MASTER OF SCIENCE (MICROBIOLOGY)

VISION

To produce intellectual mind and professionals through innovative research and inventions for the enhancement of society.

MISSION

- To establish overall competence among the students by inculcating energetic thinking and positive spirit.
- To cultivate knowledge, skills, values and confidence for the students excellence through research in their area of expertise or interest.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO 1: To provide the students with subject proficiency, environmental awareness, ethical codes and guidelines, along with life education for a successful professional career.

PEO2: To inculcate the student's professional competencies and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and related to life science.

PEO3: To train students with good technical skills in research to comprehend, analyze, design, novel products and to give solutions for the real life problems.

PROGRAMME OUTCOMES (PO)

After completion of the programme, the graduates will be able to

PO1: Acquire and apply specialized skills and knowledge relevant to the needs of the society.

PO2: Develop the skills in handling instruments, planning and performing experiments to meet desired needs within realistic constraints through domain knowledge.

PO3: Expand a modern and scientific outlook with respect to science subjects and apply in all aspects of life.

PO4: Apply modern tools and technologies for sustainable development and welfare of the society.

PO5: Create and develop eco-friendly environment and microbial products through innovative research ideas.

PROGRAMME SPECIFIC OUTCOMES (PSO)

After completion of the programme, the graduates will be able to

PSO1: Recall the fundamentals of microbiology which would enable them to comprehend the emerging and advanced scientific concepts in life sciences.

PSO2: Apply the acquired conceptual knowledge by connecting interdisciplinary aspects of microbiology.

PSO3: Evaluate the need and impact of scientific solutions on the environment for the betterment of society.

PSO4: Analyze the technical knowledge in microbiology for research and lifelong learning.

PSO5: Create and develop the employable, entrepreneur and socially responsible citizens.

REGULATIONS

ELIGIBILITY

Candidate who has passed the B.Sc., degree in any Life sciences [Microbiology/ Applied Microbiology / Industrial Microbiology/ Botany / Plant Sciences and Plant Biotechnology/ Zoology /Animal Science/Applied Animal Science and Animal Biotechnology/Biochemistry /Bioinformatics /Biology /Life Sciences/ Home Science/ Food Science & Nutrition / BSMS/ BAMS/ BUMS/ Chemistry with Botany/ Zoology] as Allied Subjects of this University or any Examination of any other University accepted by the Syndicate as equivalent thereto shall be eligible for admission to M.Sc. Degree Course in Microbiology.

Candidate shall be admitted to the examination only if he / she has taken the qualifying degree in Science / Medical subjects as mentioned after having completed the prescribed courses consisting of twelve years of study and has passed the qualifying examination.

DURATION OF PROGRAMME

M.Sc., Microbiology is a two years program which comprised of four semesters.

MAXIMUM DURATION FOR THE COMPLETION OF THE PG PROGRAMME

The maximum duration for completion of the PG Programme shall not exceed 8 semesters.

SCHEME OF EXAMINATION

Subject Code	Subject	Hrs of Instruction	Exam Duration (Hrs)	Max Marks			Credit Points
				CA	CE	Total	
FIRST SEMESTER							
Part A							
23PMBM101	DSC I: General Microbiology and Microbial Diversity	7	3	25	75	100	5
23PMBM102	DSC II: Immunology, Immunomics and Microbial Genetics	7	3	25	75	100	5
23PMBM103	DSC III: Forensic Science	5	3	25	75	100	3
23PMBM104	DSC IV: Herbal Technology and Cosmetic Microbiology	5	3	25	75	100	3
23PMBMP101	DSC Practical I	6	9	40	60	100	4
	Total	**30**				**500**	**20**
SECOND SEMESTER							
Part A							
23PMBM201	DSC V: Medical Bacteriology and Mycology	5	3	25	75	100	5
23PMBM202	DSC VI: Medical Virology and Parasitology	5	3	25	75	100	5
23PMBEL201	DSE I	5	3	25	75	100	4
23PMBMP201	DSC Practical II	6	9	40	60	100	4
Optional Subjects							
23PBCMBI201	GEC I: Diagnostic Biochemistry	3	3	25	75	100	2
23PBCMBIP201	GEC Practical I: Diagnostic Biochemistry	3	3	40	60	100	2
23PBTMBI201	GEC I: Plant Tissue Culture Technology	3	3	25	75	100	2
23PBTMBIP201	GEC Practical I: Plant Tissue Culture Technology	3	3	40	60	100	2
Part B							
23PVE201	Value Education :	2	3	25	75	100	2

	Human Rights						
Non Credit							
23PLS201	NCC : Career Competency Skills I	1	-	-	-	-	-
	Total	**30**				**700**	**24**
THIRD SEMESTER							
23PMBM301	DSC VII: Soil and Environmental Microbiology	4	3	25	75	100	4
23PMBM302	DSC VIII: Research Methodology, Bioethics and IPR	4	3	25	75	100	4
23PMBM303	DSC IX: Biostatistics	4	3	25	75	100	4
23PMBEL301	DSE II	4	3	25	75	100	4
23PMBMP301	DSC Practical III	5	9	40	60	100	5
23PMBMP302	DSC Practical IV	2	3	40	60	100	2
23PMBI301	Internship Training	-	-	-	-	-	-
Optional Subjects							
23PBCMBI301	GEC II: Pharmaceutical Biochemistry	3	3	25	75	100	2
23PBCMBIP301	GEC Practical II: Pharmaceutical Biochemistry	3	3	40	60	100	2
23PBTMBI301	GEC II: Animal Tissue Culture Technology	3	3	25	75	100	2
23PBTMBIP301	GEC Practical II: Animal Tissue Culture Technology	3	3	40	60	100	2
Non Credit							
23PLS301	NCC : Career Competency Skills II	1	-	-	-	-	-
	Total	**30**				**800**	**27**
FOURTH SEMESTER							
23PMBM401	DSC X: Industrial Microbiology	6	3	25	75	100	6

23PMBM402	DSC XI: Food and Dairy Microbiology	6	3	25	75	100	6
23PMBMP401	DSC Practical IV	6	9	40	60	100	5
23PMBPR401	Project and Viva voce	5	3	40	60	100	5
	Total	**23**				**400**	**22**

DSE SUBJECT

The students shall choose any one of the following subjects as DSE I and II in the Second and Third semesters respectively.

S.No.	SUBJECT CODE	SUBJECT
1.	23PMBEL201	DSE I: Bioremediation
	23PMBEL202	DSE I: Bioinformatics
2.	23PMBEL301	DSE II: Recombinant DNA Technology
	23PMBEL302	DSE II: Nanomicrobiology

***ACC:**

S.No	Semester I-IV	
1.	*Additional Credit Courses (ACC) - MOOC Courses offered in SWAYAM/ NPTEL/ CEC etc.,	Completed students can get extra credits

FOR COURSE COMPLETION

Student shall complete:

- Human Rights in II semester.
- GEC in II and III semester.
- DSE subjects in II and III semesters.
- Project & Viva-Voce in IV semester.
- NCC in II and III semester.

TOTAL MARKS AND CREDIT DISTRIBUTION

S.No.	COMPONENT	MARK	CREDITS
1.	PART A: DSC, DSE and GEC subjects	2300	91
2.	PART B: Value Education	100	02
TOTAL		**2400**	**93**

23PMBM101	**DSC I: GENERAL MICROBIOLOGY AND MICROBIAL DIVERSITY**	**SEMESTER I**

Course Objectives:

The course aims

- To learn the principles of different types of microscopes and their applications. .
- To acquire the knowledge about microbial media and sterilization.
- To study the cell structure, microbial nutrition and growth.

Credits: 05 **Total Hours: 50**

UNIT	CONTENTS	Hrs	CO
I	**History and Scope of Microbiology:** Microscopy – Principles and applications. Types of Microscopes - Bright field, Dark-field, Phase-contrast, Fluorescence microscope, Transmission electron microscope (TEM) and Scanning electron microscope (SEM). Sample preparation for SEM & TEM. Atomic force, Confocal microscope. Micrometry – Stage, Ocular and its applications.	**10**	**CO1**
II	Bacterial Structure, properties and biosynthesis of cellular components – Cell wall. Actinomycetes and Fungi - Distribution, morphology, classification, reproduction and economic importance. Sporulation. Growth and nutrition - Nutritional requirements, Growth curve, Kinetics of growth, Batch culture, Synchronous growth, Measurement of growth and factors affecting growth.	**10**	**CO2**
III	Algae - Distribution, morphology, classification, reproduction and economic importance. Isolation of algae from soil and water. Media and methods used for culturing algae, Strain selection and large-scale cultivation. Life cycle - *Chlamydomonas*, *Nostoc* (Cyanobacteria)	**10**	**CO3**
IV	Microbial techniques - Safety guidelines in Microbiology	**10**	**CO4**

	Laboratories. Sterilization, Disinfection and its validation. Staining methods – Simple, Differential and Special staining. Automated Microbial identification systems - Pure cultures techniques – Cultivation of Anaerobic organisms. Maintenance and preservation of pure cultures. Culture collection centres - National and International.		
V	Biodiversity - Introduction to microbial biodiversity – Significance, characteristics and economic importance of Thermophiles, Methanogens, Alkaliphiles and Acidophiles, Barophiles, Halophiles. Conservation of Biodiversity.	**10**	**CO5**

Text Books:

1. Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (10th Edition). Universities Press (India) Pvt. Ltd.
2. Chan E.C.S., Pelczar M. J. Jr. and Krieg N. R. (2010). Microbiology. (5th Edition). Mc.Graw Hill. Inc, New York.
3. Prescott L. M., Harley J. P. and Klein D. A. (2004). Microbiology. (6th Edition). McGraw - Hill company, New York.
4. White D. Drummond J. and Fuqua C. (2011). The Physiology and Biochemistry of Prokaryotes, Oxford University Press, Oxford, New York.
5. Dubey R.C. and Maheshwari D. K. (2009). Textbook of Microbiology. S. Chand, Limited.

Reference Books:

1. Tortora G. J., Funke B. R. and Case C. L. (2015). Microbiology: An Introduction (12th Edition).Pearson, London, United Kingdom.
2. Webster J. and Weber R.W.S. (2007). Introduction to Fungi. (3rd Edition). Cambridge University Press, Cambridge.
3. Schaechter M. and Leaderberg J. (2004). The Desk encyclopedia of Microbiology. Elseiver Academic Press, California.

4.	Ingraham, J.L. and Ingraham, C.A. (2000) Introduction to Microbiology. (2nd Edition). Books / Cole Thomson Learning, UK.
5.	Madigan M. T., Bender K.S., Buckley D. H. Sattley W. M. and Stahl (2018) Brock Biology of Microorganisms. (15th Edition). Pearson.
Web Resources	
1.	http://sciencenetlinks.com/tools/microbeworld
2.	https://www.microbes.info/
3.	https://www.asmscience.org/VisualLibrary
4.	https://open.umn.edu/opentextbooks/BookDetail.aspx?bookId=404
5.	https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf

COURSE OUTCOMES (CO)

On completion of this course, students will;

CO1	Examine various microbes employing the microscopic techniques learnt. Measure and compare the size of microbes.
CO2	Differentiate and appreciate the anatomy of various microbes. Plan the growth of microbes for different environmental conditions.
CO3	Identify and cultivate the algae understanding their habitat. Analyze the morphology, classify and propagate depending on its economic importance.
CO4	Create aseptic conditions by following good laboratory practices.
CO5	Categorize and cultivate a variety of extremophiles following standard protocols for industrial applications.

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	M	H	M	H	H	M	H	M
CO2	M	M	H	H	M	M	M	H	H	M
CO3	H	M	H	M	M	H	M	H	M	M
CO4	M	M	M	M	M	M	M	M	M	M
CO5	M	M	H	H	H	M	M	H	H	H
H – High; M- Medium; L - Low										

23PMBM102	**DSC II: IMMUNOLOGY, IMMUNOMICS AND MICROBIAL GENETICS**	**SEMESTER I**

Course Objectives:

The course aims

- To acquire the knowledge about immunity, organs and cells involved in immunity.
- To acquire knowledge about the structure of DNA in prokaryotes and eukaryotes.
- To learn about gene transfer studies in microbes

Credits: 05 **Total Hours: 50**

UNIT	CONTENTS	Hrs	CO
I	**Introduction to biology of the immune system**: Hematopoiesis and its regulations. Cells and organs of Immune System. Immunity - Innate immunity and Acquired immunity. Antigens - features associated with antigenicity and immunogenicity. MHC genes and products, Structure of MHC molecules. Antigen processing and presentation to T- lymphocytes.	**10**	**CO1**
II	**Immunoglobulins:** Structure and types, Class switching and generation of antibody diversity. Monoclonal and polyclonal antibodies. Complement system – mode of activation- Classical, Alternate and Lectin pathways, biological functions. Antigen recognition – TCR, lymphocyte activation, clonal proliferation and differentiation. Various phases of HI, CMI – Cell mediated cytotoxicity, DTH response.	**10**	**CO2**
III	**Hypersensitivity:** Types and mechanisms, Autoimmunity, Tumor Immunity and Transplantation immunology. Blood groups in humans, Bombay blood group, Diagnostic Immunology - Precipitation reaction, Immunodiffusion	**10**	**CO3**

	methods - SRID, ODD. Immunoelectrophoresis - Rocket and Counter current electrophoresis. Agglutination - Hemagglutination - Hemagglutination inhibition. Labeled Assay- Immunofluorescence assay, Radio immunoassay, ELISA. Role of cytokines, lymphokines and chemokines. Introduction to Vaccines and Adjuvants - Types of vaccines. **Immunomics**- Introduction and Applications. Antigen engineering for better immunogenicity and use for vaccine development-multiepitope vaccines. Reverse vaccinology.		
IV	**Structural of prokaryotic and eukaryotic genome:** Introduction to prokaryotic genomic structure, Eukaryotic Genome - Structure of chromatin, chromosome, centromere, telomere, nucleosome. Modifications- methylation, acetylation, phosphorylation and its effect on structure and function of chromatin, DNA methylation and gene imprinting.	**10**	**CO4**
V	**Gene Transfer Mechanisms:** Conjugation and its uses. Transduction, Generalized and Specialized, Transformation– Natural Competence and Transformation. Transposition and Types of Transposition reactions. Insertion sequences, Mechanism – Transposons of *E. coli*,.Importance of transposable elements in horizontal transfer of genes and evolution.	**10**	**CO5**
Text Books:			
1.	Coico R., Sunshine G. and Benjamini E. (2003). Immunology – A Short Course. (5th Edition). Wiley-Blackwell, New York.		
2.	Owen J. A., Punt J., Stranford S. A. and Kuby J. (2013). Immunology, (7th Edition). W. H. Freeman and Company, New York.		

3.	Abbas A. K., Lichtman A. H. and Pillai S. (2021). Cellular and Molecular Immunology. (10thEdition).
4.	Malacinski G.M. (2008). Freifelder's Essentials of Molecular Biology. (4th Edition). Narosa Publishing House, New Delhi.
5.	Gardner E. J. Simmons M. J. and Snusted D.P. (2006). Principles of Genetics. (8th Edition). Wiley India Pvt. Ltd.
Reference Books:	
1.	Travers J. (1997). Immunobiology - The Immune System in Health and Disease. (3rd Edition). Current Biology Ltd. New York.
2.	Delves P.J., Martin S., Burton D. R. and Roitt I. M. (2006). Roitt's Essential Immunology. (11th Edition). Wiley-Blackwell.
3.	Hay F. C. and Westwood O. M. R. (2002). Practical Immunology (4thEdition). Wiley-Blackwell.
4.	Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5th Edition). ASM Press.
5.	Russell P.J. (2010). Genetics - A Molecular Approach. (3rd Edition). Pearson New International Edition.
Web Resources	
1.	https://www.ncbi.nlm.nih.gov/books/NBK279395/
2.	https://med.stanford.edu/immunol/phd-program/ebook.html
3.	https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/
4.	[PDF] Lehninger Principles of Biochemistry (8th Edition) By David L. Nelson and Michael M. Cox Book Free Download - StudyMaterialz.in
5.	https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/

COURSE OUTCOMES (CO)

On completion of this course, students will;

CO1	Discuss immunity, organs and cells involved in immunity. Compare the types of antigens and their properties.
CO2	Describe immunoglobulin and its types. Categorize MHC and understand its significance.
CO3	Elucidate the mechanisms of different hypersensitivity reactions. List out the Vaccines and discuss their development.
CO4	Acquire knowledge the structure DNA in prokaryotes and eukaryotes.
CO5	Explain out gene transfer studies in microbes.

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	M	H	M	H	H	M	H	M
CO2	M	M	H	H	M	M	M	H	H	M
CO3	H	M	H	M	M	H	M	H	M	M
CO4	M	M	M	M	M	M	M	M	M	M
CO5	M	M	H	H	H	M	M	H	H	H
H – High; M- Medium; L - Low										

23PMBM103	**DSC III: FORENSIC SCIENCE**	**SEMESTER I**

Course Objectives:

The course aims

- To learn the tools and techniques in forensic science.
- To identify and examine body fluids for identification.
- To recognize medico legal post mortem procedures and their importance.

Credits: 03 **Total Hours: 50**

UNIT	**CONTENTS**	**Hrs**	**CO**
I	Forensic Science - Definition, history and development of forensic science. Scope and need of forensic science in present scenario. Branches of forensic science. Tools and techniques of forensic science. Duties of a forensic scientist.	**10**	**CO1**
II	Forensic science laboratories - Organizational setup of a forensic science laboratory. Central and State level laboratories in India. Mobile forensic science laboratory and its functions. Forensic microbiology - Types and identification of microbial organisms of forensic significance.	**10**	**CO2**
III	Forensic serology - Definition, identification and examination of body fluids - Blood, semen, saliva, sweat and urine. Forensic examination and identification of hair and fibre.	**10**	**CO3**
IV	DNA profiling - Introduction, history of DNA typing. Extraction of DNA from blood samples - Organic and Inorganic extraction methods. DNA fingerprinting - RFLP, PCR, STR. DNA testing in disputed paternity.	**10**	**CO4**
V	Forensic toxicology - Introduction and concept of forensic toxicology. Medico legal post mortem and their examination. Poisons - Types of poisons and their mode of action.	**10**	**CO5**

Text Books:

1.	Nanda B. B. and Tewari R. K. (2001) Forensic Science in India: A Vision for the Twenty First Century. Select Publishers, New Delhi. ISBN- 10:8190113526 / ISBN-13:9788190113526.
2.	James S. H. and Nordby, J. J. (2015) Forensic Science: An Introduction to Scientific and Investigative Techniques. (5th Edition). CRC Press. ISBN-10:9781439853832 / ISBN-13:978-1439853832.
3.	Li R. (2015) Forensic Biology. (2nd Edition). CRC Press, New York. ISBN-13:978-1-4398-8972-5.
4.	Sharma B.R (2020) Forensic science in criminal investigation and trials. (6th Edition)Universal Press.
5.	Richard Saferstein (2017). Criminalistics- An introduction to Forensic Science. (12th Edition).Pearson Press.
Reference Books:	
1.	Nordby J. J. (2000). Dead Reckoning. The Art of Forensic Detection- CRC Press, New York. ISBN:0-8493-8122-3.
2.	Saferstein R. and Hall A. B. (2020). Forensic Science Hand book, Vol. I, (3rd Edition). CRC Press, New York. ISBN-10:1498720196.
3.	Lincoln, P.J. and Thomson, J. (1998). (2nd Edition). Forensic DNA Profiling Protocols. Vol. 98. Humana Press. ISBN: 978-0-89603-443-3.
4.	Val McDermid (2014). Forensics. (2nd Edition). ISBN 9780802125156.
5.	Vincent J. DiMaio., Dominick DiMaio. (2001). Forensic Pathology (2nd Edition). CRC Press.
Web resources	
1.	http://clsjournal.ascls.org/content/25/2/114
2.	https://www.ncbi.nlm.nih.gov/books/NBK234877/
3.	https://www.elsevier.com/books/microbial-forensics/budowle/978-0-12-382006-8
4.	https://www.researchgate.net/publication/289542469_Methods_in_microbial_forensics
5.	https://cisac.fsi.stanford.edu/events/microbial forensics

COURSE OUTCOMES (CO)

On completion of this course, students will;

CO1	Identify the scope and need of forensic science in the present scenario.
CO2	Plan for the organizational setup and functioning of forensic science laboratories.
CO3	Analyze the biological samples found at the crime scene.
CO4	Perform extraction and identification of DNA obtained from body fluids.
CO5	Discuss the concept of forensic toxicology.

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	M	H	M	H	H	M	H	M
CO2	M	M	H	H	M	M	M	H	H	M
CO3	H	M	H	M	M	H	M	H	M	M
CO4	M	M	M	M	M	M	M	M	M	M
CO5	M	M	H	H	H	M	M	H	H	H
H – High; M- Medium; L - Low										

23PMBM104	DSC IV: HERBAL TECHNOLOGY AND COSMETIC MICROBIOLOGY	SEMESTER I

Course Objectives:

The course aims

- To impart knowledge of Indian Medicinal Plants and their applications in microbiology.
- To learn the methods to analyze the antimicrobial activity of medicinal plants.
- To gain insight into pharmacopeial microbial assays and biosafety.

Credits: 03 **Total Hours: 50**

UNIT	CONTENTS	Hrs	CO
I	Herbs, Herbal medicine - Indian medicinal plants: Scope and Applications of Indian medicinal plants in treating bacterial, fungal and viral diseases. Basic principles involved in Ayurvedha, Sidha, Unani and Homeopathy.	10	CO1
II	Collection and authentication of selected Indian medicinal plants: *Emblica officinalis, Withania somnifera, Phyllanthus amarus, Tinospora cordifolia, Andrographis paniculata, Piper longum, Ocimum sanctum, Azardirchat aindica, Terminalia chebula, Allium sativum*. Preparation of extracts- Hot and cold methods. Preparation of stock solutions.	10	CO2
III	Antimicrobial activity of selected Indian medicinal Plants: - In vitro determination of antibacterial and fungal activity of selected whole medicinal plants/ parts – well-diffusion methods. MIC - Macro and micro dilution techniques. Antiviral activity- cell lines-cytotoxicity, cytopathic and non-cytopathic effect.	10	CO3
IV	History of Cosmetic Microbiology – Need for cosmetic microbiology, Scope of cosmetic microbiology, - Role of	10	CO4

	microbes in cosmetic preparation. Preservation of cosmetics. Antimicrobial properties of natural cosmetic products – Garlic, neem, turmeric, aloe vera and tulsi. Sanitary practices in cosmetic manufacturing - HACCP protocols in cosmetic microbiology.		
V	Cosmetic microbiology test methods - Antimicrobial preservative efficacy, microbial content testing and biological toxicological testing. Validation methods - bioburden and Pharmacopeial microbial assays. Preservatives of cosmetics - Global regulatory and toxicological aspect of cosmetic preservatives.	**10**	**CO5**

Text Books:

1. Ayurvedic Formulary of India. (2011). Part 1, 2 & 3. Pharmacopoeia Commission for Indian Medicine and Homeopathy. ISBN-10:8190648977.
2. Panda H. (2004). Handbook on herbal medicines. Asia Pacific Business Press Inc. ISBN:8178330911.
3. Mehra P. S. (2019). A Textbook of Pharmaceutical Microbiology. Dreamtech Press. ISBN 13:9789389307344.
4. Geis P. A. (2020). Cosmetic microbiology: A Practical Approach. (3rd Edition). CRC Press. ISBN:9780429113697.
5. Brannan D. K. (1997). Cosmetic microbiology: A Practical Handbook. CRC Press.ISBN-10:0849337135.

Reference Books:

1.	Indian Herbal Pharmacopoeia (2002). Vol. I &II Indian Drug Manufacturers Association, Mumbai.
2.	British Herbal Pharmacopoeia.(1990).Vol.I. British Herbal Medicine Association. ISBN: 0903032090.
3.	Verpoorte R. and Mukherjee, P. K. (2010). GMP for Botanicals: Regulatory and Quality issues on Phytomedicines. In GMP for botanicals: regulatory and quality issues on phytomedicines. (2nd edition). Saujanya Books, Delhi.ISBN-10:81-900788-5-2/8190078852. ISBN-13:978-81-900788-5-6/9788190078856.
4.	Turner R. (2013). Screening methods in Pharmacology. Elsevier. ISBN:9781483264233.
5.	Cupp M. J. (2010). Toxicology and Clinical Pharmacology of Herbal Products (pp. 85-93). M. J. Cupp. Humana Press. Totowa, NJ, USA. ISBN-10:1617371904.

Web Resources

1.	https://www.academia.edu/50236711/Modern_Extraction_Methods_for_Preparation_of_Bioactive_Plant_Extracts
2.	https://www.nhp.gov.in/introduction-and-importance-of-medicinal-plants-and-herbs_mtl
3.	https://pubmed.ncbi.nlm.nih.gov/17004305/
4.	https://www.fda.gov/cosmetics/potential-contaminants-cosmetics/microbiological-safety-and-cosmetics
5.	https://pubmed.ncbi.nlm.nih.gov/15156038/

COURSE OUTCOMES (CO)

On completion of this course, students will;

CO1	Identify the applications of Indian medicinal plants in treating diseases.
CO2	Identify and authenticate herbal plants.
CO3	Evaluate the antimicrobial activity of medicinal plants.
CO4	Describe the role of microorganisms and their metabolites in the preparation of cosmetics.
CO5	Validate procedures and biosafety measures in the mass production of cosmetics.

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	M	H	M	H	H	M	H	M
CO2	M	M	H	H	M	M	M	H	H	M
CO3	H	M	H	M	M	H	M	H	M	M
CO4	M	M	M	M	M	M	M	M	M	M
CO5	M	M	H	H	H	M	M	H	H	H
H – High; M- Medium; L - Low										

23PMBMP101	**DSC PRACTICAL I (Fundamentals of Microbiology and Microbial Diversity, Immunology, Immunomics & Microbial Genetics)**	**SEMESTER I**

Course Objectives

The course aims

- To learn the basic techniques of microbiology.
- To understand the morphological structures of bacteria.
- To perform DNA extraction and gene transfer mechanisms, analyze and identify by gel electrophoresis.

Credit: 04 **Total Hours:60**

Experiment	CONTENTS	Hrs	CO
1.	Measurement of bacterial cell size – Micrometry	**3**	**CO1**
2.	Pure culture techniques	**6**	**CO2**
3.	Motility – Hanging drop technique - Soft agar deeps	**3**	**CO1**
4.	Measurement of bacterial growth – Growth curve	**6**	**CO4**
5.	Simple staining, Capsular staining	**3**	**CO1**
6.	Gram staining, Endospore staining	**3**	**CO1**
7.	Acid-fast staining	**3**	**CO1**
8.	IMViC tests, Carbohydrate fermentation, Triple sugar iron (TSI) agar test.	**6**	**CO1**
9.	ABO Blood grouping, Agglutination tests – WIDAL.	**3**	**CO1**
10.	RA, ASO and CRP	**3**	**CO4**
11.	ODD and CIE, ELISA – tridot (demo)	**3**	**CO3**
12.	Isolation of genomic DNA from *E. coli*	**6**	**CO3**
13.	Isolation of Plasmid DNA from *E.coli*.	**6**	**CO3**

14.	Separation of proteins by polyacrylamide gel electrophoresis (SDS-PAGE)	**6**	**CO5**
Reference Books:			
1.	*James G. Cappucino and Sherman Natalie* 2005.**Microbiology–A LaboratoryManual**. [Seventh edition].Pearson education India, New Delhi.		

COURSE OUTCOMES (CO)

After completion of the course, the students' will be able to

CO1	Identify and measure the size of the microbes through staining and micrometry with microscopy
CO2	Evaluate the isolation and purification of microorganisms.
CO3	Analyze the characteristics of microorganisms based on standard biochemical techniques.
CO4	Assess the bacterial growth and analyze its growth by physical environments.
CO5	Apply serological analysis for the detection of various infections.

23PMBM201	**DSC V:MEDICAL BACTERIOLOGY AND MYCOLOGY**	**SEMESTER II**

Course Objectives:

The course aims

- To acquire knowledge on collection, transportation and processing of various kinds of clinical specimens.
- To explain morphology, characteristics and pathogenesis of bacteria.
- To acquire knowledge on fungal disease diagnosis, antifungal agents and their importance.

Credits: 05 **Total Hours: 50**

UNIT	CONTENTS	Hrs	CO
I	Classification of medically important bacteria, Normal flora of human body, Collection, transport, storage and processing of clinical specimens.	**10**	**CO1**
II	Morphology, characteristics, pathogenesis, laboratory diagnosis, control and treatment of diseases caused by species of *Staphylococci, Neisseriae*, *Bacillus, Corynebacteria, Mycobacteria* and *Clostridium.*	**10**	**CO2**
III	Morphology, characteristics, pathogenesis, laboratory diagnosis, control and treatment: Enterobacteriaceae members, *Pseudomonas, Vibrio, Mycoplasma, Helicobacter, Rickettsiae, Chlamydiae, Spirochaetes- Leptospira,* and *Treponema.* Nosocomial infections.	**10**	**CO3**
IV	Morphology, characteristics, pathogenesis, laboratory diagnosis, control and treatment : Superficial mycosis -Tinea, Piedra. Cutaneous mycosis - Dermatophytoses, Systemic mycosis - Blastomycosis and Histoplasmosis. Subcutaneous mycosis -Sporotrichosis, Opportunistic mycosis – *Candida, Cryptococcus* and *Aspergillus*. Antifungal agents.	**10**	**CO4**
V	Morphology, characteristics, pathogenesis, laboratory	**10**	**CO5**

	diagnosis, control and treatment: Systemic mycoses, *Histoplasma, Sporothrix, Blastomyces.* Fungi causing Eumycotic Mycetoma, Fungi causing secondary infections in immunocompromised patients. Immunodiagnostic methods in mycology- Recent advancements in diagnosis.		

Text Books:

1. Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (2017).Orient Longman, Hyderabad.
2. Greenwood, D., Slack, R. B. and Peutherer, J. F. (2012) Medical Microbiology, (18th Edition). Churchill Livingstone, London.
3. Alexopoulos C. J., Mims C. W. and Blackwell M. (2007). Introductory Mycology, (4th Edition). Wiley Publishers.
4. Chander J. (2018). Textbook of Medical Mycology. (4th Edition). Jaypee brothers Medical Publishers.

Reference Books:

1. Salle A. J. (2007). Fundamental Principles of Bacteriology. (4th Edition). Tata McGraw-Hill Publications.
2. Collee J.C. Duguid J.P. Foraser, A.C, Marimon B.P, (1996). Mackie & McCartney Practical Medical Microbiology. 14thedn, Churchill Livingston.
3. Cheesbrough M. (2006). District Laboratory Practice in Tropical countries.- Part 22ndedn.Cambridge University Press.
4. Topley and Wilson's. (1998). Principles of Bacteriology.9thedn. Edward Arnold, London.
5. Murray P.R., Rosenthal K.S. and Michael A. (2013). Medical Microbiology.Pfaller. 7thedn. Elsevier, Mosby Saunders.

Web Resources

1. http://textbookofbacteriology.net/nd

2.	https://microbiologysociety.org/members-outreach-resources/links.html
3.	https://www.pathelective.com/micro-resources
4.	http://mycology.cornell.edu/fteach.html
5.	https://www.adelaide.edu.au/mycology/

COURSE OUTCOMES (CO)

On completion of this course, students will;

CO1	Collect, transport and process of various kinds of clinical specimens.
CO2	Analyze various bacteria based on morphology and pathogenesis.
CO3	Discuss various treatment methods for bacterial disease.
CO4	Employ various methods detect fungi in clinical samples and apply knowledge on antifungal agents.
CO5	Apply various immunodiagnostic method to detect fungal infections.

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	M	H	M	H	H	M	H	M
CO2	M	M	H	H	M	M	M	H	H	M
CO3	H	H	H	H	H	H	H	H	H	H
CO4	M	M	M	M	M	M	M	M	M	M
CO5	H	H	H	H	H	H	H	H	H	H
H – High; M- Medium; L - Low										

23PMBM202	**DSC V: MEDICAL VIROLOGY AND PARASITOLOGY**	**SEMESTER II**

Course Objectives:

The course aims

- To describe the replication strategy and cultivation methods of viruses.
- To acquire knowledge about oncogenic virus and human viral
- To develop diagnostic skills, in the identification of virus infections.
- To impart knowledge about diagnostic skills, and identification of parasitic infections.

Credits: 05 **Total Hours: 50**

UNIT	CONTENTS	Hrs	CO
I	**Viruses:** General properties - Structure and Classification - viroids, prions, satellite RNAs and virusoids. Cultivation of viruses - embryonated eggs, experimental animals and cell cultures. Purification and Assay of viruses – Physical and Chemical methods (Electron Microscopy, Protein and Nucleic acids studies.) Infectivity Assays (Plaque and end-point).	**10**	**CO1**
II	**DNA Viruses:** Virus Entry, Epidemiology, pathogenic mechanisms, Pathogenesis, laboratory diagnosis, control and treatment - Pox, Herpes, Adeno , Papova and Hepadna.	**10**	**CO2**
III	**RNA Viruses**: Picorna, Orthomyxo, Paramyxo, Rhabdo, Rota, HIV and other Hepatitis viruses, Arbo– Dengue virus, Ebola virus, Emerging and reemerging viral infections. Antiviral drugs.	**10**	**CO3**
IV	**Introduction to Medical Parasitology –** Classification, host-parasite relationships. Epidemiology, life cycle, pathogenic mechanisms, laboratory diagnosis, treatment: Protozoa causing human infections – *Entamoeba,* Aerobic and	**10**	**CO4**

	Anaerobic amoebae, *Giardia, Trichomonas, Leishmania,* and *Trypanasoma.*		
V	**Introduction to Helminthes and Protozoans:** Classification, life cycle, pathogenicity, laboratory diagnosis and treatment for parasites – Helminthes - Cestodes – *Taeniasolium, T. saginata,*.Trematodes – *Fasciola hepatica.* Nematodes - *Ascaris, Ankylostoma, Wuchereria*. Cultivation of parasites. Diagnosis of parasitic infections – Serological and molecular diagnosis. Anti-protozoan drugs.	**10**	**CO5**

Text Books:

1. Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (10th Edition). Universities Press (India) Pvt. Ltd.
2. Dubey, R.C. and Maheshwari D.K. (2010). A Text Book of Microbiology. S. Chand & Co.
3. Rajan S. (2007). Medical Microbiology. MJP publisher.
4. Paniker J. (2006). Text Book of Parasitology. Jay Pee Brothers, New Delhi.
5. Arora, D. R. and Arora B. B. (2020). Medical Parasitology. (5th Edition). CBS Publishers & Distributors Pvt. Ltd. New Delhi.

Reference Books:

1. Carter J. (2001). Virology: Principles and Applications (1st Edition). Wiley Publications.
2. Willey J., Sandman K. and Wood D. Prescott's Microbiology. (11th Edition). McGraw Hill Book.
3. Jawetz E., Melnick J. L. and Adelberg E. A. (2000). Review of Medical Microbiology. (19th Edition). Lange Medical Publications, U.S.A.
4. Levanthal R. and Cheadle R. S. (2012). Medical Parasitology. (6th Edition). S.A. Davies Co. Philadelphia.

Web Resources

1.	https://en.wikipedia.org/wiki/Virology
2.	https://academic.oup.com/femsre/article/30/3/321/546048
3.	https://www.sciencedirect.com/science/article/pii/S0042682215000859
4.	https://nptel.ac.in/courses/102/103/102103039/
5.	https://www.healthline.com/health/viral-diseases#contagiousness

COURSE OUTCOMES (CO)

On completion of this course, students will;

CO1	Cultivate viruses by different methods and aid in diagnosis.
CO2	Investigate the symptoms of viral infections and presumptively identify the viral disease.
CO3	Diagnose various viral diseases by different methods
CO4	Educate public about the spread, control and prevention of parasitic diseases.
CO5	Identify the protozoans and helminthes present in stool and blood specimens.

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	M	H	M	H	H	M	H	M
CO2	M	M	H	H	M	M	M	H	H	M
CO3	H	H	H	H	H	H	H	H	H	H
CO4	M	M	M	M	M	M	M	M	M	M
CO5	M	M	H	H	H	M	M	H	H	H
H – High; M- Medium; L - Low										

23PMBEL201	**DSE I: BIOREMEDIATION**	**SEMESTER II**

Course Objectives:

The course aims

- To describe the nature and importance of bioremediation and its applications in water treatment.
- To explain the fundamentals of treatment technologies and implementation in treatment plants.
- To explain the potential of microbes with methods of reducing health risks caused by xenobiotics.

Credits: 04 **Total Hours: 50**

UNIT	CONTENTS	Hrs	CO
I	**Bioremediation**: Process and organisms involved. Bioaugmentation - Ex-situ and in-situ processes; Intrinsic and engineered bioremediation. Major pollutants and associated risks; organic pollutant degradation. Factors affecting the process. Recent developments and significance.	**10**	**CO1**
II	**Microbes involved in aerobic and anaerobic processes in nature**: Water treatment - BOD, COD, dissolved gases, removal of heavy metals. Secondary waste water treatments - use of membrane bioreactor. Aquaculture effluent treatment. Aerobic sludge and landfill leachate process. Aerobic digestion.	**10**	**CO2**
III	**Composting of solid wastes**: Anaerobic digestion - methane production and important factors involved, Pros and cons of anaerobic process. Bioremediation of dyes, bioremediation in paper and pulp industries. Aerobic and anaerobic digesters – design.	**10**	**CO3**
IV	**Microbial leaching of ores**: Process, microorganisms involved and metal recovery with special reference to copper	**10**	**CO4**

	and iron. Biotransformation of heavy metals and xenobiotics. Petroleum biodegradation - reductive and oxidative. Dechlorination. Biodegradable of plastics and super bug.		
V	**Phytoremediation of heavy metals in soil** : Basic principles of phytoremediation - Uptake and transport, Accumulation and sequestration. Phytoextraction. Phytodegradation. Phytovolatilization. Rhizodegradation. Phytostabilization - Role of Arbuscular mycorrhizal fungi and plant growth promoting rhizobacteria in phytoremediation.	**10**	**CO5**

Text Books:

1. Bhatia H.S. (2018). A Text book on Environmental Pollution and Control. (2nd Edition). Galgotia Publications.
2. Chatterjee A. K. (2011). Introduction to Environmental Biotechnology. (3rd Edition). Printice-Hall, India.
3. Pichtel, J. (2014). Waste Management Practices: Municipal, Hazardous, and Industrial, 2nd edition, CRC Press.
4. Liu, D .H. F and Liptak, B. G (2005). Hazardous Wastes and Solid Wastes, Lewis Publishers.
5. Rajendran, P. & Gunasekaran, P. (2006). Microbial Bioremediation. 1st edition. MJP Publishers

Reference Books:

1. Sangeetha J., Thangadurai D., David M. and Abdullah M.A. (2016). Environmental Biotechnology: Biodegradation, Bioremediation, and Bioconversion of Xenobiotics for Sustainable Development. (1st Edition). Apple Academic Press.
2. Singh A. and Ward O. P. (2004). Biodegradation and Bioremediation. Soil Biology. Springer.

3.	Singh A., Kuhad R. C., and Ward O. P. (2009). Advances in Applied Bioremediation (1st Edition). Springer-Verlag Berlin Heidelberg, Germany.
4.	Rathoure, A.K. (Ed.). (2017). Bioremediation: Current Research and Applications. 1st edition. I.K. International Publishing House Pvt. Lt
Web Resources	
1.	Bioremediation- Objective, Principle, Categories, Types, Methods, Applications (microbenotes.com)
2.	https://agris.fao.org › agris-search
3.	https://www.sciencedirect.com/topics/earth-and-planetary-sciences/bioremediation
4.	https://www.intechopen.com/chapters/70661
5.	https://microbiologysociety.org/blog/bioremediation-the-pollution-solution.html

COURSE OUTCOMES (CO)

On completion of this course, students will;

CO1	Differentiate Ex-situ bioremediation and In-situ bioremediation. Assess the roles of organisms in bioremediation.
CO2	Distinguish microbial processes necessary for the design and optimization of biological processing unit operations.
CO3	Identify, formulate and design engineered solutions to environmental problems.
CO4	Explore microbes in degradation of toxic wastes and playing role on biological mechanisms.
CO5	Establish the mechanisms of Arbuscular mycorrhizal fungi and Plant growth promoting *Rhizobacteria* in phytoremediation.

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	M	M	M	M	M	M	M	M
CO2	M	M	H	H	M	M	M	H	H	M
CO3	H	M	H	M	M	H	M	H	M	M
CO4	M	M	M	M	M	M	M	M	M	M
CO5	M	M	H	H	H	M	M	H	H	H
H – High; M- Medium; L - Low										

23PMBEL202	**DSE I: BIOINFORMATICS**	**SEMESTER II**

Course Objectives:

The course aims

- To discuss about various biological data mining concepts, tools.
- To elucidate the principles and applications of sequence alignment methods and tools
- To demonstrate different phylogenetic tree construction methods and inpredicting 3D and 2D structure of proteins.
- To describe various tools and techniques used in molecular docking, immunoinformatics and subtractive genomics

Credits: 04 **Total Hours: 50**

UNIT	CONTENTS	Hrs	CO
I	**Biological Data Mining**: Exploration of Data Mining Tools. Cluster Analysis Methods. Data Visualization. Biological Data Management. Biological Algorithms – Biological Primary and Derived Databases. Concept of Alignment, Pairwise Sequence Alignment (PSA), Multiple Sequence Alignment (MSA), BLAST, CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).	**10**	**CO1**
II	**Phylogenetic Tree Construction:** Concept of Dendrograms. Evolutionary Trees - Distance Based Tree Reconstruction - Ultrametric trees and Ultrametric distances – Reconstructing Trees from Additive Matrices - Evolutionary Trees and Hierarchical Clustering - Character Based Tree Reconstruction - Maximum Parsimony Method, Maximum likelihood method - Reliability of Trees – Substitution matrices – Evolutionary models.	**10**	**CO2**
III	**Computational Protein Structure prediction:** Secondary structure – Homology modelling- Fold recognition and	**10**	**CO3**

	abinitio 3D structure prediction – Structure comparison and alignment – Prediction of function from structure. Geometrical parameters – Potential energy surfaces – Hardware and Software requirements-Molecular graphics – Molecular file formats- Molecular visualization tools.		
IV	**Prediction of Properties of Ligand Compounds:** 3D Autocorrelation -3D Morse Code-Conformation Dependent and Independent Chirality Codes –Comparative Molecular Field Analysis – 4 D QSAR –HYBOT Descriptors – Structure Descriptors – Applications – Linear Free Energy Relationships – Quantity Structure - Property Relationships –Prediction of the Toxicity of Compounds	**10**	**CO4**
V	**Molecular Docking:** Flexible - Rigid docking- Target-Ligand preparation- Solvent accessibility- Surface volume calculation, Active site prediction- Docking algorithms-Genetic, Lamarckian - Docking analyses- Molecular interactions, bonded and nonbonded - Molecular Docking Software and Working Methods. Genome to drug discovery – Subtractive Genomics – Principles of Immunoinformatics and Vaccine Development.	**10**	**CO5**
Text Books:			

1.	Lesk A. M. (2002). Introduction to Bioinformatics. (4th Edition). Oxford University Press.
2.	Lengauer T. (2008). Bioinformatics- from Genomes to Therapies (Vol-1).Wiley-VCH.
3.	Rastogi S. C., Mendiratta N. and Rastogi P. (2014). Bioinformatics - Methods and Applications (Genomics, Proteomics and Drug Discovery) (4th Edition). Prentice-Hall of India Pvt.Ltd.
4.	*Attwood, T.K. and Parry-Smith, D.J. (1999). Introduction to Bioinformatics. Addision Wesley Longman Limited, England.*
5.	Mount D.W., (2013).Bioinformatics sequence and genome analysis, 2ndedn.CBS Publishers, New Delhi.
Reference Books:	
1.	**Baxevanis A. D. and Ouellette F. (2004). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. (2nd Edition).** John Wiley and Sons.
2.	Bosu O. and Kaur S. (2007). Bioinformatics - Database, Tools, and Algorithms. Oxford University Press.
3.	David W. M. (2001). Bioinformatics Sequence and Genome Analysis (2nd Edition). CBS Publishers and Distributors(Pvt.)Ltd.
4.	Xiong J, (2011). Essential bioinformatics, First south Indian Edition, Cambridge University Press.
Web Resources	
1.	https://www.hsls.pitt.edu/obrc/
2.	https://www.hsls.pitt.edu/obrc/index.php?page=dna
3.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1669712/
4.	https://www.ebi.ac.uk/
5.	https://www.kegg.jp/kegg/kegg2.html

COURSE OUTCOMES (CO)

On completion of this course, students will;

CO1	Access to databases that provides information on nucleic acids and proteins.
CO2	Invent algorithms for sequence alignment.
CO3	Construct phylogenetic tree.
CO4	Predict the structure of proteins.
CO5	Design drugs by predicting drug ligand interactions and molecular docking.

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	M	M	M	M	M	M	M	M
CO2	M	M	H	H	M	M	M	H	H	M
CO3	H	M	H	M	M	H	M	H	M	M
CO4	M	M	M	M	M	M	M	M	M	M
CO5	M	M	H	H	H	M	M	H	H	H
H – High; M- Medium; L - Low										

23PMBMP201	DSC PRACTICAL II (Medical Bacteriology and Mycology, Medical Virology and Parasitology, Bioremediation)	SEMESTER II

Course Objectives:

The course aims

- To understand and identify unknown pathogens.
- To study plant growth promoting microorganisms.

Credits: 04 **Total Hours: 60**

Experiment	CONTENTS	Hrs	CO
1.	Isolation and Identification of bacteria causing urinary tract infection.	**6**	**CO1**
2.	Identification of unknown pathogen from pus from infected wound.	**6**	**CO1**
3.	Identification of unknown pathogen from diarrhoeic stool.	**6**	**CO1**
4.	Minimal Inhibitory Concentration for selected antibiotics against clinical pathogens.	**3**	**CO1**
5.	Examination of fungi by Lactophenol Cotton Blue Mount.	**3**	**CO1**
6.	Isolation of phage from sewage sample.	**6**	**CO2**
7.	Examination of cysts, ova by concentration, Flotation and sedimentation method.	**3**	**CO2**
8.	Biological Oxygen Demand (BOD).	**3**	**CO3**
9.	Chemical Oxygen Demand (COD).	**3**	**CO3**
10.	MPN technique.	**6**	**CO3**
11.	Isolation of amylase from soil sample.	**3**	**CO3**
12.	Isolation of antibiotic producers by crowded plate technique.	**6**	**CO3**
13.	Enzyme immobilization technique.	**3**	**CO3**

14.	Observation of VAM fungi from roots	**3**	**CO3**
Reference Book:			
1.	*James G. Cappucino and Sherman Natalie* 2005.**Microbiology–A LaboratoryManual**. [Seventh edition].Pearson education India, New Delhi.		

COURSE OUTCOMES (CO)

After completion of the course, the students' will be able to

CO1	Apply the diagnosis knowledge to detect the unknown pathogens from clinical samples.
CO2	Develop sustainable agriculture through study of agriculturally important microorganisms.
CO3	Evaluate the purity of the water and analyze the pollutants present in water bodies.
CO4	Assess the different molecular phases in eukaryotic cells.

23PBCMBI201	**GEC I: DIAGNOSTIC BIOCHEMISTRY**	**SEMESTER–II**

Course Objectives:

The Course aims

- To enable the students to develop practical and interpretative skills to contribute effectively in diagnostic haematology and clinical biochemistry

Credits: 02 **Total Hours: 40**

UNIT	CONTENTS	Hrs	CO
I	**Clinical Laboratory:** Introduction, types and set-up. Basic laboratory safety, hazards in the clinical laboratory, safety with chemical/reagents, first aid in laboratory accidents. Fundamental chemistry - Indicators, solutes, solvents and solutions.	8	CO1
II	**Clinical Haematology:** Ways of obtaining blood, Separation of serum and plasma, Anticoagulants, Blood collection system, Complete blood cell count (CBC), Erythrocyte sedimentation rate. Automation in haematology, bleeding time, clotting time	8	CO2
III	**Urine analysis and Stool examination:** Physicochemical characteristics of urine, preservation of specimen, gross examination of urine and chemical examination of urine-tests for glucose, proteins, aminoacids, ketone bodies, bile salts, bile pigments. Stool examination – Specimen collection, test for occult blood, microscopic examination of stool	8	CO3
IV	**Clinical Chemistry and Enzymology:** Diabetes Mellitus - Introduction, types, diagnostic tests –Glucose and insulin tolerance test. Glycosylated haemoglobin. Estimation and interpretation of cholesterol, urea, creatinine and protein in blood samples. Enzymology – Role of AST and ALT in diagnosis of diseases.	8	CO4

V	**Organ function tests:** Liver function test: Functions of the Liver, Tests based on abnormalities of bile pigments (Jaundice). Renal Function Test: Renal clearance test (Creatinine and urea), dilution test, phenol red test, principles of precise tests of renal function – Glomerular filtration rate, renal plasma flow and maximal tubular capacity.	**8**	**CO5**
Text Books:			
1.	*RamnikSood.* 2006. **Medical Laboratory Technology.** [First Edition].Jaypee Brother's Medical Publishers Ltd., New Delhi		
2.	*Kanai L. Mukherjee.* 2005. **Medical Laboratory Technology, Volume I.** Tata McGraw- Hill Publishing Co. New Delhi		

COURSE OUTCOMES (CO)

After the completion of the course the student will be able to

CO1	Practice the safe laboratory processes and reagent preparations
CO2	Explain the general concepts of specimen handling methods and analysis of blood cells in clinical labs
CO3	Recite the handling and analytical procedures of urine and stool samples
CO4	Describe the general concepts in diagnosis of diabetes mellitus
CO5	Perform various laboratory procedures to assess the functional status of the organs

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	M	H	H	H	H	M	H	M
CO2	H	H	M	H	H	H	H	M	H	M
CO3	H	H	M	H	H	H	H	M	H	M
CO4	H	H	M	H	H	H	H	M	H	M
CO5	H	H	M	H	H	H	H	M	H	M
H – High; M- Medium; L - Low										

23PBCMBIP201	**GEC PRACTICAL I: DIAGNOSTIC BIOCHEMISTRY**	**SEMESTER II**

Course Objectives:

The course aims

- To enable the students to develop practical knowledge in handling and testing the biological samples

Credits: 02 **Total Hours: 24**

S.No.	**EXPERIMENT**	**Hrs**	**CO**
I. Clinical haematology			
1.	Enumeration of WBC and RBC	3	CO1
2.	Estimation of haemoglobin (Sahli's method)	3	CO1
3.	Erythrocyte sedimentation rate (Westergren's method)	3	CO1
II. Blood analysis			
4.	Estimation of glucose in blood (Nelson Somogyi's method).	3	CO2
5.	Estimation of urea in blood (DAM method).	3	CO2
6.	Estimation of creatinine in blood (Jaffe's method).	3	CO2
III. Urine analysis			
7.	Estimation of creatinine in urine (Jaffe's method).	3	CO2
8.	Qualitative analysis of normal and abnormal constituents in urine	3	CO3

Reference Books:

1. *Harold Varley*. 1980. **Practical Biochemistry. Volume I & II.** [Fifth Edition]. CBS Publishers, New Delhi

COURSE OUTCOMES (CO)

After the completion of the course the student will be able to

CO1	Perform blood cell analysis procedures
CO2	Estimate the presence of metabolites in blood and urine
CO3	Use the tests to identify normal and abnormal constituents in urine by qualitative analysis

23PBTMBI201	GEC I: PLANT TISSUE CULTURE TECHNOLOGY	SEMESTER II

Course Objectives:

The course aims

- To understand the basic techniques in plant tissue culture.

Credits : 02 **Total Hours: 40**

UNIT	CONTENTS	Hrs	CO
I	Introduction to Plant cells, Types of plant cells, Principles of plant tissue culture, Tissue culture media, Growth regulators and Sterilization techniques.	**7**	**CO1**
II	Callus and suspension culture, Micropropagation, Meristem culture, Somatic embryogenesis, Protoplast isolation, Fusion of protoplast, Somaclonal variations.	**8**	**CO2**
III	*Agrobacterium mediated* gene transfer, *Agrobacterium* based vectors, direct gene transfer methods- electroporation, microinjection, particle bombardment.	**9**	**CO3**
IV	Genetic engineering for quality improvement-Protein, lipids, carbohydrates, and vitamins, Production of resistant plants-Herbicide resistance, Insect resistance (Bt approach), Abiotic stress tolerance plant production -Drought, temperature and salt.	**10**	**CO4**
V	Secondary metabolites from plants–Alkaloids, flavonoids and phenolic compounds, Germplasm conservation.	**6**	**CO5**

TextBook:

1. *Bhojwani, S.S., and Razdan, M.K.* 2008. **Plant Tissue Culture– Theory and Practice.** Elsevier Publishers, New Delhi.

Reference Books:	
1.	*Chawla, H.S.* 1998. **Biotechnology in Crop Improvement.** International Book Distribution Co., New Delhi.
2.	*Hopkins, W. G .and Hiiner, N. P. A.*2004. **Introduction to Plant Physiology.** [Third Edition]. John Wiley and Sons, New Jersey, USA.
3.	*Jain,V.K.* 2013. **Fundamentals of Plant Physiology**. [Fifth Edition].S. Chandand Company, New York.
4.	*Trivedi, P.C.* 2004. **Advances in Plant Physiology**. [Third Edition]. I.K. International Publications Pvt Ltd., New Delhi.

COURSE OUTCOMES (CO)

After the completion of the course the student will be able to

CO1	Simplify the types of plant cells and will able to utilize various sterilization techniques
CO2	Utilize the micro propagation and isolation of plant tissue
CO3	Analyze the techniques for Transfer gene by biological and physical method
CO4	Contrast the benefits and develop the genetically modified crops
CO5	Demonstrate the Extraction and identification of secondary metabolites

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	H	H	M	H	H	M	H	M
CO2	M	M	H	H	M	H	H	M	H	M
CO3	M	M	H	H	M	H	H	M	H	M
CO4	M	M	H	H	M	H	H	M	H	M
CO5	M	M	H	H	M	H	H	M	H	M
H – High; M- Medium; L - Low										

23PMBBTIP201	**GEC PRACTICAL I: PLANT TISSUE CULTURE TECHNOLOGY**	**SEMESTER II**

Course Objectives:

The course aims

- To get hands on experience on Plant tissue culture

Credits: 02 **Total Hours:30**

Experiment	**CONTENTS**	**Hrs**	**CO**
1.	Media preparation.	**3**	**CO1**
2.	Hormone stock solution preparation	**2**	**CO1**
3.	Callus induction.	**5**	**CO1**
4.	Micropropagation.	**5**	**CO2**
5.	Protoplast isolation.	**5**	**CO2**
6.	Synthetic seed preparation	**5**	**CO2**

Reference Books:

1. Aneja, K.R. 2003. **Experiments in Microbiology, Plant pathology and Biotechnology.**[Fourth Edition]. Newage international.
2. *Bhojwani, S.S. and Razdan, M.K.* 2008. **Plant Tissue Culture – Theory and Practice**. Elsevier Publishers, New Delhi.

COURSE OUTCOMES (CO)

After completion of the course, the students' will be able to

CO1	Prepare media for plant tissue culture.
CO2	Cultivate the plant tissues/cells.
CO3	Synthesis seeds and hybridoma cells.

23PVE201	VALUE EDUCATION: HUMAN RIGHTS	SEMESTER- II

Course Objectives

The Course aims

- To make the students to understand the concepts of human rights.

Credits: 2 **Total Hours: 25**

UNIT	CONTENTS	Hrs	CO
I	**Human Rights:** Definition - Historical Evolution - Classification of Rights - Universal Declaration of Human Rights - International Covenants on Economic and Social Rights - Constitutional Provision for Human Rights - Fundamental Rights - Directive Principles of the State Policy - Indian Constitution.	5	CO1
II	**Civil and Political Rights:** Right to Work - Right to Personal Freedom - Right to Freedom of Expression - Right to Property - Right to Education - Right to Equality-Right to Religion - Right to Form Associations and Unions - Right to Movement-Right to Family - Right to Contract - Right to Constitutional Remedies-Right to Vote and Contest in Elections - Right to Hold Public Offices-Right to Petition-Right to Information-Right to Criticise the Government-Right to Democratic Governance.	5	CO2
III	**Economic Rights:** Right to Work - Right to Adequate Wages - Right to Reasonable Hours of Work - Right to Fair Working Conditions - Right to Self Government in Industry - Customer Rights - Social and Cultural Rights - Right to Life - Right to Clean Environment.	5	CO3
IV	**Women's Rights:** Right to Inheritance - Right to Marriage - Divorce and Remarry -Right to Adoption - Right to Education - Right to Employment and Career. Advancement - Rights Relating to Dowry - Right for Equality - Right for Safe Working Conditions - Children's Rights - Right to Protection and Care – Right to Education - Issues Related with Infanticide - Street Children – Child Labour-Bonded Labour - Refugees Rights - Minority Rights - Dalit Rights-Tribal Rights-Nomads Rights.	5	CO4

V	**Human Rights Violation:** International, National, Regional Level Organizations to Protect Human Rights - UNO - National Commission for Human Rights - State Commissions - Non Governmental Organizations and Human Rights - Amnesty Terrorism and Human Rights - Emergency and Human Rights - Judiciary and Human Rights - Media and Human Rights - Police and Human Rights.	**5**	**CO5**

Reference Books	
1	*PaulSingh.* **Human Rights and Legal System.** Himalaya Publishing House, New Delhi.

Web References	
1	https://idwfed.org/en/about-us-1/idwf-constitution
2	https://www.womenlawsindia.com/legal-awareness/women-rights-in-india/
3	https://projectworldimpact.com/cause/Human-Trafficking

COURSE OUTCOMES (CO)

After completing the course the students will be able to

CO1	Understand the core principles of human rights philosophy
CO2	Know the importance and functions of human rights commission
CO3	Apply their rights for democracy, human rights and gender equality
CO4	Know the rights from the Governance, economic and social development through various Acts
CO5	Understand the right to information Act, rights for women, children, Nomads, refugees and various sector of people in our country

23PLS201	NCC : CAREER COMPETENCY SKILLS– I	SEMESTER – II

Course Objectives:

The course aims

- To enhance employability skills and to develop career competency.

Total Hours: 15

UNIT	CONTENTS	Hrs	CO
I	Interview Skills – Types of Interview – Pre requisites of Interview – Abide by the dress code – Importance of Body language &dress code in Interviews – opening & closing conversation during interview – A Mock Interview.	3	CO1
II	Resume Preparation – Difference between a Resume and CV – types of resuming – Antiquity of Soft Skills – Classification of Soft Skills – Personality Analysis – Interpersonal Skills – cover letter – email drafting.	3	CO2
III	Soft skills – Employability skills – Group discussion – Group discussion types – Etiquette in group discussion – telephonic conversation – Etiquette of telephonic conversation –A Mock GD.	3	CO3
IV	Listening Skills : Stages of Listening – Types of Listening – Barriers to Listening. Speaking skills: Situational conversation Reading skills: Types of reading skills- Barriers in speed reading Writing skills: Types of writing skills, Most common errors in the English – words that are singular or couple.	3	CO4
V	Self-improvement –CALL – Language Techniques and concepts, E-learning.	3	CO5

Text Book:

1. *Barun K. Mitra. 2011.* **Personality Development and Soft skills**. [Second Edition]. Oxford University Press, New Delhi.

Reference Book:

1	*S.P. Dhanavel. 2015,* **English and Soft Skills**. [Second Edition]. Orient Black Swan Publishers, New Delhi.

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Understand the types of Interviews, interview skills
CO2	Developing Resume content and structures.
CO3	Improving soft skills and group discussion.
CO4	Types of skills, attain the different level of Learning skills
CO5	Self-improvements and learning techniques.

23PMBM301	**DSC VII: SOIL AND ENVIRONMENTAL MICROBIOLOGY**	**SEMESTER III**

Course Objectives:

The course aims

- To explain the role of microorganisms in soil fertility.
- To learn the benefits of interactions among soil microbes.
- To acquire in depth knowledge about degradation of organic matter.

Credits: 04 **Total Hours: 40**

UNIT	CONTENTS	Hrs	CO
I	**Soil Microbiology** – Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity, and distribution of major group of microorganisms in soil. Mineralization of Organic & Inorganic Matter in Soil. Biological Nitrogen fixation- Chemistry and Genetics of BNF.	08	CO1
II	**Phytopathology and Disease Cycle of Plant Pathogens**: Tikka, rust, smut, Rot, Mosaic, Citrus canker - symptoms and their control measures. Structural and Inducible biochemical defenses. Systemic Acquired Resistance (SAR), pathogenesis related (PR) - proteins, Plantibodies, Phenolics, Phytoalexins.	08	CO2
III	**Microbial Interactions** - Mutualism, Commensalism, Amensalism, Synergism, Competition, Mycorrhizae – Types, Endophytes, PGPR- Plant growth promoting bacteria– symbiotic (*Bradyrhizobium, Rhizobium, Frankia*), Non-symbiotic (*Azospirillum, Azotobacter*, Mycorrhizae, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers and Biocontrol agents – Types, benefits and application. Advantages, social and environmental aspects - Bt crops, golden rice.	08	CO3

IV	**Components of Environment:** Hydrosphere, lithosphere, atmosphere and biosphere – definitions with examples. Energy flow in the ecosystem- Carbon, Nitrogen, Sulfur and Phosphorous cycles. Treatment and safety of drinking (potable) water, methods to detect potability of water samples. Space microbiology - Microbiological research in space environment.	**08**	**CO4**
V	**Degradation of Organic Matter**: Lignin, cellulose, hemicellulose, pectin, common pesticides and heavy metals. Biodegradation of Xenobiotics - Recalcitrant Halocarbons, Recalcitrant TNTs, PCBs and Synthetic polymers. Biodegradation of Hydrocarbons. Pollution Control Bodies and Environmental laws in India. Environmental impact assessment, EIA guidelines, US Environment protection Agency norms.	**08**	**CO5**

Text Books:

1.	Subba Rao. N. S. (2017). Soil Microbiology. (5th Edition). MedTech Publishers.
2.	Daniel. C. J. (2006). Environmental Aspects of Microbiology. (2nd Edition). Bright Sun Publications.
3.	Rangaswami. G. and Mahadevan. A. (2006). Diseases of Crop Plants in India. (4thEdition). Prentice–Hall of India Pvt. Ltd.
4.	Sharma P. D. (2010). Microbiology and Plant pathology. (2nd Edition). Rastogi Publications.
5.	Subba Rao. N.S. (2005). Soil microorganisms and Plant Growth. (4th Edition). Oxfordand IBH Publishing Pvt. Ltd.

Reference Books:

1.	Pepper I. L., Gerba C. P. and Gentry T. J. (2014). Environmental Microbiology (1stEdition). Academic Press, Elsevier.
2.	Bitton, G. (2011). Wastewater Microbiology. (4th Edition). Wiley-Blackwell.

3.	Bridgewater L. (2012). Standard Methods for the Examination of Water andWastewater. American Public Health Association.
4.	Shrivastava A.K. (2003). Environment Auditing. A. P. H. Publishing Corporation.
5.	Tinsley, S. and Pillai, I. (2012). Environmental Management Systems –
Web Resources	
1.	https://academic.oup.com/femsec/article/93/5/fix044/3098413
2.	http://www.fao.org/3/t0551e/t0551e05.htm
3.	www.environmentshumail.blogspot.in/
4.	https://www.frontiersin.org/articles/10.3389/fpls.2017.01617/full
5.	https://serc.carleton.edu/microbelife/index.html

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Infer the significance of soil microbes and predict the role of microbes in biological nitrogen fixation.
CO2	Gain knowledge about plant pathogens, disease control aspects.
CO3	Identify plant microbial interaction and its significance.
CO4	Know about environmental components and the role of microbes.
CO5	Acquire knowledge about environmental issues and protection.

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	M	M	H	H	H	M	M	H
CO2	M	M	M	H	H	H	M	M	H	H
CO3	M	H	H	H	M	M	H	H	H	M
CO4	H	H	H	H	H	H	H	H	H	H
CO5	H	H	H	H	H	H	H	H	H	H
H – High; M- Medium; L - Low										

23PMBM302	DSC VIII : RESEARCH METHODOLOGY, BIOETHICS AND IPR	SEMESTER III

Course objectives

- To achieve competence and proficiency in the theory and practice of research.
- To offer basic knowledge of ethical issues in medicine, health and the life sciences.
- To introduce fundamental aspects of Intellectual property rights.

Credit: 4 **Total Hours: 40**

UNIT	CONTENTS	Hrs	CO
I	**Research–** Meaning and objectives of research. Types of research – Basic and applied research. Essential steps in research. Experimental designs- Hypothesis and Null-hypothesis, Basic principle of experiment. Experimental unit and sampling unit, Experimental error, Replication, Generalization, Controls, Randomization, Measurements. Few common experimental designs.	08	CO1
II	**Research Problem Identification & Formulation:** Defining and formulating the research problem, Selecting the problem. Literature collection – Need of literature review, Review and bibliography.	08	CO2
III	**Literature citation –** Formulation of research objectives and their importance, Computer and its role in research. Report writing and scholarly publishing. Research report – components of research report, Research report – Tables and Figures. Research report – Formatting and typing. Format of thesis.	08	CO3
IV	**Bioethics in Research:** Ethics-ethical issues, ethical committees (Human & Animal). Ethical issues in clinical research. Ethical issues related to Publishing, Authorship,	08	CO4

	Plagiarism and Self-Plagiarism. Contemporary issues in research ethics.		
V	**Intellectual Property Rights (IPR):** Introduction to IPR, Patentable life science process and products, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design. Procedure for IPR registration, the effect of registration and term of protection. Govt. of India's National IPR Policy and Career opportunities in IPR.	**08**	**CO5**

Reference/Text Books

1) Kumar, R. (2011). **Research Methodology: a step-by-step guide for beginners (3rd edition)**. London, UK: TJ International Ltd, Padstow, Corwall.
2) Gurumani, N. (2017). **Research methodology for biological sciences**. MJP Publishers, Chennai.
3) Kothari, C.R. (2019).**Research Methodology: Methods and Techniques**. 4th Edition, New Age International Publishers, New Delhi.
4) Fink, A., 2009. **Conducting Research Literature Reviews: From the Internet to Paper**. Sage Publications
5) Satheesh, M. K. 2011. **Bioethics and Biosafety**. I.K. International, New Delhi.
6) Nithyananda, K V. (2019). **Intellectual Property Rights: Protection and Management**. India, IN: Cengage Learning India Private Limited.

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Learn the fundamental details of research and will have knowledge on how to design a research work
CO2	Understand to select research problem, to identify the research gap and to formulate a hypothesis and objectives of the research.
CO3	Gain knowledge to interpret the research data, to write a research report and to publish a research paper
CO4	Acquire fundamental knowledge about bioethics in research.
CO5	Understand the intellectual property rights and their by-laws.

MAPPING

PO,PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	H	H	H	M	M	M	H	H
CO2	H	H	H	H	H	M	M	M	H	H
CO3	H	H	H	H	H	M	M	M	H	H
CO4	H	H	H	H	H	M	M	M	H	H
CO5	H	H	H	H	H	M	M	M	H	H

H-High; M-Medium; L- Low

23PMBM303	**DSC IX: BIOSTATISTICS**	**SEMESTER–III**

Course Objectives:

- To familiarize the application of biostatistics in biology.
- To know about the research concepts.
- To learn the strategies of research field and also to provide knowledge to understand the role of statistics in research

Credits: 04 **Total Hours: 50**

UNIT	CONTENTS	Hrs	CO
I	**Statistics:** Introduction – Definition of Statistics – Functions of Statistics – Applications and Limitations of Statistics. **Collection of data**: Primary and Secondary data – Methods of collecting primary data – Sources of secondary data. **Classification and Tabulation of data**: Types of classification – Tabulation of data – Parts of a table - Types of tables. **Diagrammatic and Graphical Representation:** Types of diagrams – Graphs – Graphs of frequency distributions.	10	CO1
II	**Measures of Central Tendency:** Arithmetic Mean (except weighted mean and corrected values) – Median – Mode – Merits and demerits – Geometric mean - Harmonic Mean.	10	CO2
III	**Measures of Dispersion:** Range – Quartile deviation – Standard deviation – Coefficient of variation.	10	CO3
IV	**Correlation Analysis:** Types of correlation – Methods of Correlation - Karl Pearson's Coefficient – Rank correlation coefficient. **Regression Analysis:** Regression lines (except graphing) – Regression equations.	10	CO4
V	**Test of Hypothesis:** Population – Sample – Procedure of testing hypothesis – Types of errors – Standard error - t test – Chi-square test of independence of attributes. **Analysis of Variance:** One way classification – Two way classification.	10	CO5

TEXT BOOK:

1.	**S.P.Gupta**, 2008. **STATISTICAL METHODS**, [Thirty Seventh Edition] S. Chand and Company Ltd., New Delhi.
REFERENCE BOOK:	
1.	**Sancheti,D,C and Kapoor V.K** 2005. **STATISTICS**. [Seventh Editions]. S, Chand And Company limited, New Delhi.

Course Outcomes (CO)

After completion of the course, the students will be able to

CO 1	Learn the importance of statistics
CO 2	Understand the concepts of measures of central tendency
CO 3	Know the concepts of measures of dispersion
CO 4	Gain knowledge on correlation and regression analyses
CO 5	Test the samples using testing of hypothesis

MAPPING										
PO & PSO / CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO 1	M	H	H	M	H	M	L	L	H	H
CO 2	M	H	H	M	H	M	L	L	H	H
CO 3	L	H	H	M	H	M	L	L	H	H
CO 4	M	H	H	M	H	M	L	L	H	H
CO 5	M	H	H	M	H	M	L	L	H	H
H-High; M-Medium; L-Low										

23PMBEL301	DSE II: RECOMBINANT DNA TECHNOLOGY	SEMESTER III

Course Objectives:

The course aims

- To provide knowledge about artificial gene transfer mechanism and selection of recombinants.
- To understand gain knowledge on various molecular techniques and their role in biotechnology.
- To implement the knowledge of genetic engineering in various fields.

Credits: 04 **Total Hours: 50**

UNIT	CONTENTS	Hrs	CO
I	**Tools and Methods in Gene Cloning**. Restriction endonucleases – nomenclature, classification and characteristics - DNA methylases, DNA polymerases, Ligases. Adapters, linkers and homopolymer tailing. Artificial gene transfer techniques -electroporation, microinjection, protoplast fusion and microparticle bombardment. Screening for recombinants. Radiolabelling and its methods.	10	CO1
II	**Gene Cloning Vectors for Prokaryotes and Eukaryotes** - cloning properties and types of plasmids vectors (pBR322 and derivatives, pUC vectors and pGEM3Z) - Phage Vectors(M13 and Lambda), cosmids, phagemids and BACs - Eukaryotic vectors - Yeast vectors – Animal and plant vectors –expression vectors. Shuttle vectors - Expression of eukaryotic foreign genes in bacteria – merits and demerits.	10	CO2

III	**Genomic DNA and cDNA Library** - Construction and Screening. Techniques in genetic engineering. Blotting- Southern, Northern and Western. Restriction mapping - restriction fragment length polymorphism (RFLP) - Polymerase chain reaction (PCR) – Principles, types and their applications.	**10**	**CO3**
IV	**DNA Sequencing and Protein Engineering** - Primer walking, Chemical, Sanger's method and automated sequencing methods. Pyrosequencing – DNA chips and micro array. Protein engineering and techniques Site directed mutagenesis – methods - Design and construction of novel proteins and enzymes. Basic concepts in enzyme engineering. protein folding, protein sequencing, Applications of protein engineering.	**10**	**CO4**
V	**Applications of Genetic Engineering** - Transgenic animals - mice and cattle. Human Gene Therapy - Germline and Somatic Cell Therapy - Ex-vivo Gene Therapy. In-vivo Gene Therapy. Transgenic Plants – Ti Plasmid, Ti plasmid mediated vectors and its applications.	**10**	**CO5**

Text Books:	
1.	*Brown, T.A.* 1995.**Gene Cloning–An Introduction**. [Third Edition]. Chapmanand Hall, UK.
2.	*Old, R.M. and Primrose, S.B.* 2006. **Principles of Gene Manipulation**. [Seventh Edition]. Blackwell Scientific Publication, London.

References Books	
1.	*Glick, B.K.* and *Pasternik, J.J.* 2003. **Molecular Biotechnology**. **Principles and applications of recombinant DNA**. [Third Edition]. ASM Press, Washington DC,

	USA.
2.	*Winnacker, E.L.* 1987. **From Genes to Clones**. **Introduction to Gene technology**. [First Edition]. Panima Publishing Corporation, New Delhi.

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Recall the basics and importance of enzymes in molecular research.
CO2	Apply cloning for developing novel recombinant products.
CO3	Develop transformants for production of various pharmacologically important products.
CO4	Apply gene transfer technology for protein engineering.
CO5	Apply genetic engineering for gene therapy and transgenic organisms.

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	M	M	M	M	M	M	M	M
CO2	H	H	H	H	H	H	H	H	H	H
CO3	H	H	H	H	H	H	H	H	H	H
CO4	M	M	M	M	M	M	M	M	M	M
CO5	H	H	H	H	H	H	H	H	H	H
H – High; M- Medium; L – Low										

23PMBEL302	**DSE II: NANOMICROBIOLOGY**	**SEMESTER III**

Course Objectives:

The course aims

- To enable the learners to construct a good foundation in nanotechnology.
- To understand the role of microbes in the synthesis of nanoparticles.
- To know about the modern applications of nanobiology.

Credits: 04 **Total Hours: 50**

UNIT	CONTENTS	Hrs	CO
I	**Nanobiology:** Concepts, definitions, prospects. Nano-scale systems. Biological Nano objects– proteins, lipids and DNA. Bio-nano particles- Nanostarch, Nanocomposites- Dendrimers.	10	CO1
II	**Methods of Nanobiology:** Analysis of bimolecular Nanostructures by Atomic Force Microscopy, Scanning Probe Electron Microcopy and FTIR. Nano-fabrication- Lithography-hot olithography, Electron beam lithography.	10	CO2
III	**Methods for Susceptibility Testing of Nanoparticles:** Growth inhibition assay by spectrophotometer, Broth dilution method, standard agar well diffusion method, Estimation of colony forming units (CFU).	10	CO3
IV	**Antimicrobial Properties of Metal Nanoparticles:** Ag, Cu, Au nano particles- antibiofilm properties of nanoparticles. Biogenesis of bacterial silver nanoparticles, platinum nanoparticles.	10	CO4

V	**Nano Applications:** Use of microbes in relation to Bimedical applications of nanoparticles. Application of Biogenic Silver Nano particles in Fabrics. Nano biosensors and their applications. Nano drug delivery systems.	**10**	**CO5**

TextBooks:	
1.	*Balaji Subbaih.* 2010. **Nanobiotechnology**. MJP Publishers, India.

ReferenceBooks:	
1.	*Pradeep,T.* 2008. **Nano: The Essentials: Understanding Nanoscience and Nanotechnology.** Tata Mc Graw-Hill Publishing Company Limited,New Delhi.
2.	*Mahendra Roiand Nelson Dura.*2011.**Metal nanoparticles in Microbiology**. Springer.
3.	*Christ of M. Niemayer, ChadA. Mirkin*. 2004. **Nanobiotechnology: Concepts, applications and perspectives.**Wiley VCH publishers.

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Understand the basic concepts of bionanoparticles.
CO2	Compute the bimolecular nano structures by AFM, Scanning Probe Electron Microcopy and FTIR.
CO3	Assess the various methods for susceptibility testing of nanoparticles.
CO4	Analyze antimicrobial properties of metal nanoparticles.
CO5	Prepare effective nano based drug delivery systems for infectious disease.

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	M	M	M	M	M	M	M	M
CO2	H	H	H	H	H	H	H	H	H	H
CO3	H	H	H	H	H	H	H	H	H	H
CO4	M	M	M	M	M	M	M	M	M	M
CO5	H	H	H	H	H	H	H	H	H	H
H – High; M- Medium; L – Low										

23PMBMP301	**DSC PRACTICAL III**	**SEMESTER III**

Course Objectives:

The course aims

- To understand molecular techniques for strain improvement.
- To study the quality of the water by standard protocols.
- To know the preparative work for soil fertility.

Credits: 05 **Total Hours: 50**

Experiment	**CONTENTS**	**Hrs**	**CO**
1.	Spontaneous Mutation: Isolation of auxotrophic mutant by Gradient Plate Technique	**5**	**CO1**
2.	Induced Mutation: Isolation of auxotrophic mutant by Replica Plate Technique	**5**	**CO1**
3.	Isolation of free-living nitrogen fixers from soil and *Rhizobium* from root nodules of leguminous plants.	**5**	**CO1**
4.	Isolation and enumeration of phosphate-solubilizing bacteria from soil.	**5**	**CO1**
5.	Preparation of Biofertilizers.	**3**	**CO1**
6.	Preparation of a vermicompost.	**5**	**CO2**
7.	Cultivation of edible mushroom from solid waste.	**5**	**CO2**
8.	Cultivation of *Azolla.*	**5**	**CO2**
9.	Biological Oxygen Demand (BOD)	**2**	**CO2**
10.	Chemical Oxygen Demand (COD)	**5**	**CO2**
11.	MPN	**5**	**CO2**

Reference Book:

1.	James G Cappucino. and Natalie Sherman. (2016). Microbiology – A laboratory manual. (5th Edition). The Benjamin publishing company. New York.

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Apply the molecular techniques for strain improvement for product recovery.
CO2	Demonstrate the economically important microbial products.

23PMBMP302	**DSC PRACTICAL IV: STATISTICAL SOFTWARE**	**SEMESTER III**

Course Objectives:

The course aims

- To give a good grip on concepts in analyzing the data using statistical software.

Credits: 02 **Total Hours: 24**

PROGRAM	CONTENTS	Hrs	CO
1	Diagrams and graphs	**03**	**CO 1**
2	Measures of Central Tendency	**03**	**CO 2**
3	Measures of Dispersion	**03**	**CO 2**
4	Correlation Coefficient (Karl Pearson and Spearman Rank Method)	**03**	**CO 3**
5	Regression lines	**03**	**CO 3**
6	Small Sample Test (t and F)	**03**	**CO 4**
7	Chi-square Test for Independence of Attributes.	**03**	**CO 4**
8	ANOVA (one way and two way classification)	**03**	**CO 4**

Reference Books:

1.	*Shentan J. Coakes, Lyndall Steed and Peta Dzidic.* **SPSS 13.0 version for Windows analysis without Anguish.** John Wiley & Sons, Australia.
2.	*Andy Field.* 2006. **Discovering Statistics using SPSS.** [Second Edition]. SAGE Publications.

COURSE OUTCOMES (CO)

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

CO 1	Demonstrate the data in diagrammatic and graphical representation
CO 2	Find the averages and measures dispersion
CO 3	Calculate correlation and regression for huge amount data
CO 4	Gain knowledge about test of significance

23PBCMBI301	GEC II: PHARMACEUTICAL BIOCHEMISTRY	SEMESTER–III

Course Objectives:

The Course aims

- To enable the students to learn about Pharmacodynamics and pharmacokinetics of drugs.
- To make the students aware of Plant therapeutics

Credits: 02 **Total Hours: 40**

UNIT	CONTENTS	Hrs	CO
I	**Drugs**: History of Drugs, Definition-Nomenclature. Classification of drugs based on their source – Plant, animal, mineral and synthetic, based on action. Routes of drug administration, Drug absorption- mechanism. Factors influencing drug absorption	8	CO1
II	Distribution and elimination of drugs. Factors influencing drug distribution and elimination. Mechanism of drug action- Physical, Chemical, Enzymes, Receptors. Drug-Receptor interactions: Receptor – Definition. Agonists, partial aganoists, inverse agonists and antagonists. Forces involved in drug-receptor interaction. Drug action not mediated through receptor. Dose response relationship (LD50 and ED50)	8	CO2
III	Adverse drug reactions- Definition, Classification and drug induced side effects, biological effects of drug abuse and drug dependence, drug tolerance and intolerance. Drug discovery- Animal toxicity studies and clinical evaluation Phase I-IV (Elementary details)	8	CO3
IV	Phytomedicine: History, Definition and Scope of Phytomedicine. Indian Medicinal systems– Ayurveda, Siddha	8	CO4

	and Unani. Medicinal properties and active principles of plant parts (leaves, flowers, roots, seeds, rhizome, bark etc). Role of medicinal and aromatic plants in national economy.		
V	Secondary metabolites of plants - Alkaloids, flavonoids and terpenoids, phenols – occurrence, distribution and functions. (Synthesis not required). Extraction of Phytopharmaceuticals or crude drugs – (Aqueous, Methonol and Chloroform extracts) maceration, percolation (soxhlet) extraction - Analysis of phytochemicals (carbohydrates, aminoacids, proteins, phenols, flavonoids, alkaloids tannins, glycosides, saponins and terpenoids).	**8**	**CO5**
Text Books:			
1.	*Tripathi, K. D*. 1999. **Essentials of Medical Pharmacology.** [Fourth Edition]. Jaypee Brothers Medical Publishers, New Delhi **(UNIT - I, II & III).**		
2.	*Kokate, C. K., Purohit, A. P.* and *Gokhale, S.B.* 2007. **Pharmocognosy.** [Thirty Seventh Edition]. Nirali Prakasham, Pune. **(UNIT – IV & V)**		
Reference Books:			
1.	*Satoskar, R. S., Nirmala N. Rege* and *Bhandarkar S.D,* 2011. **Pharmacology and Pharmacotherapeutics** [Twenty-Second edition]. Popular Prakashan Pvt Ltd, Mumbai		
2.	*Roseline, A*. 2011**. Pharmacognosy.** M.J.P Publishers, Chennai		

COURSE OUTCOMES (CO)

After completion of the course, the student will be able to

CO1	Describe the drug sources, classification and its pharmacodynamics
CO2	Explain the mechanisms of action and fate of drugs inside living organisms
CO3	Analyze the effects of adverse drug reactions
CO4	Appreciate the various medical systems that utilize phytoconstituents as medicines
CO5	Explore the new strategies in the development of efficient drugs to combat diseases from plants

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	M	H	M	H	H	M	H	M	H
CO2	H	M	H	M	H	H	M	H	M	H
CO3	H	M	H	M	H	H	M	H	M	H
CO4	H	M	H	M	H	H	M	H	M	H
CO5	H	M	H	M	H	H	M	H	M	H
H – High; M- Medium; L - Low										

23PBCMBIP301	GEC PRACTICAL II: PHARMACEUTICAL BIOCHEMISTRY	SEMESTER – III

Course Objectives:

The Course aims

- To enable the students to understand the basic concepts in extraction, screening, quantification process of secondary metabolites

Credits: 02 **Total Hours: 23**

S.No.	EXPERIMENT	Hrs	CO
1.	Extraction of phytoconstituents of neem leaves using water and methanol as solvents- Maceration and Soxhlet extraction	3	1
2.	Preliminary phytochemical screening for the presence of following constituents (i) Carbohydrates (ii) Lipids (iii) Proteins and Amino acids (iv) Phenols (v) Flavonoids (vi) Anthraquinones (vii) Alkaloids (viii) Terpenoids (xi) Glycosides (x) Saponins	6	1
3.	Quantitative estimation of proteins (Lowry's method).	3	2
4.	Quantitative estimation of carbohydrates (Anthrone method).	3	2
5.	Quantitative estimation of phenols (Singleton and Rossi's method).	3	2
6.	Isolation and partial purification of phytoconstituents (Phenol and Flavonoids) using Chromatographic techniques (TLC)	6	2

Reference Books:

1.	*Kokate, C.K., Purohit, A.P.* and *Gokhsale, S.B.* 2008. **Phytochemical Methods.** Nirali Prakasham, Pune

COURSE OUTCOMES (CO)

After completion of the course the student will be able to:

CO1	Extract and screen the presence of various plant metabolites
CO2	Quantify the presence of biomolecules and secondary metabolites in samples

23PBTMBI301	GEC II: ANIMAL CELL CULTURE TECHNOLOGY	SEMESTER III

Course Objectives

The course aims

To understand the basic techniques in Animal cell culture.

Credits: 02 **Total Hours: 40**

UNIT	CONTENTS	Hrs	CO
I	Introduction to Animal cell culture, Applications of cell culture, Designing the cell culture laboratory – washing and sterilization area, Storage area and cell culture room, Equipments in tissue culture laboratory – Inverted Microscope, Centrifuge, Laminar flow benches, CO_2 incubator.	08	CO1
II	Glassware and other plastic ware in tissue culture – Substrate materials for growing cells, cell culture vessels, culture media – Properties and special requirements, Complete media, Conditioned media.	08	CO2
III	Type of cell culture - Isolation of primary explants culture, Isolation of cells and disaggregation method cell culture, organ culture.	08	CO3
IV	Cell culture - Transformation, Differentiation and Dedifferentiation, Growth curve of cells, Types of microbial contamination, Stem cell culture.	08	CO4
V	Applications of Animal cell culture technology – Somatic cell fusion, Transgenic fish and sheep.	08	CO5

Reference Books:	
1.	*Sudha Gangal*, 2010. **Principles and Practice of Animal Tissue Culture**. [Second Edition]. University Press (India) Pvt. Ltd.
2.	*Freshney, R.I.* 2005. **Culture of Animal Cells: A manual of basic technique.** [Fifth Edition]. John Wiley and Sons, New Jersey.

COURSE OUTCOMES (CO)

After the completion of the course the student will be able to

CO1	Handle animal cells and familiar with instruments
CO2	Prepare animal tissue culture media for culturing animal cells
CO3	Disaggregate the animal tissues
CO4	The differentiation of cells and stem cells
CO5	Apply the animal cell culture technology in day to day life

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	M	M	H	H	H	M	H	M	H
CO2	H	M	M	H	H	H	M	H	M	H
CO3	H	M	M	H	H	H	M	H	M	H
CO4	H	M	M	H	H	H	M	H	M	H
CO5	H	M	M	H	H	H	M	H	M	H
H – High; M- Medium; L - Low										

23PBTMBIP301	GEC PRACTICAL II: ANIMAL CELL CULTURE TECHNOLOGY	SEMESTER III

Course Objectives:

The course aims

- To get hands on experience on Animal cell culture

Credits: 02 **Total Hours: 20**

Experiment	CONTENTS	Hrs	CO
1.	Sterilization techniques in Animal cell culture.	**3**	**CO1**
2.	Media preparation for Animal Cell Culture.	**2**	**CO1**
3.	Primary culture of Chick embryo fibroblast.	**5**	**CO2**
4.	Trypsinization and subculturing.	**5**	**CO2**
5.	Determination of viability of cells using Trypan blue stain.	**5**	**CO2**

Reference Books:

1.	*Freshney, R.I.* 2005. **Culture of Animal Cells: A manual of basic technique.** [Fifth Edition]. John Wiley and Sons, New Jersey.

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Sterilize the media and utensils for Animal cell culture.
CO2	Cultivate the animal cells and maintain it for further studies.
CO3	Analyze viable cells

23PLS301	NCC : CAREER COMPETENCY SKILLS - II	SEMESTER – III

Course Objectives:

The course aims

- To impart knowledge on the Aptitude.
- To enhance employability skills and to develop career competency.

Total Hours: 15

UNIT	CONTENTS	Hrs	CO
I	Solving Simultaneous Equations Faster – Number System : HCF, LCM – Square roots and Cube roots - Averages	3	CO1
II	Problems on Numbers –Problems on Ages	3	CO2
III	Calendar – Clocks – Pipes and Cisterns	3	CO3
IV	Time and Work – Time and Distance	3	CO4
V	Ratio and Proportion – Partnership – Chain Rule	3	CO5

Text Book:

1	*Aggarwal R.S. 2013. Quantitative Aptitude. [Seventh Revised Edition]. S.Chand & Co., New Delhi*

Reference Book:

1	*Quantitative Aptitude for Competitive Examinations, Abhijith Guha, 5th Edition, Tata McGraw Hill, 2015,New Delhi.*

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Solve the problems involving the concepts HCF, LCM, Square roots and Cube roots.
CO2	Solve the problems on numbers and age.
CO3	Solve the problems involving the concepts Calendar-Clocks, Pipes and Cisterns
CO4	Solve the problems on Time & Work and Time & Distance.
CO5	Calculate Ratio & Proportion, Partnership with shortcuts.

23PMBM401	DSC X : INDUSTRIAL MICROBIOLOGY	SEMESTER IV

Course Objectives:

The course aims

- To acquire an overview about the industrial processes.
- To understand the design of fermenters and its components.

Credits: 06 **Total Hours: 50**

UNIT	CONTENTS	Hrs	CO
I	**An Introduction to Fermentation Process:** Origin and Economic importance of fermentation process. Screening of industrial microorganisms– Primary Screening – Secondary Screening. Preservation of microorganisms.	10	CO1
II	**Strain Improvement and Media Formulation:** Mutation – ionizing and non-ionizing radiation – rDNA technology. Strain development technique – bacteria, fungi and yeast. Medium formulation and optimization. Sterilization – Batch and Continuous. Del factor. Types of fermentation – Submerged – Solid State fermentation.	10	CO2
III	**Instrumentation and Control of Fermentor:** Body construction – aeration and agitation. Stirrer glands and bearings – baffles. Maintenance of aseptic conditions – sterilization of fermentor, air supply, mass and heat transfer. Types of fermentor . Measurement and control - Temperature, pH and Foam.	10	CO3
IV	**Production and Purification of Microbial Products**: Antibiotics – Penicillin and Streptomycin. Organic acids – Citric acid and Acetic acid. Enzymes – Amylase and Protease. Yeast – Brewer's and Baker's. Aminoacids – L-Glutamic acid and L-Lysine. Vitamins – $B_{12.}$	10	CO4

V	**Downstream Processing**: Intracellular products: Cell disruption methods. Extracellular products: Separation-Precipitation, Filtration, Centrifugation, Solid – Liquid Extraction, Liquid –Liquid Extraction, Chromatography, Solvent Extraction, drying and crystallization.	**10**	**CO5**
Text Books:			
1.	*Stanbury, P.F., Whittaker, A. and Hall, S.J.* 1997. **Principles of Fermentation Technology.** [Second Edition]. Reed Elsevier India Pvt. Ltd., New Delhi.		
2.	*Patel, A.H., 2005*. **An Introduction to Industrial Microbiology.** Macmillan India Ltd., Chennai.		
Reference Books:			
1.	*Michael J Waites, John S Roackey, Neil L. Morgan and Garry Highton.* 2006. **Industrial Microbiology – An Introduction**. Blackwell Science Ltd., USA.		
2.	*Cruegar, W and Cruegar, A.* 1989. **Biotechnology**: **A Textbook of Industrial Microbiology**. Panima Publishing Corporation, New Delhi.		

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Understand and screen the industrially important microorganisms.
CO2	Develop strain improvement and media formulation.
CO3	Demonstrate the design and maintenance of the fermenter.
CO4	Optimize production and purification of microbial products.
CO5	Apply the recovery process for purification of intra and extra cellular products

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	M	M	M	M	H	M	M	M	M
CO2	H	H	H	H	H	H	H	H	H	H
CO3	M	M	M	M	M	M	M	M	M	M
CO4	M	H	H	H	H	M	H	H	H	H
CO5	M	M	H	H	H	M	M	H	H	H
H – High; M- Medium; L - Low										

23PMBM402	DSC XI : FOOD AND DAIRY MICROBIOLOGY	SEMESTER IV

Course Objectives:

The course aims

- To understand the basic concepts of contamination, spoilage and preservation of food.
- To acquire an overview about food borne infections and intoxications.
- To learn about the fermented food products.

Credits: 06 **Total Hours: 50**

UNIT	CONTENTS	Hrs	CO
I	**Introduction to Food Microbiology:** Importance of food and dairy Microbiology– Types of microorganisms in food – Source of contamination (primary sources) – Factors influencing microbial growth in foods (extrinsic and intrinsic).	10	CO1
II	**Spoilage and Preservation of Different Kinds of Foods:** Cereals and cereal products– Milk and milk products – Vegetable and fruits– Meat and meat products– Fish and eggs.	10	CO2
III	**Food Borne Infections and Intoxications:** Bacterial, non-bacterial (*Staphylococcus*, *Clostridium*, *Escherichia coli* and *Salmonella* infections) Hepatitis, Amoebiosis and Mycotoxins – Food borne disease outbreaks– Laboratory testing– preventive measures.	10	CO3
IV	**Food Preservation and Fermented Food Products:** Principles of food preservation–methods of preservation. Physical methods and Chemical preservatives. Production of fermented food products - Bread, Sauerkraut, cheese, Yoghurt, Buttermilk and Tempeh.	10	CO4

V	**Food Quality Indicators:** Food standards, Food Safety and Security and Agencies (India and Foreign countries). HACCP, SOP, ISO, methods in food quality assessment – Microbial quality, toxin detection and Adulterant detection. Food sanitation and its control.	**10**	**CO5**

Text Book:	
1.	*Frazier, W.C. and Westhoff, D.C.* 2001. **Food Microbiology**. [Fourth Edition]. Tata Mc Graw-Hill Publishing Company Limited, New Delhi.

Reference Books:	
1.	*Banwart, G.J.*1989. **Basic Food Microbiology.** Chapman and Hall New York.
2.	*Jay,J. M.* 1987. **Modern Food Microbiology**. CBS Publishers and distributors, New Delhi
3.	*Adams, M.R. and Moss, M.O.* 1995. **Food Microbiology.** The Royal Society of Chemistry, Cambridge.

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Discuss importance of food and dairy microbiology.
CO2	Understand the spoilage and preservation of food products.
CO3	Analyze food borne infections and intoxications.
CO4	Demonstrate different kinds of food preservation methods for product safety.
CO5	Evaluate the food quality standards.

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	M	M	M	M	H	M	M	M	M
CO2	H	H	H	H	H	H	H	H	H	H
CO3	H	M	H	M	H	H	M	H	M	H
CO4	H	H	H	H	H	H	H	H	H	H
CO5	H	H	H	H	H	H	H	H	H	H
H – High; M- Medium; L - Low										

23PMBMP401	**DSC PRACTICAL IV (Industrial Microbiology & Food and Dairy Microbiology)**	**SEMESTER IV**

Course Objectives:

The course aims

- To gain knowledge to handle industrially important organisms and their products.
- To study the quality of the milk by standard protocols.

Credits: 05 **Total Hours: 60**

Experiment	CONTENTS	Hrs	CO
1.	Crowded plate technique for screening antibiotic producing organism from soil	**6**	**CO1**
2.	Solid state fermentation for citric acid production	**3**	**CO2**
3.	Submerged fermentation for amylase enzyme production.	**3**	**CO3**
4.	Paper chromatography.	**6**	**CO3**
5.	Thin Layer Chromatography.	**6**	**CO3**
6.	Column Chromatography.	**6**	**CO3**
7.	Effect of temperature, pH, sugar and salt conc. on growth of microbes.	**6**	**CO3**
8.	Wine production.	**3**	**CO3**
9.	Isolation and identification of fungi from spoiled food.	**6**	**CO4**
10.	Methylene Blue Reduction test.	**3**	**CO4**
11.	Breeds count method to enumerate microbes from milk.	**6**	**CO4**

Reference Book:

1. James G Cappucino. and Natalie Sherman. (2016). Microbiology – A laboratory manual. (5th Edition). The Benjamin publishing company. New York.

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Screening and assess the ability of organisms for economically important products.
CO2	Assess the quality of milk.

GUIDELINES

1. SUBMISSION OF RECORD NOTE BOOKS AND PROJECT DISSERTATION:

Candidates appearing for Practical Examinations and Project Viva-voce shall submit Bonafide Record Note Books/ Dissertation prescribed for Practical/ Project Viva-voce Examinations, otherwise the candidates will not be permitted to appear for the Practical/ Project Viva-voce Examinations.

2. PASSING MINIMUM AND INTERNAL MARK DISTRIBUTION (Theory, Practical and Project)

A). THEORY

The candidate shall be declared to have passed the Examination, if the candidate secure not less than 50 marks put together out of 100 in the Comprehensive Examination in each theory paper with a passing minimum of 38 marks in External out of 75.

Internal Marks Distribution [CA- Total Marks: 25]

Attendance	: 5 Marks
Assignment	: 5 Marks
Seminar	: 5 Marks
Internal Examinations	: 10 Marks
Total	**: 25 Marks**

(B) PRACTICAL

The candidate shall be declared to have passed the Examination, if the candidate secure not less than 50 marks put together out of 100 in the Comprehensive Examination in each Practical paper with a passing minimum of 30 marks in External out of 60.

Internal Marks Distribution [CA- Total Marks: 40]

Experiment	: 10 Marks
Attendance	: 5 Marks
Record	: 5 Marks
Internal Examinations	: 20 Marks
Total	**: 40 Marks**

(C) PROJECT WORK

- The project work shall be carried out by each student in the IV semester and has to complete the work at the end of the Semester.

- Upon completion of the project work the candidate will be required to appear for a Viva-Voce conducted by an external examiner.
- The Student has to attend 2 reviews before completing his/her Project.
- Two reviews will be reviewed by internal members
- Final project Viva-Voce examination conducted by an external examiner.
- A candidate failing to secure the prescribed passing minimum in the dissertation shall be required to resubmit the dissertation with the necessary modifications.

MARK DISTRIBUTION PATTERN

Continuous Assessment (CA) : 50 Marks
Comprehensive Examination (CE) : 150 Marks

The candidate shall be declared to have passed the Examination, if the candidate secure not less than 100 marks put together out of 200 in the Comprehensive Examination in each Project with a passing minimum of 75 marks in External out of 150.

Internal Mark Distribution [CA - Total Marks: 50 Marks]

1. Research work done : 20 Marks
2. Attendance : 5 Marks
3. Observation Note : 10 Marks
4. Review : 15 Marks

Total : 50 Marks

External Mark Distribution [CE - Total Marks: 150 Marks]

1. Project report : 100 Marks
2. Presentation : 25 Marks
3. Viva Voce : 25 Marks

Total : 150 Marks

Question paper pattern for DSC practical

(Maximum marks: 60) Time: 6 Hours

Experiment–I (Major)	- 30 Marks
Experiment–II (Minor)	- 15 Marks
Spotters (5 x3)	- 15 Marks
Total	**- 60 Marks**

CAREER COMPETENCY SKILLS

- **On Line Objective Examination (Multiple Choice questions) – Semester I**
  - 100 questions-100 minutes
  - Twenty questions from each UNIT.
  - On line examination will be conducted at the end of I Semester.
- **Viva Voce – Semester II**
  - The student has to come in proper dress code and he/she should bring 2 copies of resume for the Viva Voce
  - The student may be asked to
    - Give Self introduction
    - Submit the resume to the examiner(s) and answer the questions based on it.
    - Speak on any given topic for at least two minutes.
    - Give a presentation for 10 minutes on a topic of their choice.
    - Sit with other students in a group for a discussion.

GEC PRACTICALS

Comprehensive Examination (CE): 60 Marks

Continuous Assessment (CA): 40 Marks

Question paper pattern for GEC practical

(Maximum marks: 60)	**Time: 3 Hours**
One experiment (1x30)	: 30 Marks
Spotters (10x2)	: 20 Marks
Viva Voce	: 10 Marks
Total	**: 60 Marks**

QUESTION PAPER PATTERN AND MARK DISTRIBUTION *THEORY*

Question Paper Pattern and Mark Distribution **(For 75 marks)**

1. PART – A (5 x 5 = 25 Marks)

Answer ALL questions

One question from each UNIT with Internal Choice

2. PART – B (5 x 10 = 50 Marks)

Answer ALL questions

One question from each UNIT with Internal Choice

GEC COURSES OFFERED

S.NO.	SUBJECT CODE	SEMESTER	SUBJECT	OFFERED TO THE STUDENTS OF
1.	23PMBBCI201/ 23PMBBTI201	II	GEC I : Clinical Microbiology	M.Sc. Biochemistry/ M.Sc. Biotechnology
2.	23PMBBCIP201/ 23PMBBTIP201		GEC Practical I: Clinical Microbiology	M.Sc. Biochemistry/ M.Sc. Biotechnology
3.	23PMBBCI301/ 23PMBBTI301	III	GEC II: Industrial Microbiology	M.Sc. Biochemistry/ M.Sc. Biotechnology
4.	23PMBBCIP301/ 23PMBBTIP301		GEC Practical II: Industrial Microbiology	M.Sc. Biochemistry/ M.Sc. Biotechnology

23PMBBCI201/ 23PMBBTI201	**GEC I: CLINICAL MICROBIOLOGY**	**SEMESTER II**

Course Objectives:

- To enable the learners to know basics in clinical Microbiology.
- To learn the diagnosis of infectious diseases.
- To know about the modern approaches in clinical microbiology.

Credits: 02 **Total Hours: 40**

UNIT	CONTENTS	Hrs	CO
I	**Infection: S**ources of infection - transmission of infection - types of infection. Classification of microbes based on hazard – Types of diseases - disease carriers.	08	CO1
II	**Collection and Transport of Clinical Specimens**: Urine, Pus, Faeces, Sputum and Blood.	08	CO2
III	**Microbiological examination of samples:** Sputum, Pus, Faeces and Urine. Diagnosis of anaerobic infections.	08	CO3
IV	**Serological Diagnosis of Microbial Diseases:** Antigen tests- Agglutination test for pregnancy, Elek's gel precipitation test, ELISA. Antibody tests - WIDAL, ASO. Monoclonal antibodies in clinical microbiology.	08	CO4
V	**Molecular Diagnosis of Infectious Diseases:** Tuberculosis, Malaria, AIDS. RFLP as a molecular marker in disease diagnosis.	08	CO5

Text Books:	
1.	*Ananthanarayan,R. and JayaramPaniker, C.K.*2008.**Textbook of Microbiology**. [Seventh edition]. University Press (India) Private Limited, Hyderabad.
2.	*Monica Cheesbrough* 1994. **Medical Laboratory Manual for Tropical countries**. Volume II: Microbiology. ELBS Publishers.
3.	*Sathyanarayana, U*. 2010. **Biotechnology**. Books and Allied (P) Ltd, Kolkatta.

Reference Books:	
1.	*Jawetz,E, Melnic,J.K. and Adelberg, E.A*. 1998. Review of Medical Microbiology, Lange Medical Publications, U.S.A.

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Evaluate the infectious disease caused by microorganisms.
CO2	Apply the methods of collection and processing of clinical samples.
CO3	Apply the preliminary detection of pathogens for disease diagnosis.
CO4	Assess the serological detection of pathogens.
CO5	Develop diagnose the disease based on molecular methods.

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	H	M	H	H	M	H	H	H
CO2	M	H	H	M	H	H	M	H	H	H
CO3	M	H	H	M	H	H	M	H	H	H
CO4	M	H	H	M	H	H	M	H	H	H
CO5	M	H	H	M	H	H	M	H	H	H
H – High; M- Medium; L - Low										

23PMBBCIP201/ 23PMBBTIP201	**GEC PRACTICAL I: CLINICAL MICROBIOLOGY**	**SEMESTER II**

Course Objectives:

The course aims

- To learn the basic techniques in clinical microbiology.
- To acquire knowledge on identification of clinical pathogens.

Credits: 02 **Total Hours: 25**

Experiment	**CONTENTS**	**Hrs**	**CO**
1.	Colony morphology of pathogenic bacteria on selective media.	**3**	**CO1**
2.	Morphological characterization of pathogenic bacteria by differential staining.	**2**	**CO1**
3.	Identification of pathogenic bacteria by preliminary test, biochemical test and special test. a) *Staphylococcus aureus* b)*Pseudomonas aeruginosa*	**5**	**CO1**
4.	Culture methods of fungi i. Media usage–PDA, SDA, Corn meal agar	**5**	**CO2**
5.	Examination of fungi by Lactophenol cotton blue stain.	**5**	**CO2**
6.	Examination of *Candida albicans* - Gram's stain, Germ tube test.	**5**	**CO2**

Reference Books:

1.	*Gerald Collee, J. Barie P.Marmion, Andrew, G. Fraser and Anthony Simmons*. 1996. **Mackie and MacCartney Practical Medical Microbiology.** Fourteenth edition. Churchill Livingstone Publishers.
2.	*Sundararaj, T.* **Microbiology Laboratory Manual.** Dr.A.L.Mudaliyar Post Graduate Institute of Basic Medical Sciences, Chennai.

COURSE OUTCOMES (CO)

After completion of the course, the students will be able to

CO1	Identify and detect the pathogenic bacteria based on the morphological and physiological studies.
CO2	Evaluate the mycological diseases.

23PMBBCI301/ 23PMBBTI301	GEC II : INDUSTRIAL MICROBIOLOGY	SEMESTER III

Course Objectives:

The course aims

1. To learn the basics of bioprocess techniques.
2. To know about fermentor design and production of various fermented products.

Credits: 02 **Total Hours: 40**

UNIT	CONTENTS	Hrs	CO
I	**An Introduction To Fermentation Process:** Historical development of industrial microbiology– Component parts of a fermentation process – Screening of industrial microorganisms– primary screening – Crowded plate method, auxanography, indicator dye and enrichment. Secondary screening. Preservation of microorganisms - lyophilization, cryogenic storage.	**08**	**CO1**
II	**Strain Improvement And Media Formulation:** rDNA technology. Medium formulation and sterilization – batch, continuous. Types of fermentation –submerged – solid state fermentation.	**08**	**CO2**
III	**Fermentor:** Components and parts of fermentor – Body construction - stirring and mixing – scale up window – control of pH, temperature, foam and pressure – types of bioreactors – Air lift and cylindro conical bioreactors.	**08**	**CO3**
IV	**Microbial Production Of Fermented Products**: Antibiotics – Penicillin .Organic acid – Citric acid. Vitamin – Vitamin B12. Enzyme – α-amylase. Wine.	**08**	**CO4**
V	**Production And Recovery:** Solvents – Ethyl alcohol. Aminoacids –L-Lysine. Vitamins – B_{12}. Downstream processing.	**08**	**CO5**

Text Books:	
1.	*Stanbury, P.F., Whitaker, A., and Hall, S.J.,* 2005. **Principles of Fermentation technology.** Reed Elsevier India Ltd., New Delhi.
2.	*Patel, A.H.,* 2005. **An Introduction to Industrial Microbiology.** MacMillan India Ltd., Chennai.
3.	*Cruegar, W and Cruegar, A.* 1989. **Biotechnology**: **A Textbook of Industrial Microbiology**. Panima Publishing Corporation, New Delhi.

Reference Books:	
1.	*Michael J Waites, John S Roackey, Neil L. Morgan and Garry Highton.* 2006. **Industrial Microbiology – An Introduction**. Blackwell Science Ltd., USA.
2.	*Hugo, W.B. and Russell, A.D.* 1998. **Pharmaceutical Microbiology.**[Sixth Edition]. Blackwell Scientific Company Ltd., USA.

COURSE OUTCOMES (CO)

After the completion of the course the student will be able to

CO1	Recall the basics and importance of industrially important microbes.
CO2	Apply the techniques for the formulation of media for microbial products.
CO3	Develop the suitable conditions for maximum product yield.
CO4	Apply fermentation technology for production of microbial products.
CO5	Demonstrate chemotherapeutic drugs production under *in vitro* conditions.

MAPPING										
PO &PSO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	M	M	H	H	M	H	H	H
CO2	M	H	M	M	H	H	M	H	H	H
CO3	M	H	M	M	H	H	M	H	H	H
CO4	M	H	M	M	H	H	M	H	H	H
CO5	M	H	M	M	H	H	M	H	H	H
H – High; M- Medium; L - Low										

23PMBBCIP301/ 23PMBBTIP301	**GEC PRACTICAL II: INDUSTRIAL MICROBIOLOGY**	**SEMESTER II**

Course Objectives:

The course aims

- To learn the basic techniques in industrial microbiology.
- To acquire knowledge on antibiotics and its susceptibility.

Credits: 02 **Total Hours: 24**

Experiment	**CONTENTS**	**Hrs**	**CO**
1.	Screening of antibiotic producing organisms from soil.	**3**	**CO1**
2.	Screening of amylase enzyme producing organisms from soil.	**3**	**CO1**
3.	Antibiotic sensitivity disc preparation.	**3**	**CO1**
4.	MIC determination by filter paper disc assay.	**3**	**CO2**
5.	Antibiotic susceptibility method - Kirby Bauer method.	**3**	**CO2**
6.	Evaluation of disinfectant - Phenol Coefficient method.	**3**	**CO2**
7.	Wine production	**6**	**CO2**

Reference Books:

1.	*Gerald Collee, J. Barie P. Marmion, Andrew, G. Fraser and Anthony Simmons*. 1996. **Mackie and MacCartney Practical Medical Microbiology.** Fourteenth edition. Churchill Livingstone Publishers.
2.	*Sundararaj, T.* **Microbiology Laboratory Manual.** Dr.A.L.Mudaliyar Post Graduate Institute of Basic Medical Sciences, Chennai.

COURSE OUTCOMES (CO)

After completion of the course, the students' will be able to

CO1	Assess antibiotic and enzyme production and produce industrially important products.
CO2	Evaluate the susceptibility of antibiotics and disinfectants.