II	K1 & K2
CO2	Understand drugmechanismanditsadverse effects.	K2
CO3	Understand biotechnology in drug development, especially for AIDS	K3
CO4	Understand drug acting on various systems of human body.	K4 & K5
CO5	Know drugs and its importance various treatment like diabetes, cancer, lipidemia and infertility and able to know various application of drug depend enceandabuse-management	K3 & K6

Cognitive Level: K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Specific Outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	2	3	3	2	3
CO2	3	3	3	3	3	2	3	3	2	3
CO3	3	3	3	3	3	3	2	3	3	2
CO4	3	3	3	3	2	3	3	2	3	3
CO5	3	3	3	3	3	3	2	2	3	2

3 - Strongly Correlated; 2- Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
II	23P2PBTAECC2	Ability Enhancement Compulsory Course - Language Lab	2	2

Nature of the course

Employability Oriented	√	Relevant to Local need	√	Addresses Gender Sensitization	
Entrepreneurship Oriented	√	Relevant to national need	√	Addresses Environment and Sustainability	
Skill development Oriented	√	Relevant to regional need	√	Addresses Human Values	√
		Relevant to Global development need	√	Addresses Professional Ethics	√

Course Objectives

The main objectives of this course are to:

- To facilitate computer-assisted multi-media instruction enabling individualized and independent language learning
- To sensitize students to the nuances of English speech sounds, word accent, intonation and rhythm
- To bring about a consistent accent and intelligibility in students' pronunciation of English by providing an opportunity for practice in speaking
- To improve the fluency of students in spoken English and neutralize their mother tongue influence
- To train students to use language appropriately for public speaking and Interviews

Unit – I LSRW

Listening Skills: Introduction to Phonetics – Speech Sounds – Vowels and Consonants, Listen to News, poem, songs, Motivational speech, stories, movies, interesting facts, sign of zodiac, dialogues, idioms, dictation – Common errors

Speaking Skills: Stress, Intonation, Homophone, Silent Letters, Greetings, Small Talk, Telephone English, Role Play, Tongue Twisters, Welcome Speech & Vote of Thanks, Compering, Declamation, Sing Along, Brain Storming, JAM (Just A Minute)

Reading Skills: Reading test, Skit, Proof Reading, Oral Reading Fluency, Reading Stories,

Writing Skills: learn English Grammar through Tamil Translation, Reading Comprehension-short stories, informational passages, Advanced Critical reading – Intelligence Augmentation, Dialogues, Sentence Completion, Word Definition, Classic Analogy Bridges, Sentence Analogies, Same Sound, Divided Syllables, Finish the Story, Answering the questions, Practical Writing, Making a formal Argument, Free Writing, Using Precise Language

Unit – II Career and Soft Skills

Career Skills: Body Language (BL) : BL Interview, BL Model, BL Tips, Business English, Communication skills, GD, Interview Skills
Soft Skills: Assertiveness, Creativity, Critical Thinking and Problem Solving, Empathy, Enthusiasm and attitude, Goal Setting, Great interviews, Negotiation Skills, Personality Development, Professionalism, Self Esteem, Stress Management, Team Building, Time Management, Motivation and Attitude, Interpersonal relationship and skills, Networking,

Reference:

1. Materials prepared by the Department of English for Writing skills
2. Soft Skills – Know Yourself and know the world, Dr.K.Alex, Chand Publications, 3rd revised edition 2014
3. Software : Express Pro Lite

The Language Lab focuses on the production and practice of sounds of language and familiarizes the students with the use of English in everyday situations both in formal and informal contexts.

Learning Outcomes: Students will be able to attain

- Better understanding of nuances of English language through audio- visual experience and group activities
- Neutralization of accent for intelligibility
- Speaking skills with clarity and confidence which in turn enhances their employability skills

Minimum Requirement of infrastructural facilities for Language Lab:

1. Computer Assisted Language Learning (CALL) Lab:

The Computer Assisted Language Learning Lab has to accommodate 40 students with 40 systems, with one Master Console, LAN facility and English language learning software for self- study by students.

System Requirement (Hardware component):

Computer network with LAN facility (minimum 40 systems with multimedia) with the following specifications:

- i) Computers with Suitable Configuration
- ii) High Fidelity Headphones

2. Interactive Communication Skills (ICS) Lab:

The Interactive Communication Skills Lab: A Spacious room with movable chairs and audio-visual aids with a Public-Address System, a LCD and a projector etc.

Semester	Course code	Title of the course	Hours of teaching / week	No. of Credits
III	23P3BTC8	PLANT BIOTECHNOLOGY	4	4

Nature of the Course

Relevant to Local need		Employability Oriented	√	Addresses Professional Ethics	√
Relevant to national need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need		Skill development Oriented	√	Addresses Environment and Sustainability	√
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

- Understand the role of plants nuclear, chloroplast and mitochondrial genomes and Equip students with knowledge on molecular markers and marker-aided breeding
- Understanding the mechanism of gene transfer in plant and various methods of gene transfer
- Understand various Components of plant genetic engineering
- Expedite the students to understand the techniques involved in plant tissue culture
- Enrich the students' knowledge with respect to different applications of transgenic technology

Unit	Content	No. of Hours
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
II	Methods of gene transfer in plants Structure and function of Ti plasmid of Agro bacterium, 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
III	Plant Genetic Engineering Plant vectors: Co-integrate, binary vectors and viral vectors. Designing gene constructs - Promoters and poly-A signals, Protein targeting signals, Plant selectable markers, Reporter genes. Positive selection, Select able marker elimination, Trans gene silencing. Trans plastomics: Chloroplast transformation: advantages. Strategies for marker free transformation.	12

	Analysis of transgenic plants. Genome editing technology in Plant - CRISPR/ Cas.	
IV	Plant Cell and Tissue Culture Tissue culture media (composition and preparation), Callus and suspension culture, Somaclonal variation, Micro propagation, 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
V	Application of Plant Biotechnology 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 immune therapy. Expression of recombinant antibody fragments in plants.	12

Textbook:

1. Plant Biotechnology: The genetic manipulation of plants. Second edition. Slater, Scott, and Fowler, 2008, Oxford University Press, UK.
2. An Introduction to Plant Tissue Culture, Third Edition, M.K. Razdan, Oxford and IBH Publishing Co., 2003.
3. Introduction to plant biotechnology, Third edition, HS Chawla, 2009.
4. Cassells, A. 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. Second Edition. Oxford University Press. Paul Christou and Harry Klee. (2004).
7. Handbook of Plant Biotechnology, 2nd volume set, Wiley publisher.
8. Bhojwani and Dantu, (2013). Plant Tissue Culture: an Introductory Text, Springer, New Delhi.
9. Bhojwani, S. Sand Razdan. M.K. (2009). Plant Tissue Culture-Theory and Practice. Elsevier India Pvt. Ltd.

Reference Book:

1. Slater A, NWS Scott, MR Fowler. Plant biotechnology, Oxford University Press, 2003.
2. Nigel W. Scott, Mark R. Fowler, Adrian Slater. Plant Biotechnology: The genetic manipulation of plants 2nd Edition, Oxford University Press, 2008.
3. Bob Buchanan, Wilhelm Gruissem, Russell Jones. Biochemistry & Molecular Biology of Plants. I.k. International Pvt. Ltd, 2007.
4. Introduction to Plant Biotechnology by H.S. Chawla, 2002. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
5. Plant molecular genetics by Monica. A. Hughes. 1999. Pearson Education limited, England.
6. An introduction to genetic engineering in plants, Mantel S.H, Mathews J.A. Mickee R.A. 1985. Blackwell Scientific Publishers. London.

7. ScottandMarkR.Fowler,2003,OxfordUniversitypress,UK.11.MolecularPlantBiology: A practical approach (Vol. I and II), Edited by Gilmartin and Bowler, 2002, Oxford Universitypress,UK.
8. Plantcellculture.A practical approach.Second edition.Edited by R.A.Dixon and R.A.

Web Link:

1. Website: [links:https://library.fvvc.edu/MLT/Links,](https://library.fvvc.edu/MLT/Links)
[https://libguides.gvsu.edu/MLS/websites,](https://libguides.gvsu.edu/MLS/websites)
2. E-Books: [https://www.pdfdrive.com/medical-laboratory-technician-e23958474.html,](https://www.pdfdrive.com/medical-laboratory-technician-e23958474.html)
3. E-journals:[https://onlinelibrary.wiley.com/journal/10982825,](https://onlinelibrary.wiley.com/journal/10982825)
[https://academicjournals.org/journal/JMLD.](https://academicjournals.org/journal/JMLD) Mapping with Programme Outcomes

Pedagogy: Teaching / Learning methods

Lecture, PPT presentation, Quiz, Group Discussion, e-content Seminar

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Follow the safety precautions in the diagnostic laboratory	K1, K2, K3, K4, K5 & K6
CO2	Understand the general laboratory and instrumentation practices	K1, K3, K4 & K5
CO3	Know the significance of biological samples and their importance for the examination of disease diagnosis	K1, K2, K4 & K5
CO4	Understand the various types of infection and clinical symptoms caused by microorganisms and get an idea about precaution	K1, K2, K3, K4 & K5
CO5	Analyze and cross-examine the haematology tests of patients who visit the hospital and recognize the method of discarding the blood	K1, K2, K3, K4, K5 & K6

Cognitive Level : K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	2	3
CO2	3	3	2	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	3	3	3	3
CO4	3	2	3	3	2	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3		3

3 - Strongly Correlated; 2- Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course code	Title of the course	Hours of teaching / week	No. of Credits
III	23P3BTC9	ANIMAL BIOTECHNOLOGY	4	4

Nature of the Course

Relevant to Local need		Employability Oriented		Addresses Professional Ethics	
Relevant to national need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need		Skill development Oriented	√	Addresses Environment and Sustainability	√
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

- Provide the basic knowledge on cloning methods, animal tissue culture techniques and application of genetic engineering to the students.
- Obtain the knowledge of research related Various laboratory animals
- Know the advanced methods in animal handling according to CPCSEA guidelines
- Provide an overview and current developments in different areas of animal Biotechnology and its application.
- Obtain knowledge on difference between in vivo & in vitro for uses of animal modelling

Unit	Content	No. of Hours
I	Introduction to animal tissue culture: Mammalian cell culture, Tissues, Continuous cell lines, Suspension cultures, Cryopreservation and transport of Animal germ plasm, (Embryo, Semen and ovum).	12
II	Cell culture and culture media 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 Micro manipulation.	12
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
IV	Cyto toxicity analysis Testing the drug toxicity of environmental pollutants in cell culture, Cytotoxicity, Apoptosis, Tissue, Diagnostic antigens	12

V	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 <i>invitro</i> , cultures technology in production of pharmaceutical proteins and animal viral vaccines.	12
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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. Animal Cell Culture Techniques. Ed. Martin Clynes, Springer.
3. Biotechnology by Kashav. T (Wiley Eastern Ltd).
4. Animal Cell Biotechnology; Methods and protocols, Nigel Jenkins, Humana Press.
5. Biotechnology of Animal Tissue. P. R. Yadav & Rajiv Tyagi, 2006. Discovery 54 publishing House. New Delhi.
6. From Genes to Clones Introduction to Gene Technology – Winnacker, E. L. 1987., Panima Educational Book Agency, New Delhi.
7. Gene VII – Benjamin Lewin, 2000. Oxford University Press, UK.
8. Principles of Gene Manipulation and Genomics – Primrose, S. B. and Twyman, R. M. 2006. 7th Edition. Blackwell Publishing Company.
9. Recombinant DNA Second Edition – James D. Watson, Micheal Gilman, Mark Zoller, 2001. W. H. Freeman and Company, New York.
10. 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)
4. Freshney R. I. (2005). Culture of animal cells: A manual of basic techniques, 5th Edition, John Wiley and Sons.
5. John R W Masters. (2000). Animal cell culture, 3rd Edition, Oxford University Press.
6. Migel J. (2005). Animal cell Biotechnology- Methods and Protocols, Humana press.
7. Florence PR. (2006). Animal Biotechnology, Dominant Publishers and Distributors.
8. Sandy Primrose, Richard Twyman and Bob Old. (2001). Principles of Gene Manipulation, 6th Edition, Blackwell Science Ltd. p: 174-319.
9. Stem cell Biology by Marshak (2001), Cold Spring Harbour Symposium publication.

Web Link:

1. <https://www.sciencedirect.com/book/9780128117101/animal-biotechnology#book-description>
2. <https://www.pdfdrive.com/animal-biotechnology-e41305678.html>
3. <https://ocw.mit.edu/courses/biology/7-342-pluripotent-stem-cells-and-genome-engineering-for-modeling-human-diseases-spring-2015>
4. <https://www.tandfonline.com/toc/labt20/current>,

Pedagogy: Lecture, PPT presentation, e-content Seminar

Lecture, PPT presentation, Quiz, Group Discussion, e-content Seminar

Course Outcome

After completion of this course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Know about the genetic engineering tools, vectors, methods of genecloning.	K1, K2, K3, K4, K5& K6
CO2	know techniques and application fanimalin rDNA technology	K1, K3, K4& K5
CO3	develop skills in stem cell culture techniques and gene transfer technologies for animal cell lines.	K1, K2, K3, K4, K5& K6
CO4	knowhow to conduct research in breeding	K1, K2, K3&K4
CO5	Understand applications of animal biotechnology	K1, K2, K3, K5& K6

Cognitive Level :K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	3	2	2	2	3	2	3	3
CO2	2	3	2	2	2	3	3	3	2	2
CO3	3	2	2	3	3	2	2	3	2	3
CO4	2	3	3	2	2	3	2	2	3	3
CO5	3	2	3	2	3	2	3	2	3	3

3 - Strongly Correlated; 2- Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course code	Title of the course	Hours of teaching / week	No. of Credits
III	23P3BTC10	MICROBIAL BIOTECHNOLOGY	4	4

Nature of the Course

Relevant to Local need		Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need		Entrepreneurship Oriented	√	Addresses Gender Sensitization	
Relevant to regional need		Skill development Oriented		Addresses Environment and Sustainability	
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

- To understand the scope and importance of bioprocess engineering technology.
 - To well understood the fermentation technology
 - To obtain knowledge about downstream processing
 - To obtain knowledge of immobilization and bio transformation
- To know the basic Production of Industrially important prod

Unit	Content	No. of Hours
I	Introduction to bio process technology: Development and strain improvement of industrially important microorganisms. Bioreactors: Typical structure of advanced bioreactor and working mechanism; Design features – Heat transfer and Mass transfer; Specialized bioreactors- design and functions; Air lift bioreactor, Tubular bioreactors, Membrane bioreactors, Tower bioreactors, Fluidized bed reactor, Packed bed reactors and Photo bioreactors.	12
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 anti foam agents. Types of fermentation process – submerged fermentation, the surface solid –state fermentation, batch fermentation, continuous fermentation, the kinetics of fermentation process, bioprocess control, monitoring variables temperature, agitation, pH, and pressure.	12
III	Down stream processing: Cell disruption, precipitation methods, solid – liquid separation, liquid – liquid extraction, filtration, centrifugation, chromatography, drying devices	12

	(Lyophilization and spray dry technology), crystallization – biosensors – construction and applications	
IV	Immobilization and Biotransformation: Methods of immobilization -adsorption, cross linking, ionic bonding, entrapment, encapsulation; Advantages and industrial applications of Immobilization of enzymes and whole cells. Biotransformation of antibiotics, steroids, and their applications.	18
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 - polyhydroxy alkanooates (butyrate, propionate).	12

Text Books:

1. MicrobialBiotechnology:PrinciplesAndApplications(2ndEdition)byYuanKunLee, Aug ust24,2006.
2. MicrobialBiotechnology:PrinciplesAndApplications(ThirdEdition):PrinciplesandAppl ications(3rdEdition)Paperback–Import,15April2013byYuanKun Lee(Editor)
3. Microbialbiotechnology:principlesandapplications, YuanKunLee.Edition3rded.Imprint Singapore;Hackensack,NJ:WorldScientific,c2013.
4. MicrobialBiotechnology,PrinciplesandApplications, YuanKunLee,Publisher- WorldScientificPublishingCompany2013.
5. MicrobialBiotechnology,ElsaCooper,SyraWoodPublishingHouse,2016M0524- 216pages
6. [MicrobBiotechnol.](#)2016Sep;9(5):529.Publishedonline2016Aug11.doi:[10.1111/175179 15.12403](#)
7. MicrobialBiotechnology □2020KennethTimmis,JuanLuisRamos, WillemdedeVos,SiegfriedVlaeminck, AuxiPrieto,AntoineDanchin,WillyVerstraete,andVictorde Lorenzo
8. MicrobialBiotechnology:MethodsandApplicationsby ElsaCooper06/11/2019Publisher:MLBooksInternationaL.
9. Microbial Biotechnology Hardcover – 23 March 2006 by [A. R. Alagawadi](#) (Editor), [P.U. Krishnaraj](#) (Editor), [K. S.Jagadeesh](#)(Editor),[J.H.Kulkarni](#)(Editor), &1More

Reference Book:

10. Basic Biotechnology 2nd Edition by [Colin Ratledge](#) (Editor), [Bjorn Kristiansen](#) (Editor)Cambridge UniversityPress;2ndedition(April30,2001)
11. ManualofIndustrialMicrobiologyandBiotechnology 3rdEditionby [RichardH.Baltz](#) (Editor), [ArnoldL.Demain](#)(Editor), [Julian E.Davies](#)(Editor)ASMPress;3rdedition(March25,2010)
12. NewandFutureDevelopmentsinMicrobialBiotechnologyandBioengineering:Trendsof MicrobialBiotechnologyforSustainableAgricultureandBiomedicineSystems:Perspectiv esforHumanHealth 1stEdition,KindleEditionElsevier;1stedition(May15,2020)
13. Microbial Biotechnology: Principles And Applications (3rd Edition) 3rd Edition, Kindle Edition by [Yuan KunLee](#)(Editor)Format:KindleEditionWorldScientific;3rdedition(January30,2013)
14. Microbial Biotechnology: Basic Research and Applications (Environmental and Microbial Biotechnology Book1)1sted.2020Edition,KindleEditionSpringer; 1sted.2020edition(July7,2020)

M.Sc., Biotechnology

15. Microbial Biotechnology by [Elsa Cooper](#) (Editor) Syrawood Publishing House (June 20, 2019)
16. Microbial Biotechnology Principles and Applications Third Edition <https://doi.org/10.1142/8265> April 2013
17. 2017 Microbial Biotechnology Volume 1. Applications in Agriculture and Environment
18. Microbial Biotechnology, Fundamentals of Applied Microbiology, 2nd Edition
TEXTBOOK: AUTHORS: [Alexander N. Glazer](#), University of California, Berkeley
[Hiroshi Nikaido](#), University of California, Berkeley
DATE PUBLISHED: October 2007

Web resources :

<https://www.nifa.usda.gov/microbial-biotechnology>

Pedagogy: Lecture, Assignment, PPT presentation, Quiz, Demonstration

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Identify the nature of bio process engineering technology practicals	K1, K2, K3, K4, K5 & K6
CO2	differentiate the fermentation technology and types of fermentation process	K1, K2, K3 & K5
CO3	Describe the down stream processing in cell disruption, Precipitation methods, etc.	K2, K4, K5 & K6
CO4	Explain the advantage of industrial application	K2, K3, K4, K5 & K6
CO5	After studying unit the students will be able to analyze and can cross-examine the Production of industrial importance.	K1, K2, K4, K5 & K6

Cognitive Level : K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	2	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	3	2	3	3	3	3
CO5	2	2	3	3	2	3	2	3	3	3

3 - Strongly Correlated; 2- Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course Code	Title of the Paper	Hours of Teaching / Week	No. of Credits
III	23P3BTC11	ENVIRONMENTAL BIOTECHNOLOGY	4	4

Nature of the Course			
Employability Oriented	√	Relevant to Local need	
Entrepreneurship Oriented	√	Relevant to regional need	√
Skill development Oriented		Relevant to national need	√
Addresses Gender Sensitization		Relevant to Global development need	
Addresses Environment and Sustainability		Addresses Professional Ethics	

Course Objectives

The main objectives of this course are to:

1. Introduce the student to the different areas in which biotechnology is developed and the environmental application methods.
2. Emphasize the knowledge of the different types of biotechnological processes that exist in the field of environmental applications.
3. To make known the wider range of professional activities linked to biotechnological knowledge.
4. Know the possibilities of environmental application presented by the biotechnology of higher organisms.
5. To make known the great biodiversity existing in the microbial world and the biogeochemical cycles that governs the terrestrial ecosystem.

SYLLABUS		
Unit	Content	No. of Hours
I	Environmental pollution: Basic concepts and global issues-Global warming & Acid rain. Pollution measurements- air and water. Biosensor in environmental monitoring. Impact of environmental pollutants in soil and water. Bio fouling.	12
II	Waste treatment: Waste water treatment: Physical, chemical and biological treatment processes. Various industrial effluent treatment methods - Sugar, distillery, dairy, tannery and pharmaceutical industries. Solid wastes: Types and characteristics. Solid waste disposal- land filling incineration. Biogas from solid waste. Composting and vermin composting. Monitoring parameters for composting.	12
III	Bioremediation: Introduction, advantages and applications. Types of bioremediations. Microbial remediation of phenolics - sewage nutrients (phosphate and nitrate). Impact of bioremediation in the petroleum industry, paper	12

	industry, marine oil pollutants and chemical industry. Phytore mediation advantages and applications (agriculture).	
IV	Bio corrosion and microbial mediated recovery: Microbial corrosion and its control (petroleum industry and cooling tower system). Bio metallurgy – Bioleaching - application, biotechnology approaches for heavy metal elimination from effluents. Bio –mediated recovery of metals (gold and platinum). Microbial Enhanced Oil Recovery (MEOR), Bio surfactant.	12
V	Biodegradation: Biodegradation of organic pollutants, Mechanisms and factors affecting biodegradation. Pollution problems and biodegradation of simple aliphatic, aromatic, polycyclic aromatic hydrocarbons, halogenated hydrocarbons, azodyes, lignin and pesticides. Bio energy.	12

Text Book

1. Peter F Stannbury, Allan Whitaker, Stephen J Hall. Principles of Fermentation Technology. (2016) Butterworth-Heinemann Press. UK.
2. MurugesanAG and Rajakumari C.(2005).Environmental Science and Biotechnology: Theory and Techniques.
3. SharmaPD.(1994).EnvironmentalBiology, Rastogi Publications.
4. Fundamentals of Ecology Eugene P.Odumand GaryW(2007).Barrett. Saunders Publishers.
5. Environmental Biotechnology by S.N.Jogdand.(1995).Istedt. Himalaya Publishing House. Bombay

Reference Book

1. EugeniaJ.Olguin.(2000).EnvironmentalBiotechnologyandcleanerBioprocesses,TaylorandFrancis.
2. BeechIBandGaylardeCC(1999).Recentadvanceinthestudyofbiocorrosion-anoverview.*RevMicrobial***30**,177-190.
3. BoothGH(1971).Microbiological corrosion, Mand BmonographsCE11,Millsand Boon, London.
4. AgarwallKV.(2005).EnvironmentalBiotechnology,NidhiPublishers.
5. JogdandSN.(2008).EnvironmentalBiotechnology,4thEdtHimalayaPublishingHousePvt. Ltd.
6. InstantNotesinEcologyAulayMacKenzie,AndyBallandSoniaVirdee(2001).Taylor&FrancisPublishers.
7. EnvironmentalBiotechnologybyAlanScragg(2005).IIndedition.PearsonEducationLimited,Eng.
8. WastewaterEngineering– Treatment,DisposalandReuse.MetcalfandEddy(2017).TataMcGrawHill,NewDelhi.
9. EnvironmentalchemistrybyA.K.De(2007).NewAgeinternationalPublishers.
10. IntroductiontoBiodeteriorationbyD.AllsoppandK.J.Seal,(2004).CambridgeUniversityPress.

Web Link:

1. <http://www.fao.org/3/t0551e/t0551e05.htm>
2. <http://www.fao.org/fcit/environment-health/solid-waste/en/>

Pedagogy: Teaching / Learning methods

Lecture, Assignment, PPT presentation, Group Discussion, e-content, Seminar

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Understand and assimilate the specific concepts and terminology of environmental biotechnology.	K1, K2, K3, K4, K5 & K6
CO2	Describe the properties of microorganisms with potential application to environmental biotechnology processes.	K1, K2, K3, K4, K5 & K6
CO3	Various techniques in the field of environmental biotechnology.	K1, K2, K3, K4, K5 & K6
CO4	Know the role of microorganisms as biotechnological agents.	K1, K2, K3, K4, K5 & K6
CO5	Study biodegradation for environmental application	K1, K2, K3, K4, K5 & K6

Cognitive Level: K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	3	3	2	2	2	2
CO2	2	2	3	3	3	3	3	3	3	2
CO3	2	3	3	3	3	3	3	3	3	2
CO4	2	3	3	3	3	3	3	3	3	2
CO5	2	3	2	3	3	3	2	2	2	2

3 - Strongly Correlated; 2 - Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course Code	Title of the Paper	Hours of Teaching /Week	No. of Credits
III	23P3BTC5	Practical-V PLANT BIOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY	3	3

Nature of the Course

Relevant to Local need	√	Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need	√	Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need	√	Skill development Oriented	√	Addresses Environment and Sustainability	√
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

1. Familiarize the students with the key developments in the sphere of Plant Biotechnology.
2. Train students with the techniques associated with the invitro propagation of plants and their maintenance.
3. Provide hands on experience related to Animal Cell Culture.

Lab in 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 Agrobacterium on Agar medium
6. Agrobacterium mediated gene transformation
7. Use of Agro in filtration for Transient Expression in Plant
8. Gus assay
9. Analysis of WT/ Transgenic plant by PCR
10. Isolation of Total RNA from leaves
11. Gene gun method of transformation
12. Synthetic seed preparation

Lab in Animal Biotechnology

1. Development of primary cell lines/maintenance of established cell lines.
2. Cell counting and cell viability.
3. Trypsinization of monolayer and sub culturing.
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

Reference Book

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.OxfordUniversitypress, UK,2002.
3. Plant Cell Culture: Essential Methods. Michael R. Davey, Paul Anthony.Wiley, 2010.
4. Plant Tissue Culture, Third Edition:Techniques and Experiments . 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.

WebLink:

https://www.academia.edu/14547380/Cell_And_Tissue_Culture_Laboratory_Manual

Pedagogy:Teaching/ Learningmethods

Lecture,Tutorial,Group Discussion,e-contentSeminaretc.

Course Outcomes

On the successful completion of the course, students will beable to

CONumber	CO Statement	Cognitive Level
CO1	Establish different types of plant cultures.	K1& K2
CO2	Apply the technical skills learnt to establish nurseries for horticultural and agricultural crops.	K2
CO3	Illustrate the methodology to establish animal cell culture.	K2& K4
CO4	Describe the importance of engineering animal cells for the production of therapeutic proteins	K3& K4
CO5	Compare the pros and cons of transgenic plants on environment	K3& K6

Cognitive Level: K1-Remember;K2 -Understanding;K3-Apply;K4-Analyze; K5-Evaluate; K6-Create

Mapping of Course Outcomes with Programme Outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	3	3	2	2	2	2
CO2	2	2	3	3	3	3	3	3	3	2
CO3	2	3	3	3	3	3	3	3	3	2
CO4	2	3	3	3	3	3	3	3	3	2
CO5	2	3	2	3	3	3	2	2	2	2

3 -StronglyCorrelated;2 –Moderately Correlated; 1-WeaklyCorrelated; 0– Nocorrelation

Semester	Course Code	Title of the Paper	Hours of Teaching / Week	No. of Credits
III	23P3BTC6	Practical – VI MICROBIAL BIOTECHNOLOGY & ENVIRONMENTAL BIOTECHNOLOGY	3	3

Nature of the Course

Relevant to Local need	√	Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need	√	Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need	√	Skill development Oriented	√	Addresses Environment and Sustainability	√
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

1. Acquire the knowledge on basic microbial biotechnology techniques.
2. Gain the knowledge on basic environmental biotechnology techniques
3. Understand the various fields of medical applications.
4. Understand the various fields of Environmental applications.

Microbial Technology

1. Study of fermentor-Demonstration.
2. Production and isolation of antibiotics (Penicillin and Streptomycin)
3. Production and analysis of Singlecell protein(Spirulina and yeast)
4. Production of yoghurt and estimation of lactic acid.
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/whole cells
8. Estimation of amount of citric acid in the given sample

Environmental Biotechnology

1. Water Analysis: Measurement of Total Solids, Total-dissolved solids, Total-suspended solids, dissolved oxygen, total hardness, chloride, turbidity, nitrite, nitrate, fluoride and total nitrogen.
2. Estimation of COD, BOD of industrial effluents.
3. Potability test of water (MP technique).
4. Degradation of phenols. Colorimetric assay
5. Estimation of MIC and Heavy metal tolerance of chromium resistant bacteria
6. Screening of Biosurfactant activity-Oil Displacement test-Drop collapse test
7. Isolation of *Thiobacillus ferrooxidans* and *Thiobacillus thiooxidans* from metal sulphides, rock and acid mine water.
8. Microbial degradation, decolorization and adsorption of organic dyes by free and immobilized cells
9. Studies on halophiles from seawater (pigmentation and salt tolerance)

Text Book

1. Text book of Experimental Procedures in Life Sciences; Rajan. S First edition; 2018.

Reference Book

1. Practical Immunology. Franck C. Hay, Olwyn M. R. Westwood. Wiley-Blackwell publications, 2010.
2. immunoassays: A Practical Approach. James P. Gosling (editor). Oxford university press, USA, 2010.
3. Lab manual in biochemistry, immunology and biotechnology. Arti Nigam Archana ayyagari. McGraw-Hill education, 2008.
4. Practical immunology. Rabindra Narain, dom & wisdom publications, 2012

Web Link:

1. <http://www.fao.org/3/t0551e/t0551e05.htm>
2. <http://www.fao.org/fcit/environment-health/solid-waste/en/>

Pedagogy: Teaching / Learning methods

Lecture, Tutorial, Group Discussion, e-content Seminar etc.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Understand and assimilate the specific concepts Immunology.	K1 & K2
CO2	Describe the potential application of immune diffusion techniques	K2
CO3	Explain tools and techniques in the field of Immunology.	K2 & K4
CO4	Know the role and application of blotting techniques in biotechnological.	K3 & K4
CO5	Gain knowledge about ELISA	K3 & K6

Cognitive Level: K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	3	3	2	2	2	2
CO2	2	2	3	3	3	3	3	3	3	2
CO3	2	3	3	3	3	3	3	3	3	2
CO4	2	3	3	3	3	3	3	3	3	2
CO5	2	3	2	3	3	3	2	2	2	2

3 - Strongly Correlated; 2 - Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
III	23P3BTEL3A	Major Elective – III GENOMICS AND PROTEOMICS	4	3

Nature of the course

Relevant to Local need		Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need	√	Entrepreneurship Oriented	√	Addresses Gender Sensitization	
Relevant to regional need		Skill development Oriented	√	Addresses Environment and Sustainability	
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

1. Provide the basic knowledge of gene characteristic feature and mapping concepts
2. Understand about the sequencing technologies
3. Provide the basic concept for protein analysis
4. Understand about protein sequencing
5. Enrich the students' knowledge with respect to meta genomic and applications

SYLLABUS

Unit	Content	No. of Hours
I	Organization of genes across living systems Interrupted genes, overlapping genes, alternative genes, (RNA editing and RNA Splicing) etc. identification and characterization of insert DNA fragments, gene content and C value paradox –gene cluster and gene families. Restriction mapping, chromosome walking and chromosomal localization of genes. RFLP and other uses of cloned sequences, cloning of microbial genes.	12
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 and molecular chimeras, gun gal genome and genomics.PCR based Analysis, DNA Finger printing.	12
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, amino acid composition, N- terminal sequencing); SDS - PAGE, two dimensional gel electrophoresis and image	12

	analysis.	
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 and sequencing individual spots by mass spectrometry (MALDI- ToF) and protein micro arrays.	12
V	Meta genomics Introduction, construction, vector design and screening of meta genomic libraries- biotechnological applications of meta genomics. Biological database - Overview, applications, gene and protein sequence databases, Gen Bank, EMBL, DDBJ, and PDB.	12

Text book:

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

References:

1. Expression Genetics: accelerated and High Throughput Methods (1999). Edited by M. McClelland and A. Pardee, Eaton Publishing, MA.
2. 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 and Current Opinion Series.
4. Principles of Gene Manipulation and Genomics (2013) Sandy B. Primrose, Richard Twyman – Blackwell Publishing.
5. An Introduction to Genetic Engineering 3rd Edition Desmond S. 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
7. Post-translational modifications in host cells during bacterial infection, D. Ribert, P. Cossart, FEBS letters, 2010.
8. Proteomics in practice: a laboratory manual of proteome analysis (2002). Westermeier, R., & Naven, T. John Wiley & Sons, Inc.
9. Proteomics for biological discovery. Veenstra, (2006). Timothy D. and John R. Yates John Wiley & Sons,
10. Plant proteomics: methods and protocols. (2007). Thiellement, H., Zivy, M., Damerval, C. and Méchin, V. eds. Totowa (NJ): Humana Press.

Web resources:

1. <https://www.frontiersin.org/articles/10.3389/fgene.2020.00309/full>
2. <https://www.denbi.de/online-training-media-library/proteomics>
3. <https://www.sciencedirect.com/science/article/pii/S1874391912001479>

Pedagogy: Teaching / Learning methods

Lecture, PPT presentation, Group Discussion

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Know about genes functional properties.	K1
CO2	Understand how genesequencingaredone	K2
CO3	Understand Protein analysis.	K2 & K4
CO4	Protein sequencing methods.	K1& K5
CO5	Know about metagenomics and its application.	K4

Cognitive Level :K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze;
K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	2	3
CO2	3	3	2	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	3	3	3	3
CO4	3	2	3	3	2	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3

3 - Strongly Correlated; 2 - Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
III	23P3BTEL3B	Major Elective – III FOOD AND NUTRITION	4	3

Nature of the course

Relevant to Local need		Employability Oriented	√	Addresses Professional Ethics	
Relevant to national need	√	Entrepreneurship Oriented	√	Addresses Gender Sensitization	
Relevant to regional need		Skill development Oriented	√	Addresses Environment and Sustainability	
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

- Enable the students to learn the basic concepts of nutrition and different categories of foods.
- Enable the students to gain knowledge of different nutrient contents and their importance.
- Make them learn the basics of nutritive and calorific value.
- Enable the students to know food adulterants and food poisoning, disadvantages & health problems.
- Enable the students learn the food spoilage and preservation methods

Unit	Content	No. of Hours
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.	12
II	Introduction to Vitamins. Fat soluble vitamins, Water soluble vitamins.	12
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.	12
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.	12
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.	12

Text books:

1. Albanese, Anthony A Ed, Protein And Amino Acid Nutrition Academic Press New York 1959.
2. Devlin T.M., Biochemistry by Stryer Textbook 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 long 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, Springfield.
7. Michael, J. Gibney, Barrie, M. Margetis, John, M. Kearney. Lenore Arab. Public Health Nutrition. Blackwell science, Blackwell Publishing Company (2004).
8. Frazier, W., Food Microbiology, Tata McGraw Hill 1978.
9. Meyer, Lilian H. Ed. (1987), Food Chemistry. Indian Ed. CBS Publishers and Distributors
10. Barker, D. J. P (1998), Mothers, Babies and Health in later life. Edinburgh, Churchill Livingstone.
11. Ward, R. H. T; Smith, S. K. Donnai, D. (Eds.) (1994) Early fetal Growth and Development. London, & CO G Press.
12. Wallace, H. M. and Giri, K. (1990), Health care of women and children in developing countries, third party publishing co. Oakland.

Reference Book:

1. Seemayadav:- Food Chemistry, anmol publishing (P) Ltd, New Delhi
2. Car H. Synder:- the extraordinary chemistry for ordinary things, John Wiley & sons inc, New York, 1992.
3. .B. Sivasankar – food processing and preservation – PHI learn 9ng (P) LTD, New Delhi – 11001.

Web Link

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

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Differentiate the food types and their nutritive value	K1, K2, K4, K5
CO2	Develop competence to carry out investigation in nutrition	K1, K2, K3, K4 & K5
CO3	Measure and calculate calorific value of different types of foods	K1, K2, K3, K4 & K5
CO4	Identify the food adulterants and food poisoning	K1, K2, K3, K4 & K5
CO5	Practice food sterilization, preservation and processing.	K1, K2, K3, K4, K5 & K6

Cognitive Level : K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Mapping of course outcomes with Programme Outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	2	3
CO2	3	3	2	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	3	3	3	3
CO4	3	2	3	3	2	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3

3 - Strongly Correlated; **2**- Moderately Correlated; **1** - Weakly Correlated; **0** – No correlation

Semester	Course code	Title of the course	Hours of teaching / week	No. of Credits
III	23P3BTEDC	Extra Disciplinary Elective - MEDICAL LABORATORY TECHNOLOGY	4	3

Nature of the Course

Relevant to Local need		Employability Oriented	√	Addresses Professional Ethics	√
Relevant to national need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need		Skill development Oriented	√	Addresses Environment and Sustainability	√
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

- Teach the physical and chemical nature of Body fluids
- Explain the safety measures in diagnostic laboratory
- Acquire knowledge about laboratory techniques
- Learn hematology and pathology laboratory techniques
- Explicate the advanced methods in collection and storage, preparation, analysis of body fluids, and results.

Unit	Content	No. of Hours
I	General Laboratory and instrumentation Code of conduct for laboratory personnel - safety measures the laboratory - chemical/Reagents, labeling, storage, and usage. First aid in laboratory accidents - Precautions and first aid equipment. Sterilization, and preparation of reagents. The general approach to quality control, quality control of quantitative data	12
II	Clinical Hematology Collection of blood - Anticoagulant, preservation Estimation of Hb, PCV, WBC (TC & DC), RBC, platelets, ESR Clotting time, bleeding time – normal value, clinical interpretation Serology - VDRL, CRP, RA, HIV, HBsAg.	12
III	Clinical pathology Urine analysis: Collection, composition, preservation, gross examination, chemical examination. Significance of sugar in the urine, ketone bodies, bile pigment, hematuria, uric acid, microscopic examination of the urinary sediment: Stool Examination- specimen collection, pH, Interfering substance. Test for occult blood, fecal fat, and microscopic examination of a stool specimen.	12

IV	Histology Basic concepts of different mammalian tissues and their histological structure. Different human organs and their gross and histological structure and functions. Receiving of biopsy specimens at the laboratory (Clinical notes/fixatives). Fixation of tissue – different fixatives and their mode of action. Methods of decalcification. Use of microtomes, selection, and maintenance of knives, the technique of section cutting & mounting on slides. Staining of tissue sections, preparation of different stains, staining methods for Haematoxylin & Eosin.	18
V	Blood banking: Blood group (ABO & Rh) – methods of grouping & reverse grouping. Basic blood banking procedures- a collection of blood, anticoagulants used, cross-matching, different screening, Tests including Coombs Test for incomplete antibodies preparation of different blood components for use and how to serve a requisition. preparation of red cell suspension. Blood transfusion & hazards. Detect the time when to discard blood in the blood bank, computerized record.	12

Textbook:

1. Medical Laboratory Technology - 6th edition L.Mukherjee. vol.I, II, III. 2010 Tata Mcgraw - Hill Publishing company limited.
2. Hand book medical laboratory technology 2nd edition-V.H.Talib CBS publishers & 2008.
3. Clinical laboratory practices in CMC procedure, CMC, Vellore
4. Text book of Medical lab technology, 1st Edition-Ranmniksood.jaypee2006.
5. Laboratory manual in biochemistry-Jayaraman New Age International Pvt Ltd publishers2011.

Reference Book:

1. Kanai L. Mukherjee and Anuradha Chakravarthy, Medical Laboratory Technology, Procedure Manual for Routine Diagnostic Tests, Vols. I, II and III. Tata McGraw Hill Publishing Company Ltd., 2017.
2. RamnikSood, Concise Book of Medical Laboratory Technology Methods and Interpretations. Jaypee Brothers Medical Publishers (P) Ltd., New Delhi, 2015.
3. N. Pattabiraman. Laboratory Manual in Biochemistry, 4th Edition. All India Publishers & Distributors, 2015.
4. Namita Jaggi. Microbiology Theory for MLT. 2nd Edition. Jaypee Brothers Medical Publishers (P) Ltd., 2013.
5. Alan H. Lowenclock. Varley's Practical Clinical Biochemistry, 6th Edition. CBS Publishers and Distributors, 1988.

Web Link:

2. Website: [links:https://library.fvvc.edu/MLT/Links](https://library.fvvc.edu/MLT/Links),
<https://libguides.gvsu.edu/MLS/websites>,
3. E-Books: <https://www.pdfdrive.com/medical-laboratory-technician-e23958474.html>,
4. E-journals:<https://onlinelibrary.wiley.com/journal/10982825>,
<https://academicjournals.org/journal/JMLD>. Mapping with Programme Outcomes

Pedagogy: Teaching / Learning methods Lecture, PPT presentation, Quiz, Group Discussion, e-content Seminar

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Follow the safety precautions in the diagnostic laboratory	K1, K2, K3, K4, K5 & K6
CO2	Understand the general laboratory and instrumentation practices	K1, K3, K4 & K5
CO3	Know the significance of biological samples and their importance for the examination of disease diagnosis	K1, K2, K4 & K5
CO4	Understand the various types of infection and clinical symptoms caused by microorganisms and get an idea about precaution	K1, K2, K3, K4 & K5
CO5	Analyze and cross-examine the haematology tests of patients who visit the hospital and recognize the method of discarding the blood	K1, K2, K3, K4, K5 & K6

Cognitive Level : K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	3	2	2	2	3	2	3	3
CO2	2	3	2	2	2	3	3	3	2	2
CO3	3	2	2	3	3	2	2	3	2	3
CO4	2	3	3	2	2	3	2	2	3	3
CO5	3	2	3	2	3	2	3	2	3	3

3 - Strongly Correlated; **2**- Moderately Correlated; **1** - Weakly Correlated; **0** – No correlation

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
II	23P3PBTA ECC3	Ability Enhancement Compulsory Course – Research Methodology	2	2

Nature of the course

Relevant to Local need		Employability Oriented	√	Addresses Professional Ethics	√
Relevant to national need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need		Skill development Oriented	√	Addresses Environment and Sustainability	√
Relevant to Global need	√			Addresses Human Values	√

Course Objectives:

The main objectives of this course are:

1. To write report / thesis / dissertation and or for publications in appropriate research journals.
2. The aim of the paper is a strong foundation for the student for thesis writing, editing, analysis and interpretation

UNIT	Content	No. of hours
I	Research: Selection of research problem – stages in the execution of research: choosing a topic to publication – preparation of manuscript – report writing – format of journals – proof reading – sources of information : journals, reviews, books, monographs etc –Thesis writing and their standard format – standard organization of bibliography. Planning of research: Research proposals, time scheduling of research, available sources and generation of funds and facilities.	2 hours
II	Journals: Standard of research journals – paid and refereed journals – impact factor, citation index, H-index and plagiarism. Choice of journals for publication. Information retrieval: access to archives and databases, search engines: Google, Pubmed, NCBI, etc., National Informatic Center - Online data base library.	2 hours

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.

M.Sc., Biotechnology

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. Dawson, Catherine, 2002, *Practical Research Methods*, New Delhi, UBS
6. Kothari, C.R., 1985, *Research Methodology- Methods and Techniques*, New Delhi

Reference Books

1. J.A. Bryan, *Introduction to bioethics* (2018), 2nd edition
2. P. Narayanan, *Intellectual Property Laws*, Eastern Law House.
3. Meenu Paul, *Intellectual Property Laws*, Allahabad Law Agency.

Web resources

- <https://bbamantra.com/research-methodology/>
- <https://www.researchgate.net/publication/329736173> Research Methodology Msc notes of Dr Judu illavarasusvyasa univ

Expected Course Outcome:		
Upon completion of this course, Students would have		
I	After studied unit 1, the student will be able to understand research concepts, issues and types and basic knowledge of qualitative research, observation and Collection of data and Generalization and Interpretation	K1 & K2
II	After studied unit-2, the student will be able to Have adequate knowledge of ethics, plagiarism, citation and acknowledgment	K3 & K4

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**- Analyze; **K5**- Evaluate; **K6**- Create

Mapping with Programme Outcomes										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	1	1	2	2	1	1
CO2	3	2	1	1	3	1	2	2	1	2
CO3	2	1	2	1	3	3	2	3	2	3
CO4	3	3	3	3	2	3	1	1	1	3
CO5	3	1	1	1	2	1	1	3	2	2

3 - Strongly Correlated; 2 - Moderately Correlated;
1 - Weakly Correlated; 0 – No correlation

Semester	Course code	Title of the course	Hours of teaching / week	No. of Credits
IV	23P4BTC12	RESEARCH METHODOLOGY AND PUBLICATION ETHICS	6	4

Nature of the course

Relevant to Local need		Employability Oriented	√	Addresses Professional Ethics	√
Relevant to national need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need		Skill development Oriented	√	Addresses Environment and Sustainability	√
Relevant to Global need	√			Addresses Human Values	√

Course Objectives

The main objectives of this course are to:

- Enable the students to learn the basic concepts of nutrition and different categories of foods.
- Enable the students to gain knowledge of different nutrient contents and their importance.
- Make them learn the basics of nutritive and calorific value.
- Enable the students to know food adulterants and food poisoning, disadvantages & health problems.
- Enable the students learn the food spoilage and preservation methods

Unit	Content	No. of Hours
I	Objectives and types of research: Motivation and objectives – Research methods vs Methodology. Types of research –Descriptive vs. Analytical, Applied vs. Fundamental, Quantitativevs. Qualitative, Conceptualvs. Empirical.	12
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
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 are search plan - Exploration, Description, Diagnosis, experimentation. Determining	12

	experimental and sample designs. Research techniques -microscopy, HPLC, HPTLC, GC-MS, FTIR, SEM/TEM, NMR and AAS.	
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
V	Publication Ethics Definition, introduction, and importance; Standards setting initiatives and guidelines; Conflicts of interest; Publication misconduct: Definition, concept, problems that lead to unethical behaviour and vice versa, types; Violation of publication ethics, authorship, and contributor ship; Identification of publication misconduct, complaints, and appeals; Predatory publishers and journals. Copy right.	12

Text Books

7. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. *An introduction to Research Methodology*, RBSA Publishers.
8. Kothari, C.R., 1990. *Research Methodology: Methods and Techniques*. New Age International. 418p.
9. Sinha, S.C. and Dhiman, A.K., 2002. *Research Methodology*, EssEss Publications. 2 volumes.
10. Trochim, W.M.K., 2005. *Research Methods: the concise knowledgebase*, Atomic Dog Publishing. 270p.
11. Wadehra, B.L. 2000. *Law relating to patents, trademarks, copyright designs and geographical indications*. Universal Law Publishing.
12. Satarkar, S.V., 2000. *Intellectual property rights and Copyright*. EssEss Publication
13. Dawson, Catherine, 2002, *Practical Research Methods*, New Delhi, UBS
14. Kothari, C.R., 1985, *Research Methodology- Methods and Techniques*, New Delhi
15. MS office, Sexena, S. 2001. *Vikas Publishing House Pvt. Ltd.*, New Delhi
16. Kothari, C.R., 1985, *Research Methodology- Methods and Techniques*, New Delhi
17. IPR, Biosafety and Bioethics (2013), by Deepa Goel, Shomini Parashar
18. *The basics of bioethics* (2019), 4th edition by Guidry-Grimes, Laura; Veatch, Robert.
19. *Biotechnology and Safety Assessment*, Thomas (2003).
20. *Environmental Health Hazards*, Kumar (2004).

Reference Books

1. J.A. Bryan, *Introduction to bioethics* (2018), 2nd edition
2. P. Narayanan, *Intellectual Property Laws*, Eastern Law House.
3. Meenu Paul, *Intellectual Property Laws*, Allahabad Law Agency.
4. *Intellectual Property Law containing Acts and Rules*, Universal Law Publication Company.
5. *Progress in Bioethics*, Jonathan *et al.*, 2010.
6. *The Ethics of Protocells* – Mark 2009.
7. *Design and Destiny* – Ronald and Turner, 2008.

Web resources

- <https://bbamantra.com/research-methodology/>
- <https://www.researchgate.net/publication/329736173> *Research Methodology Msc notes of Dr Judu illavarasusvyasa univ*

Pedagogy: Teaching / Learning methods

(Please mention teaching / Learning methods like **Lecture**, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	understand research concepts, issues and types and basic knowledge of qualitative research	K1, K2, K3, K4, K5 & K6
CO2	Know read, comprehend, and explain research articles in their academic discipline.	K1, K2, K3, K4, K5 & K6
CO3	Develop an understanding of various kinds of research, Objectives of doing research, Research process, research designs, sampling, principles and research techniques.	K1, K2, K3, K4, K5 & K6
CO4	Detailed know the Observation and Collection of data and Generalization and Interpretation	K1, K2, K3, K4, K5 & K6
CO5	Have a dequate knowledge of ethics, plagiarism, citation and acknowledgment	K1, K2, K3, K4, K5 & K6

Cognitive Level :K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3

3 - Strongly Correlated; 2- Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course code	Title of the course	Hours of teaching / week	No. of Credits
IV	23P4BTEL4A	Major Elective – IV BIOETHICS, BIOSAFETY AND IPR	6	3

Nature of the course

Relevant to Local need		Employability Oriented	√	Addresses Professional Ethics	√
Relevant to national need		Entrepreneurship Oriented		Addresses Gender Sensitization	
Relevant to regional need		Skill development Oriented	√	Addresses Environment and Sustainability	√
Relevant to Global need	√			Addresses Human Values	√

Course Objectives: The main objectives of this course are to

- Provide basic knowledge on intellectual property rights and their implications in biological research and product development
- To become familiar with India's IPR Policy
- To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products
- To become familiar with ethical issues in biological research.
- This course will focus on consequences of biomedical research technologies such as cloning of whole organisms, genetic modifications, DNA testing

Unit	Content	No. of Hours
I	Introduction to Biodiversity Levels of biodiversity – values of biodiversity – threats to biodiversity, loss of biodiversity – Species concept – Classification and systematics: biological nomenclature – biological classification; Biodiversity conservation: <i>insitu</i> and <i>exsitu</i> - Magnitude and distribution of biodiversity – wildlife biology – conservation strategies – measures of biodiversity – biodiversity in India and global level – biodiversity hot spots. National Biodiversity Authority (NBA)	12
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	12
III	Ethical Implications Ethical implications of cloning: Reproductive cloning, therapeutic cloning ; Ethical, legal and socio- economic aspects of gene therapy, germline, somatic, embryonic and adult stem cell research – GM crops – biotechnology and bio piracy – Ethical, Legal and Social Implication (ELSI) of human genome project.	12

IV	Introduction to Bio safety Bio safety issues in biotechnology – risk assessment and risk management – safety protocols: risk groups – Bio safety levels –Bio safety guidelines and regulations (National and International) –operation of Bio safety guidelines and regulations – types of bio safety containments - definition of GMOs & LMOs ;principles of safety assessment of transgenic plants.	12
V	Introduction to 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 data bases – country – wise patent searches (USPTO, EPO, India) –History of world intellectual property rights organization (WIPO), GATT, WTO and TRIPS.	12

Text Books

1. IPR, Biosafety and Bioethics (2013), by Deepa Goel, Shomini Parashar
2. Biodiversity and Biomedicine: Our Future (2020), 1st edition by Munir Ozturk, Dilfuza Egamberdieva, Milica Pešić.
3. The basics of bioethics (2019), 4th edition by Guidry-Grimes, Laura; Veatch, Robert.
4. Biotechnology and Safety Assessment, Thomas (2003).
5. Environmental Health Hazards, Kumar (2004).

Reference Books

1. J.A. Bryan, Introduction to bioethics (2018), 2nd edition
2. P. Narayanan, Intellectual Property Laws, Eastern Law House.
3. Meenu Paul, Intellectual Property Laws, Allahabad Law Agency.
4. Intellectual Property Law containing Acts and Rules, Universal Law Publication Company.
5. Progress in Bioethics, Jonathan *et al.*, 2010.
6. The Ethics of Protocells – Mark 2009.
7. Design and Destiny – Ronald and Turner, 2008.

Web resources

- https://swayam.gov.in/nd1_noc20_hs18/preview
- <https://nptel.ac.in/courses/109/106/109106092/>
- https://onlinecourses.nptel.ac.in/noc20_hs18/preview
- <https://nptel.ac.in/courses/102/104/102104068/>
- <https://www.futurelearn.com/courses/biosecurity>
- <http://www.icid.com/overview.html> (Institute for Biosafety and Biosecurity Canada)
- https://www.bitmesra.ac.in/UploadedDocuments/adminbioeng/files/M_Tech%20Syllabus%202011.pdf (Birla institute of technology, Mesra, Ranchi)
- <https://www.mcgill.ca/continuingstudies/area-of-study/intellectual-property> (Mc.Gill University)

Pedagogy: Teaching / Learning methods

(Please mention teaching / Learning methods like **Lecture**, Tutorial, Assignment, PPT presentation, Quiz, Group Discussion, e-content Seminar etc.)

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Able to Understand the rationale for and against IPR and especially patents.	K1, K2, K3, K4, K5 & K6
CO2	Understand why India has adopted an IPR Policy and be familiar with broad out line of patent regulations	K1, K2, K3, K4 & K5
CO3	Comprehend the different types of intellectual property rights ingeneral and protection of products derived from biotechnology research and issues related to application and obtaining patents	K1, K2, K3, K4, K5 & K6
CO4	Acquire the knowledge of bio safety and risk assessment of products derived from recombinant DNA research and environmental release of genetically modified organisms, national and international regulations	K1, K2, K3, & K4
CO5	Obtain the knowledge on ethical aspects related to biological, biomedical, healthcare and bio technology research	K1, K2, K3, K5 & K6

Cognitive Level :K1 - Remember; K2 - Understanding; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create

Mapping of Course Outcomes with Programme Outcomes

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	2	3
CO2	3	3	2	3	3	3	3	2	3	2
CO3	3	3	3	3	3	2	3	3	3	3
CO4	3	2	3	3	2	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3

3 - Strongly Correlated; 2- Moderately Correlated; 1 - Weakly Correlated; 0 – No correlation

Semester	Course Code	Course Title	Hours of Teaching / Cycle	No. of Credits
IV	23P4BTEL4B	Major Elective –IV NANOBIOTECHNOLOGY	6	3

Nature of the course

Employability Oriented	√	Relevant to Local need		Addresses Gender Sensitization	
Entrepreneurship Oriented		Relevant to regional need		Addresses Environment and Sustainability	
Skill development Oriented	√	Relevant to national need	√	Addresses Human Values	
		Relevant to Global development need	√	Addresses Professional Ethics	

Course Objectives

The main objectives of this course are:

- Create Knowledge on Nano particle synthesis, characterization.
- Know the Nano particles importance in drug delivery
- Compare the analytical methods knowledge in nano particle characterization like (SEM & TEM)
- Apply then an oparticles on various in vivo & in vitroforits applications
- Compare various nanopartcles on biomedical & environmental applications

SYLLABUS

Unit	Content	No. of Hours
I	Introduction to nanotechnology: characteristic scale for quantum phenomena, nano particles, nano-clusters, nano composite, nano-tubes, nano wirese mergece of bionano technology. Characterization of nano particles-UV-Vis spectroscopy, electron Microscopy-HRTEM, SEM, AFM, EDS, XRD.	12
II	Microbial nanotechnology: Microbial synthesis of nano drugs –metal nano particles and drug delivery vehicles - Nan oshels – Tectodentrimers Nano particle drug systems – diagnostic applications of nanotechnology.	12
III	Preparation of nano materials: Physical, chemical and Green methods: Polymeric scaffolds collagen, elastin’s, Mucopolysaccharides, Proteoglycans, cellulose and derivate, dextran’s, alginates, Pectin’s; Chitin. Nano particles –types, functions-Silver, Gold and Titanium. Physical and chemical properties of nano particles.	12
IV	Nano scale Applications in Biology and Medicine: Nanotechnology for biology and medicine – micro and nano – fluids - scanning probe microscopy in biology and medicine- self –assembly of biological molecules, drug delivery – protein mediated and nano particle mediated. Hybrid conjugates of gold nano particles –DNA oligomers –use of DNA molecules in nano mechanics and computing	12

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.	12
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Textbooks:

1. Parthasarathy, B.K (2007). Introduction to Nanotechnology, Ishapublication.
2. Elisabeth Papazoglou and Aravind Parthasarathy (2007). Bionanotechnology. Morgan & Claypool publishers.
3. Bernd Rehm (2006). Microbial bionanotechnology: biological self-assembly and systems and biopolymer-based nanostructures. Horizons scientific press.
4. David E. Reisner, Joseph D. Bronzino (2008). Bionanotechnology: global prospects. CRC Press.
5. Ehud Gazit (2006). Plenty of room for biology at the bottom: An introduction to bionanotechnology. Imperial college press.
6. K. Ravichandran, K. Swaminathan, P.K. Praseetha and P. Kavitha (2019) Introduction to Nanotechnology, JAZYM Publications.

References Books:

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

Web Link:

- https://ec.europa.eu/health/scientific_committees/opinions_layman/en/nanotechnologies/1-3/1-introduction.htm#:~:text=Nanotechnology%20is%20the%20term%20given,%2C%20structures%2C%20devices%20and%20systems.
- https://www.nanowerk.com/nanotechnology/introduction/introduction_to_nanotechnology_1.php
- <https://ccsuniversity.ac.in/bridge-library/pdf/L-3%20Synthesis%20of%20Nanostructured%20Materials%20Prof%20BPS.pdf>
- <https://byjus.com/chemistry/carbon-nanotubes/>
- https://web.stanford.edu/group/mota/education/Physics%2087N%20Final%20Projects/Beta_Nanoparticles.ppt

Pedagogy::

Assignment, PPT presentation, Seminar, Group discussion

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Cognitive Level
CO1	Understand Nanotechnology on Cancer treatment	K1, K2, K5 & K6
CO2	Know Nanotechnology application in Diabetes	K1, K3, K5& K6
CO3	Develop an understanding Nanotechnology effect on target drug delivery	K1, K2, &K4
CO4	Understand the Nanotechnology uses in environmental remediation and recycling process	K1, K3, K4, K5& K6
CO5	Understand the Nanotechnology uses in various biomedical and agriculture applications	K1, K2, K3, K4, K5 & K6

Cognitive Level: **K1** - Remember; **K2** - Understanding; **K3** - Apply; **K4** - Analyze; **K5** – Evaluate; **K6** – Create

Mapping of Course Outcomes with Programme Outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	3	2	2	3	3	2	3	3
CO2	2	3	2	2	2	2	3	3	2	2
CO3	3	2	2	3	3	3	2	3	2	3
CO4	2	3	3	2	2	2	2	2	3	3
CO5	3	2	3	2	3	3	3	2	3	3

3 - Strongly Correlated; **2**- Moderately Correlated; **1** - Weakly Correlated; **0** – No correlation