

DEPARTMENT OF MICROBIOLOGY

COURSE STRUCTURE & SYLLABI
(For the students admitted from year 2023-2024 onwards)

Programme : M.Sc. Microbiology



JAMAL MOHAMED COLLEGE (AUTONOMOUS)
Accredited with A++ Grade by NAAC (4th Cycle) with CGPA 3.69 out of 4.0
(Affiliated to Bharathidasan University)
TIRUCHIRAPPALLI – 620 020

M.Sc. MICROBIOLOGY

Sem	Course Code	Course Category	Course Title	Ins. Hrs/ Week	Credit	Marks		Total
						CIA	ESE	
I	23PMB1CC1	Core - I	General Microbiology	6	6	25	75	100
	23PMB1CC2	Core - II	Microbial Metabolism	6	5	25	75	100
	23PMB1CC3	Core - III	Virology	6	5	25	75	100
	23PMB1CC4P	Core - IV	General Microbiology, Microbial Metabolism and Virology - Practical	6	4	20	80	100
	23PMB1DE1A/B	Discipline Specific Elective - I		6	4	25	75	100
Total				30	24			500
II	23PMB2CC5	Core - V	Molecular Biology and Genetics	6	5	25	75	100
	23PMB2CC6	Core - VI	Genetic Engineering	6	5	25	75	100
	23PMB2CC7	Core - VII	Environmental and Agricultural Microbiology	6	5	25	75	100
	23PMB2CC8P	Core - VIII	Molecular biology and Genetics, Genetic Engineering , Environmental and Agricultural Microbiology - Practical	6	4	20	80	100
	23PMB2DE2A/B	Discipline Specific Elective - II		6	4	25	75	100
	23PCN2CO	Community Outreach	JAMCROP	-	@	-	-	@
Total				30	23			500
@ Only grades will be given								
III	23PMB3CC9	Core - IX	Clinical Microbiology	6	5	25	75	100
	23PMB3CC10	Core - X	Principles of Immunology	6	5	25	75	100
	23PMB3CC11	Core - XI	Enzymology	6	5	25	75	100
	23PMB3CC12P	Core - XII	Clinical Microbiology, Principles of Immunology and Enzymology - Practical	6	4	20	80	100
	23PMB3DE3A/B	Discipline Specific Elective - III		6	4	25	75	100
	23PMB3EC1	Extra Credit Course - I*	Online Course	-	*	-	-	-
Total				30	23			500
IV	23PMB4CC13	Core - XIII	Food Microbiology and Food Safety	6	6	25	75	100
	23PMB4CC14	Core - XIV	Industrial Microbiology	6	6	25	75	100
	23PMB4CC15	Core - XV	Biofertilizer and Biopesticides	6	5	25	75	100
	23PMB4PW	Project Work	Project Work	12	8	-	200	200
	23PCNOC	Mandatory Online Course**	Online Course	-	1	-	100	100
	23PMB4EC2	Extra Credit Course - II*	Online Course	-	*	-	-	-
Total				30	26			600
* Programme Specific Online Course for Advanced Learners								
** Any Online Course for Enhancing Additional Skills								
Grand Total					96			2100

DISCIPLINE SPECIFIC ELECTIVE

Semester	Course Code	Discipline Specific Elective
I	23PMB1DE1A	Cell biology and Biomolecules
	23PMB1DE1B	Biostatistics and Bioinstrumentation
II	23PMB2DE2A	Microbial Ecology
	23PMB2DE2B	Bioremediation and Biodegradation
III	23PMB3DE3A	Bioinformatics
	23PMB3DE3B	Biosafety and IPR

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PMB1CC1	Core – I	6	6	25	75	100
Course Title		GENERAL MICROBIOLOGY					

SYLLABUS		
Unit	Contents	Hours
I	Microbial Planet: Main themes of Microbiology- Impact of microbes on earth - Microbial involvement in energy and nutrient flow- Application using microorganism. Historical foundation: discovery of pathogens and germ theory of disease. *Development of aseptic techniques*.	18
II	Microbial Taxonomy: Classification and nomenclature of microorganism. Microbial kingdom concept. Levels of classification- *system of presenting a universal tree of life*. Methods used in bacterial identification: Traditional approaches in bacterial classification - Modern approaches in bacterial taxonomy - Numerical taxonomy. Classification system of prokaryotes by Bergey's manual of systematic bacteriology (9 th edition).	18
III	Prokaryotic Groups: General characteristics, Structure, composition and function of cell wall, cell membrane, capsule, mesosome, flagella and pili. Genome organization. Bacterial cell division and reproduction. Prokaryotic with unusual characteristics: Cyanobacteria, Actinobacteria, Mycoplasma Rickettsiae, *Chlamydiae and Spirochaete*.	18
IV	Fungi: Habit, habitats, characteristics, mode of nutrition and importance. Classification of Fungi based on Alexopoulos system. Heterokaryon- Dimorphic fungi and imperfect fungi. Morphology, structure and life cycle of <i>Saccharomyces cerevisiae</i> and * <i>Aspergillus niger</i> *. Symbiotic associations of algae with fungi. Economic importance of fungi.	18
V	Microalgae and Protozoa: Classification of Algae based on Fritsch system – General Characters, structure and life cycle of Blue green Algae. Microalgae- Biological and Economic importance of <i>Chlorella</i> and * <i>Dunaliella</i> *. Protozoa– structural characteristics, classification and reproduction of <i>E.histolytica</i> . Role of protozoan in environment and health implication.	18
VI	Current Trends (For CIA only) – Drug discovery for the emerging diseases from secondary metabolites of bacteria and fungi.	

..... Self Study

Text Book(s):
1. J. Michael, J. R. Pelczar, E. C. S. Chan and N. R. Kreig, Microbiology, 5th edition, McGraw Hill. Inc, New York, 2004.
2. S. S. Purohit and A. K. Saluja, H. N. Kakrani, Pharmaceutical Microbiology, Mrs.Sarwathi purohit for student edition, India, 2006.
3. K. S. Bilgrami and R. K. Sinha, Essentials of Microbiology, 1 st edition, SK Jain for CBS publishers and distributors, 2005
4. P. S. Bisen Kavitha Verma, Hand book of Microbiology, 2004.
Reference Book(s):
1.J.G. Holt, N.R. Kreig, P.H.A. Sneath, and S.T. Williams, Bergey's Manual of Systematic Bacteriology, 9th edition, Williams and Wilkins, Baltimore, 2004.
2.L. M. Prescott, J. P. Harley and D. AKlein, Microbiology, 7th edition, Mc Grow Hill, 2007.
3. M.T. Madigan, J.M. Martinko and J.Parker, Brock Biology of microorganisms, 11 th edition, Pearson Education international, USA, 2006
4. G. J. Tortora, B.R Funke and C. L. Case, Microbiology an Introduction, 8 th edition, LPE-Pearson Education, Inc, 2005

Web Resource(s):

1. <https://nptel.ac.in/courses/102103015/>
2. <https://courses.lumenlearning.com/suny-biology2xmaster/chapter/ecology-of-fungi/>
3. <https://www.onlinebiologynotes.com/phylum-protozoa-general-characteristic-classification/>

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Outline the themes, historical foundation and applications of microbial adaptations in planet.	K2
CO2	Identify the evolutionary history, group and proper name of organisms through standardized system	K3
CO3	Distinguish the structure, function and features of bacteria.	K4
CO4	Explain the characteristics, structures and life cycle of fungi.	K5
CO5	Compile the economic importance of Microalgae and protozoan in environment and health.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	1	2	2	2	2	1	2	3	1	2	1.8
CO2	2	2	3	2	2	2	3	3	2	1	2.2
CO3	2	2	2	3	2	3	1	2	1	2	2.0
CO4	2	2	2	2	3	3	1	3	2	2	2.2
CO5	2	2	2	3	3	1	2	2	2	3	2.2
Mean Overall Score											10.4/5 = 2.08
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. M. Mohamed Mahroop Raja

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PMB1CC2	Core - II	6	5	25	75	100
Course Title		MICROBIAL METABOLISM					

SYLLABUS		
Unit	Contents	Hours
I	Bioenergetics: First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy and Entropy and mathematical relationship among them, Standard free energy change and *equilibrium constant*. Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP.	18
II	Metabolite Transport: Uptake of Nutrients - Diffusions- passive and facilitated diffusions – Active transport: Primary active transport (ABC transporter) and Secondary active transport – Symport, antiport and uniport – Growth factors (vitamins) – Group translocation (Phosphotransferase system) – *Iron uptake (Siderophores)*.	18
III	Microbial Growth: Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve. Microbial growth in response to nutrition and energy. *Factors affecting microbial growth*- Cell division-mechanisms involved in formation of Z-ring. Endospore: Structure, formation and stages of sporulation.	18
IV	Microbial Phototrophy: Photosynthesis: Adsorption light, photosynthetic and accessory pigments, (chlorophyll, bacteriochlorophyll, carotenoides, phycobilliproteins); Oxygenic and non-oxygenic photosynthesis in prokaryotes. Calvin cycle; effect of light, temperature, pH, and CO ₂ on the rate of photosynthesis; Photosynthetic yield and Photorespiration. *Genetics of bacterial photosynthesis*. Bioluminescence: mechanism and applications.	18
V	Microbial Catabolism and Anabolism- Fermentation and Respiration-EMP pathway-Pasture effect, ED pathway, Glyoxalate pathway, *Krebs cycle*. Anabolism- Gluconeogenesis and reverse TCA cycle. Important electron acceptors for bacteria- Ferric Iron Reduction, Manganese Reduction and other inorganic substances. Organic Electron acceptors-Halogenated compounds.	18
VI	Current Trends (For CIA only) – Pigment producing microbes and therapeutics application.	

..... Self Study

Text Book(s):
1.M. L. Gupta and M. L. Jangir, Cell biology: Fundamentals and Applications, Agrobios, India, 2010. 2. H. G. Schlegel, General Microbiology, 7 th edition, Cambridge university press, 2004. 3. Stuart Hogg, Essential Microbiology, John Wiley and sons Ltd, 2005. 4.D. L. Nelson and M. M. Cox, Lehninger: Principles of Biochemistry, 4th edition, W. H. Freeman and company, 2005. 5. L. M. Prescott, J. P. Harley and D. AKlein, Microbiology, 7 th edition, Mc Grow Hill, 2007

Reference Book(s):
1. Rani Gupta and Namita Gupta, Fundamentals of Bacterial Physiology and Metabolism, Springer Publishers, 2021. 2. J.L. Ingraham and C.A. Ingraham, Introduction to Microbiology, 3rd edition, Thomson Brooks/Cole publication, 2004. 3. G. Gottychalk, Bacterial Metabolism, 2nd edition, Springer-Verlag, Berlin Hissar, Agricultural University, Prentice Hall of India Pvt Ltd, Delhi, 2006. 4. H.W. Doelle, Bacterial Metabolism, 2nd edition, Academic Press, Elsevier Publication, New Delhi, India, 2005.
Web Resource(s):
1. https://nptel.ac.in/courses/102103015/ 2. https://courses.lumenlearning.com/microbiology/chapter/introduction-to-microbial-metabolism/ 3. https://www.cliffsnotes.com/study-guides/biology/microbiology/microbial-metabolism/photosynthesis

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Understand the principles of thermodynamics law and biological energy conversion.	K2
CO2	Apply the knowledge on nutrient transport system and its mechanism.	K3
CO3	Analyze the specific growth rate of microbes under different physicochemical conditions.	K4
CO4	Conclude the knowledge on photosynthesis and its pigments produced by microorganism	K5
CO5	Compile the principles catabolic and anabolic reactions occurring in the organism	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	1	2	2	1	2	2	1	3	2	1.8
CO2	3	2	2	3	2	3	2	3	2	3	2.5
CO3	2	2	2	2	3	3	2	2	2	3	2.3
CO4	2	2	2	1	2	2	2	1	3	2	1.9
CO5	1	2	1	2	2	2	1	2	2	2	1.7
Mean Overall Score											10.2/5 = 2.04
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. M. Mohamed Mahroop Raja

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PMB1CC3	Core - III	6	5	25	75	100

Course Title | VIROLOGY

SYLLABUS

Unit	Contents	Hours
I	General Virology: History of viruses, virus taxonomy, classification and nomenclature. Properties of viruses, morphology and ultrastructure; capsids and capsomers arrangements; *types of viruses and their composition*. Viral multiplication and replication strategies: Host virus interaction, replication of viruses as per baltimore classification - assembly, maturation and release of virions. Viral agents (viroids, virusoids and prions).	18
II	Bacteriophages: Bacteriophages- one step growth curve, Life cycle- Lytic and Lysogenic, Classification, Morphological groups - virulent dsDNA phage, ssDNA phage, phage lambda, Temperate and Transposable phage, Phage Mu, M13, T4, P1, Bacteriophage typing, Phage therapy (bacteriophage therapy), *Cyanophages, Mycoviruses (Mycophages) *, Rhizobiophages.	18
III	Plant viruses: History and classification and plant viruses. Transmission of plant viruses with vectors insects, nematodes, fungi and without vectors (contact, seed and pollens). Transmission, Multiplication, symptoms and control of plant viral diseases- Tobamovirus group (TMV), Tymovirus group (Circular mosaic virus), *Tomato spotted wilt virus*, potato virus X, cauliflower mosaic virus, Potato leaf roll virus, Rice tungro virus and Mosaic disease of sugarcane.	18
IV	Human and animal viruses: Classification, Multiplication, Epidemiology, Pathogenesis, Diagnosis, Prevention and Treatment of DNA viruses- Adenovirus, Pox virus and Simian Virus – 40 (SV40). RNA viruses- Picornavirus, *Rota virus, Retrovirus*, Chikungunya, Dengue, Ebola and Corona viruses (RNA containing). Oncogenic viruses- Epstein–Barr virus, Hepatitis B and C virus. Viral Vaccines, Interferon and Antiviral drugs.	18
V	Virus cultivation and Diagnosis: Characterization and Cultivation of viruses- Embryonated eggs, Primary and secondary cell cultures, monolayer cell cultures- cell strains, cell lines and transgenic system. Serological methods- haemagglutination, haemagglutination inhibition, complement fixation, immunofluorescence, ELISA, *RIA* and assay of viruses. Biosafety and containment facility in virology lab.	18
VI	Current Trends (For CIA only) – Emerging and re-emerging human viral disease and assessing the impact of co-infection on an organism.	

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Text Book(s):

1. S. J. Flint, L. W. Enquist, V. R. Rancaniello and A. M. Skalka, Principles of Microbiology, 3rd edition, American Society for Microbiology, 2009.
2. J. Michael, J. R. Pelczar, E. C. S. Chan and N. R. Kreig, Microbiology, 5th edition, McGraw Hill. Inc, New York, 2004.
3. P. Saravanan, Virology, MJP Publishers, 2006.
4. Apoorva Karanth, Plant virology, Dominant publishers and distributors, New Delhi, 2008

Reference Book(s):

- 1.S.J. Flint, L.W. Enquist, R. Krung, V.R. Racaniello and A.M. Skalka, Principles of Virology, ASM press, Washington, 2000.
2. Geeta Sumbali and R.S. Mehrotra, Principles of Microbiology, 1st edition, Tata McGraw Hill Pvt ltd, New Delhi, 2009.
3. H.F. Conrat, P.C. Kimball and J.A. Levy, Virology, 2nd edition, Prentice Hall, New Jersey, 2003.
4. J.A. Cann, Principles of Molecular virology, 3rd edition, Academic press, California, 2001.

Web Resource(s):

1. <https://courses.lumenlearning.com/boundless-biology/chapter/viral-evolution-morphology-and-classification/>
2. <https://www.khanacademy.org/science/biology/biology-of-viruses/virus-biology/a/bacteriophages>
3. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7151951/>

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Summarize the concepts studied in virus discovery, taxonomy, structure, classification and replication strategies.	K2
CO2	Construct the structure and characteristics and classification bacteriophages.	K3
CO3	Inspect the knowledge on virus infecting plants and its control measures.	K4
CO4	Explain the pathogenesis, diagnosis and treatment of human and animal viruses	K5
CO5	Compile the principles of different types of virus cultivation and biosafety methods	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	2	2	2	2	1	2	2.0
CO2	2	1	1	2	2	2	2	2	2	2	1.8
CO3	2	2	1	2	3	3	2	2	2	3	2.2
CO4	2	2	2	2	2	2	2	2	2	2	2.0
CO5	3	2	2	2	3	3	2	2	2	3	2.4
Mean Overall Score											10.4/5 = 2.08
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. M. Mohamed Mahroop Raja

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PMB1CC4P	Core – IV	6	4	20	80	100
Course Title		GENERAL MICROBIOLOGY, MICROBIAL METABOLISM AND VIROLOGY - PRACTICAL					

SYLLABUS		
S.NO	Contents	Hours
1.	Enumeration of Bacteria and Fungi by serial dilution and standard plate count method	90
2.	Pure culture techniques- Pour, Spread and Streak plate method	
3.	Measurement of size of microbes - micrometry method.	
4.	Motility determination - Hanging drop method and stab method	
5.	Staining methods- Gram staining, Acid fast, Endospore, PHB, and Capsule staining.	
6.	Detection of Fungi using Lactophenol cotton blue staining method	
7.	Measurement of growth curve- Direct and indirect methods.	
8.	Effect of pH and Temperature on microbial growth.	
9.	Effect of high salt concentration on microbial growth.	
10.	Biochemical tests: IMVIC, Catalase, Oxidase, TSI test, Gelatin, Casein, Starch Hydrolysis, and Urease test.	
11.	Isolation of Bacteriophage.	
12.	Phage titration.	
13.	Animal virus propagation- chick embryo and fibroblast culture preparation.	
14.	Plant virus transmission method - Mechanical	

Text Book(s):
1.R.C.Dubey and D.K. Maheswari, Practical Microbiology, 1 st edition, S.Chand & Company Limited, New Delhi,2002.
2.P.Gunasekaran,Laboratory Manual in Microbiology,New Age International Private Limited Publishers, New Delhi,2005
3.S.Ram Reddy and S.M.Reddy, Essential of Virology, Scientific Publishers, India,2012.
Reference Book(s):
1.K.R. Aneja, Experiments in Microbiology, Plant pathology and Biochemistry, 4th edition, New age International publishers, India, 2003.
2.Cappuccino and G. James, Microbiology a laboratory manual, 10th edition, Addison Wesley Publishing Company Inc. California,2019.
3. B.W.J. Mahy and H.O. Kangro , Virology Methods Manual, Academic Press, New York, 2006
Web Resource(s):
1. https://www.biologydiscussion.com/organism/culture-organism/obtaining-pure-culture-of-microorganisms-6-methods/55042 .
2. https://microbeonline.com/overview-of-biochemical-tests-used-to-identify-bacteria-in-microbiology-laboratory/
3. https://microbiologyinfo.com/techniques-of-virus-cultivation/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Understand the principles and methodology for isolation and characterization of microorganisms.	K2
CO2	Apply the acquired knowledge on microorganism and its biochemical regulation.	K3
CO3	Compare the various factors affecting bacterial growth.	K4
CO4	Asses the reproducible data from biochemical experiments.	K5
CO5	Compile the principles governing the cultivation of bacteriophages and animal virus.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	2	3	2	3	2	2	2	2	2.3
CO2	2	3	2	3	2	2	2	3	2	2	2.3
CO3	2	2	2	2	2	3	2	2	3	2	2.2
CO4	3	3	2	2	2	2	2	3	2	3	2.4
CO5	2	2	2	2	1	2	2	1	2	2	1.8
Mean Overall Score											11/5 = 2.2
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. M. Mohamed Mahroop Raja

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PMB1DE1A	DSE - I	6	4	25	75	100
Course Title		CELL BIOLOGY AND BIOMOLECULES					

SYLLABUS		
Unit	Contents	Hours
I	Introduction to cell biology: An Overview of cells – Origin and evolution of cells. Cell theory, Protoplasm theory and organismal theory, Classification of cells – Prokaryotic cells and Eukaryotic cells. *Comparison of prokaryotic and eukaryotic cells*. Molecular composition of cells - Water, Carbohydrates, lipids, nucleic acids and proteins. Cell Cycle: Phases, Meiotic and Mitotic division.	18
II	Cellular organelles: Structure and function of cytoplasmic compartments of the cell, ribosome and protein synthesis, energy flow through mitochondrion, chloroplast, *Golgi apparatus, lysozymes* and microbodies, endoplasmic reticulum, vacuoles, peroxysomes, lysosomes and Nuclear compartment. Heterochromatin and euchromatin, polytene chromosomes.	18
III	Carbohydrates and Proteins: Classification, structure and reactions of monosaccharides and disaccharides. Structure and conformation of polysaccharides - Cellulose, *Amylose and Chitin*. Protein- properties of aminoacids, Classification of proteins, structure of protein -primary, secondary, tertiary and quaternary structure.	18
IV	Nucleic acids and vitamins: Classifications and Structure of nucleic acids, Biosynthesis and degradation of nucleic acids (de novo and salvage path way). Definition, structure, properties and classification of vitamins- fat soluble vitamins-vitamin A, D, E and K; water soluble vitamins B12, B2, B6 group and *vitamin-C*.	18
V	Cell signaling: Molecular mechanism of signal transduction-gated ion channel, cell surface receptor and hormones. Signaling through G protein coupled receptor and second messengers. Protein kinase in signal transduction. Regulation of signaling pathways and *Programmed cell death*.	18
VI	Current Trends (For CIA only) -Classical and Non-classical intercellular communication in senescence and aging, Metabolic regulation of Tissue stem cells.	

..... Self Study

Text Book(s):
1. M. L. Gupta and M. L. Jangir, Cell biology: Fundamentals and Applications, 1 st edition Agrobios, India, 2010.
2. U. Satyanarayana and U. Chakrapani, Biochemistry, 3 rd edition, Arunabha Sen Publisher, 2016.
3. Eric E. Conn, Paul K. Stumpf, George Bruening and Roy H. Doi, Outlines of Biochemistry, 5 th edition, Wiley India Publisher, 2006.
4. Ajoy Paul, Text book of cell and molecular biology, 4 th edition, Arunabha Sen Publisher, 2015.

Reference Book(s):
1. J. M. Berg, J. L. Tymoczko and L. Stryer, Biochemistry, 5 th Edition, W.H. Freeman, New York., 2005. 2. W. B. Wood, J. H. Wilson, R. M. Benbow and L. E. Hood, Biochemistry: A problems approach, 2 nd Edition, Benjamin/Cummins Publishing Company., 1981. 3. D. Voet and J. G. Voet, Biochemistry, 4 th Edition, Wiley & Sons., 2011. 4. A. L Lehninger, D. L Nelson, M. M Cox, Principles of Biochemistry, 1 st edition, CBS Publishers., 1993.
Web Resource(s):
1. https://www.vedantu.com/biology/mitosis-and-meiosis 2. https://nptel.ac.in/courses/102103015/ 3. https://www.ncbi.nlm.nih.gov/books/NBK9924/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Discuss the molecular composition of cells and cell cycle.	K2
CO2	Explain the Structure and function of cytoplasmic compartments of the cell.	K3
CO3	Analyze the role of carbohydrates and proteins in living cells.	K4
CO4	Assess the Biosynthesis and degradation of nucleic acids .	K5
CO5	Design the Molecular mechanism of signal transduction.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	1	1	1	3	2	1	2	2	1.9
CO2	3	2	2	1	1	2	3	1	2	3	2.0
CO3	3	2	2	1	2	3	2	1	2	2	2.0
CO4	3	2	2	1	2	3	2	1	2	2	2.0
CO5	3	3	2	2	2	3	1	1	2	3	2.2
Mean Overall Score											10.1/5= 2.02
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. N. Packialakshmi

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PMB1DE1B	DSE - I	6	4	25	75	100
Course Title		BIOSTATISTICS AND BIOINSTRUMENTATION					

SYLLABUS		
Unit	Contents	Hours
I	Introduction to Biostatistics: Basic definitions and applications. Sampling: Representative sample, sample size, sampling bias and sampling techniques. Data collection and presentation: Types of data, methods of collection of primary and secondary data, methods of data presentation, graphical representation by histogram, polygon, Ogive curves and pie diagram. confidence limits, Probability distribution, normal, *binomial and Poisson distribution*.	18
II	Measures of Central Tendency: Inferential statistics – Probability and distributions – Poisson, Binomial and Normal distribution – Chi-square test – Hypothesis test - Student’s t-test – Correlation and Regression – *ANOVA*.	18
III	Cell analysis: Principles and Applications of Light, Phase Contrast, Fluorescence Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Confocal Microscopy. Structural analysis of Biomolecules: UV-Visible, IR, NMR, LASER Raman Spectroscopy, Mass Spectroscopy, *Fluorescence Spectroscopy*.	18
IV	Centrifugation and Filtration Techniques: Centrifugation: Principle, methodology and application of Analytical, Differential and Density gradient centrifugation. Filtration: Methods, filter media, filter aid, ultrafiltration. Industrial filter- dead end filter, *cross flow filter*, rotary vacuum filter and frame filter.	18
V	Electrophoresis and Chromatographic Techniques: Electrophoresis- AGE, PFGE, isoelectric point and focusing, Capillary electrophoresis, mobility shift electrophoresis and Native PAGE, SDS-PAGE and Two dimensional PAGE. Theory and application of Gel filtration, *Ion-exchange*, Gas and HPLC.	18
VI	Current Trends (For CIA only) -Microarray techniques for screening of gene expression profiles of biological samples.	

..... Self Study

Text Book(s):
1. Pranabkumar, Banerjee Introduction to Biostatistics, S. chand and company Ltd., (2007). 2. K.L.A.P. Sharma, B. Ravindra reddy, T. Pullaiah, Daya Publishing house, 2013. 3.L. Veerakumari, Bioinstrumentation, MJP Publishers, 2006. 4. N.Gurumani, Research Methodology for Biological Sciences, MJP publishing, Chennai, 2006.
Reference Book(s):
1. P. Banerjee, Introduction to Biostatistics, S. Chand and Company Ltd, 2007. 2. P.N. Arora and P.K. Malhon Biostatistics Himalaya Publishing House, Mumbai, 2008. 3.Ruchi Singh and Richa Sharma. Bioinformatics: Basics, algorithms and applications, Universities Press, (India) Pvt. Ltd, Hyderabad, India. 2010 4.Cynthia Gibas and Per Jambeck Developing Bioinformatics Computer Skills: First Edition Shroff Publishers and Distributors Pvt. Ltd (O’Reilly), Mumbai.2001.

Web Resource(s):

1. <https://www.easybiologyclass.com/graphical-representation-of-data-frequency-polygon-frequency-curve-ogive-and-pie-diagram/>
2. <https://www.britannica.com/technology/transmission-electron-microscope>
3. <https://www.creative-proteomics.com/resource/how-does-sds-page-work.htm>

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Describe the basics knowledge of Biostatistics, data collection and classification methods.	K2
CO2	Apply the concept and methods of Correlation and Regression.	K3
CO3	Illustrate the principle and mechanism of microscopic techniques.	K4
CO4	Summarize the principles of equipment used in biological and medical field	K5
CO5	Facilitate the application of electrophoresis and chromatographic Techniques.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	1	2	2	3	3	2	2	1	2.1
CO2	2	2	2	2	1	2	3	2	2	1	1.9
CO3	1	3	2	2	2	2	2	3	2	2	2.1
CO4	3	2	3	2	1	2	2	1	2	2	2.0
CO5	2	3	2	1	2	3	2	2	2	1	2.0
Mean Overall Score											10.1/5 =2.02
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. H. Vajiha Banu

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PMB2CC5	Core – V	6	5	25	75	100
Course Title		MOLECULAR BIOLOGY AND GENETICS					

SYLLABUS		
Unit	Contents	Hours
I	Introduction Molecular biology: Structure of nucleic acid. Nucleic acids as hereditary material- Griffith, Blender jar experiment, *Avery experiment*. Structure and types of RNA- rRNA, tRNA and mRNA; RNA as a genetic material- Beadle and Tatum experiment. DNA replication: general principles, various modes of replication, isolation and properties of DNA polymerases, proof reading, continuous and discontinuous synthesis.	18
II	Transcription and Translation: Transcription process in prokaryotes and eukaryotes, Initiation, elongation & termination. Reverse transcription, post transcriptional processing, *Genetic code*, Steps in translation - Amino acid activation, initiation, chain elongation & termination. Inhibitors of protein synthesis. Post translational modification, Regulation of gene expression.	18
III	Mutation and Repair mechanisms: Spontaneous mutations, induced mutations, types of mutations, silent mutation, missense mutation, *nonsense mutation, frame shift mutations*, Mutagenesis – physical and chemical mutagens, base and nucleoside analog, alkylating agents, intercalating agents, ionizing radiation. Repair mechanisms of damaged DNA: Excision repair, Mis-match repair, Recombinational repair, SOS response. Mutant detection methods- selection of mutants, testing of chemicals for their cancer causing ability by Ames test.	18
IV	Mechanism of Gene transfer: Bacterial Transformation – competence cells, regulation, general process; *Transduction – general and specialized*; Conjugation – Hfr, triparental mating, self transmissible and mobilizable plasmids, sex pili.	18
V	Concept of Gene: Operon concept, lac and trp operons, promoters and repressors. Regulation of gene expression – Transcriptional control – promoters, terminators, attenuators and anti terminators; Induction and repression; the lac operon – catabolite repression; Biosynthesis: trp operon – upstream activator sequences and enhancers, two component regulatory systems. Translational control – ribosome binding, codon usage, antisense RNA; *post-transcriptional gene silencing – RNAi*.	18
VI	Current Trends (For CIA only) – CRISPR –mediated analogue multi-event recording apparatus system- Molecular computation strategy for classifying complex gene expression-splice Detector- Nanobot-imotifs inside human cells.	

..... Self Study

Text Book(s):
1. Friedbreg, E.C., Walker, G.C., Siede, W., Wood, R.D., Schultz, R.A. and Ellenberger, T. DNA Repair and Mutagenesis, 2nd edition, ASM Press, Washington, D.C. 2006.
2. Strickberger, M.W. Genetics, 3rd edition, Prentice-Hall of India Private Limited, New Delhi. 2006.
3. Tropp, B.E. Molecular Biology (Genes to Proteins), 3rd editions, Jones and Barlett Publishers, London. 2008.
Reference Book(s):
1. J.D Watson, T.A. Baker, S.P. Bell and Alexander Gann. Molecular Biology of the Gene, 5 th edition, Benjamin/cummings, Publishing Company Inc, New York, 2004.
2. P. Steller and D.E. Bianchi, Cell and molecular biology, 3rd edition, Wiley publication, India, 2009.
3. T.A. Brown, Essential Molecular Biology - A Practical approach, Oxford University Press, Oxford, 1991.

Web Resource(s):

- [https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3A_Biochemistry_Free_For_All_\(Ahern%2C_Rajagopal%2C_and_Tan\)/2%3A_Structure_and_Function/2.6%3A_Structure_and_Function_-_Nucleic_Acids](https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3A_Biochemistry_Free_For_All_(Ahern%2C_Rajagopal%2C_and_Tan)/2%3A_Structure_and_Function/2.6%3A_Structure_and_Function_-_Nucleic_Acids)
- <https://www.khanacademy.org/science/biology/gene-regulation/gene-regulation-inbacteria/a/the-lac-operon>
- <https://microbenotes.com/category/molecular-biology/>

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Identify the knowledge on nucleic acids.	K2
CO2	Explain the mechanisms of transcription, translation and gene expression.	K3
CO3	Analyze the processes behind mutations and fundamental concepts in microbial genetics repair mechanisms.	K4
CO4	Summarize the principle of gene transfer mechanism and its regulations.	K5
CO5	Express the system of Operon concept.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	1	3	3	2	2	2	2.1
CO2	2	2	1	1	2	3	3	1	3	1	1.9
CO3	3	3	2	2	2	1	3	2	2	2	2.2
CO4	3	3	1	1	2	2	3	1	2	1	1.9
CO5	2	2	1	2	2	2	3	2	2	1	2.0
Mean Overall Score											10.1/5= 2.02
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr.N.Reehana

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PMB2CC6	Core – VI	6	5	25	75	100
Course Title		GENETIC ENGINEERING					

SYLLABUS		
Unit	Contents	Hours
I	Recombinant DNA Technology: DNA polymerase, reverse transcriptase, restriction endonucleases, polynucleotide kinase, terminal deoxynucleotidyl transferase, DNase, methylase, phosphatases, ligases RNase and their mode of action. Vectors- properties and classification- types of vector: plasmids, cosmids, phages, *BAC and YAC* and viruses.	18
II	Nucleic Acid Amplification & Hybridization Techniques: Polymerase chain reaction (PCR), types and applications. Methods of nucleic acid detection, methods of nucleic acid hybridization, *sequencing methods*, probes and target sequences, Southern blotting, Northern blotting, in situ hybridization, nucleic acid mutagenesis <i>in vitro</i> and <i>in vivo</i> .	18
III	Construction of DNA Library: Construction of genomic and cDNA libraries, Screening libraries with gene probes, Insertional inactivation, *Blue white selection*, colony hybridization, plaque hybridization and immunological screening.	18
IV	Gene Transfer Techniques: Gene transfer techniques in microbes, animals and plants- electroporation, microprojectile system, liposome-mediated gene transfer, DNA/calcium phosphate co-precipitate method, gene- gun, transfection with phage vectors etc. Agrobacterium based gene transfer in plants - Ti plasmid: structure and functions, Ti plasmid based vectors. *Chloroplast transformation*.	18
V	Applications of recombinant DNA technology: Gene mapping-restriction mapping, RFLP, RAPD, AFLP. Engineering microbes for the production of antibiotics, *enzymes*, Insulin, growth hormones, monoclonal antibodies etc. Transgenic organisms from mice to rice, Human genetic engineering and Gene therapy- methods of gene therapy, gene therapy in treatment of diseases, Stem cell therapy, Future of stem cell therapy. Science and the constitution- ethical, legal and environmental issues.	18
VI	Current Trends (For CIA only) – Production of genetically modified food good or bad, Impact of Genetically Engineered Crops on Biodiversity, Transgenic Mice as Test Systems, Genetically modified organisms.	

..... Self Study

Text Book(s):
1. Madigan, M.T, and Martinko, J.M. Brock Biology of Micro-organisms 8 th edition. Parker J. Prentice Hall International, Inc. 2006.
2. Sandhya Mitra, Genetic Engineering, Rajiv Beri Macmillan India Ltd, 1996.
3. Watson, Baker, Bell, Gall, Levina and Lorick. Molecular Biology of the Gene, 6 th edition, Pearson Benjamin Cummings Publishers, Cold Spring Harbor Laboratory Press, New York. 2008.
Reference Book(s):
1. Glick B.R. Pasternak J.J. Molecular Biotechnology. ASM Press Washington D.C. 2003.
2. Helen Kreuz, Adrienne Massey. Recombinant DNA and Biotechnology: Guide for Teachers, ASM Publications, 2nd Edition, 2001.
3. C. Lenk, N. Hoppe and R. Andorno, Ethics and law of intellectual property: Current problems in politics, Science and technology, Ashgate publisher Pvt. Ltd. 2007.

Web Resource(s):

1. https://www.abmgood.com/marketing/knowledge_base/next_generation_sequencing_introduction.php
2. <https://courses.lumenlearning.com/boundless-biology/chapter/biotechnology/>
3. <https://unacademy.com/content/bpsc/study-material/science-and-technology/notes-on-genetics-and-genetic-engineering/>

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Describe the enzymes and vector which serves an indispensable tools in recombinant DNA technology	K2
CO2	Apply the techniques of blotting and restriction mapping	K3
CO3	Illustrate the construction and screening of genomic and cDNA libraries.	K4
CO4	Summarize the methods and protocols to transfer genes into host.	K5
CO5	Report the recombinant DNA technology applications and its ethical issues	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	1	2	2	2	2	3	2	2	1	1.9
CO2	3	3	1	2	1	3	3	2	2	2	2.2
CO3	2	2	2	2	2	2	3	3	2	2	2.2
CO4	2	2	2	2	2	2	3	2	3	1	2.1
CO5	2	1	2	2	3	2	3	2	2	1	2.0
Mean Overall Score											10.4/5= 2.08
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. N. Reehana

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PMB2CC7	Core – VII	6	5	25	75	100
Course Title ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY							

SYLLABUS		
Unit	Contents	Hours
I	Soil Microbiology: Soil profile and Soil Microorganisms- Structure, Types, Physical and Chemical properties. Weathering and Humus formation, Soil pollution. Soil microbes- Types and Microbial interaction. Biogeochemical cycles and their sedimentary- Carbon, nitrogen, oxygen, hydrogen, phosphorous, *sulfur and iron*.	18
II	Recycling of Liquid and Solid wastes: Characterisation and types of liquid waste management and treatment- Primary, Secondary treatment and Tertiary treatment. Characterization and types of solid waste-solid waste management and treatment- Silage, Pyrolysis and saccharification. *Composting and Biogas production and process *. Application of GIS (Geographic Information System) and RS (Remote sensing) techniques in environmental monitoring.	18
III	Agricultural Microbiology: Importance of microorganisms in agriculture, Rhizosphere and phylloplane microorganisms. Rhizosphere concept - quantitative and qualitative studies – R: S ratio - Rhizoplane -spermosphere - phyllosphere microorganisms and their importance in plant growth. PGPR (plant growth promoting rhizobacteria), siderophores and *antimicrobial resistance in Agriculture*.	18
IV	Diazotrophs: Ecology of diazotrophs. Biological fixation of nitrogen, Nitrogen fixation sites, symbiotic and nonsymbiotic nitrogen fixation. Mechanism of biological nitrogen fixation. Nitrogenase enzyme complex - azoferredoxin and molybdo ferredoxin. Physiological electron donors and mechanism of nitrogen reduction, *regulation of nitrogenase enzyme*. Nif genes and its regulation. Role of hydrogenase enzyme in nitrogen fixation.	18
V	Bioinoculants: Biofertilizers Characteristics, Production and application of <i>Rhizobium</i> , <i>Azotobacter</i> , <i>Azospirillum</i> , Phosphate solublizing and mobilizing bacteria *Blue green algae*, <i>Azolla</i> and Mycorrhizae. Formulation of biofertilizer. Biopesticides- types, mechanism and application of Bacterial, Fungal and Viral insecticides.	18
VI	Current Trends (For CIA only) – Bio-methane production from animal waste in arid environments, Nutrient recovery from bio-waste, Agricultural Diversification.	

..... Self Study

Text Book(s):
1. K.Vijaya Ramesh, Environmental Microbiology, 1 st edition, MJP Publishers, 2004. 2. P.Rajendran, Microbial Bioremediation, 1 st edition, MJP Publishers, 2006. 3. G.Rangasami and D.J.Bagyaraj, Agricultural Microbiology, 2 nd edition, Prentice- Hall publications 1993.
Reference Book(s):
1. C.F. Forster, Biotechnology and Wastewater Treatment, 2 nd editin, Cambridge University Press, Cambridge, 1985. 2. W.D. Grant and P.L. Long, Environmental Microbiology, 1 st edition, Blackie Glasgow, London, 1981. 3. N.F.Gray, Biology of waste water Treatment, 1 st edition, Oxford University Press, Oxford, 1989. 4. M.K. Rai, Handbook of Microbial biofertilizers, 1 st edition, Food Products Press, New York, 2005. 5. M. Gareth, Evans and J.C. Furlong, Environmental Biotechnology Theory and Application, 1 st edition, John Wiley and sons Ltd, 2003.

Web Resource(s):

1. <http://www.futuredirections.org.au/publication/living-soils-role-microorganisms-soil-health/>
2. <https://courses.lumenlearning.com/trident-boundless-microbiology/chapter/microbial-bioremediation/>
3. <https://microbenotes.com/rhizospheric-microorganisms/>
4. <https://www.biologydiscussion.com/fertilizers/production-of-various-bio-fertilizers-microbiology/66873>

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Describe the role of microbes and Biogeochemical cycles prevailing in environment.	K2
CO2	Examine the recycling of liquid and solid wastes	K3
CO3	Analyze the Antimicrobial resistance in agriculture	K4
CO4	Assess the mechanism of nitrogen fixation and nif gene regulation	K5
CO5	Design the production and applications of bioinoculants and biopesticides	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	1	3	1	3	2	1	2	3	2.2
CO2	3	2	1	3	1	1	3	2	2	3	2.1
CO3	3	3	3	2	2	3	2	3	3	2	2.6
CO4	3	3	3	2	2	2	3	2	3	2	2.5
CO5	2	3	3	2	2	3	2	3	3	2	2.5
Mean Overall Score											11.9/5= 2.38
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr.N. Packialakshmi

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PMB2CC8P	Core – VIII	6	4	20	80	100
Course Title		MOLECULAR BIOLOGY AND GENETICS, GENETIC ENGINEERING, ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY - PRACTICAL					

SYLLABUS		
S.NO	Contents	Hours
1.	Isolation and separation of chromosomal DNA.	90
2.	Isolation and separation of plasmid DNA.	
3.	Scoring of mutants through physical agents.	
4.	Replica plate technique.	
5.	Restriction digestion of DNA	
6.	Separation and identification of protein by gel electrophoresis (SDS PAGE).	
7.	Protein Purification (partial) by Ammonium Sulphate precipitation.	
8.	DNA amplification- PCR analysis.	
9.	Isolation of Protoplast and Spheroplast from bacteria.	
10.	Determination of BOD of polluted / pond water.	
11.	Determination of COD of polluted / pond water.	
12.	Assessment of water quality by MPN technique.	
13.	Isolation of cellulose, amylase producing microbes from soil.	
14.	Detection of water pollution using Algae.	
15.	Assessment of indoor air quality using settle plate method.	
16.	Microbial examination of industrial waste water/sewage.	

Text Book(s):
1. T.A. Brown, Essential Molecular Biology - A Practical approach, Oxford University Press, Oxford, 1991.
2. K.R. Aneja, Experiments in Microbiology, Plant pathology and Biochemistry, 4 th edition, New age International publishers, India, 2003.
3. Cappuccino and G. James, Microbiology a laboratory manual, 4 th edition, Addison Wesley Publishing Company Inc. California, 1996.
Reference Book(s):
1. J. Jayaraman, Laboratory Manual in Biochemistry, 2 nd edition, New age publication, 2011.
2. R.M. Atlas and R. Bortha, Microbial Ecology Fundamentals and Application, 4th edition, LPE Pearson Education, Inc, 2005.
3. Vennison, S. John, Laboratory Manual for Genetic Engineering, PHI Learning Pvt. Ltd., 2009.
Web Resource(s):
1. https://www.researchgate.net/publication/322697322_Laboratory_manual_on_Molecular_Biology_Genetic_Engineering_A_new_Approach
2. https://faculty.ksu.edu.sa/sites/default/files/bch361_handnote_1.pdf
3. https://coabnau.in/uploads/1609240154_p-1manual.pdf

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Observe the hands-on experience on isolating genomic DNA and plasmid	K2
CO2	Experiment the principle and characterization of SDS PAGE.	K3
CO3	Focus on training of DNA amplification by PCR.	K4
CO4	Compare the estimation of BOD and COD in polluted water.	K5
CO5	Validate the indicator organism and cellulose producing microorganism.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	1	1	2	2	3	2	3	1	2.0
CO2	2	3	2	2	2	1	3	2	3	1	2.1
CO3	3	3	1	1	1	3	3	2	3	1	2.1
CO4	2	3	2	2	2	1	3	2	3	2	2.2
CO5	1	3	1	2	2	2	3	1	3	1	1.9
Mean Overall Score											10.3/5= 2.06
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr.N. Reehana

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PMB2DE2A	DSE - II	6	4	25	75	100
Course Title		MICROBIAL ECOLOGY					

SYLLABUS		
Unit	Contents	Hours
I	Microbial Environment: Distribution and communities of microbial environment- Factors influencing the microbial density in soil- zymogenous and autochthonous flora in soil. Terrestrial ecosystem: Forest-grassland- Desert. *Biological equilibrium*. Meaning of succession: Tolerance and inhibition patterns of succession, theories of succession. Biological Interactions: Microbe–Microbe Interactions, Microbe–Plant Interactions, Microbe–Animal Interactions. Methods of studying microbial ecosystem.	18
II	Aero Microbiology: Stratification of atmosphere. Microbial contamination of air- Sources of contamination -Biological indicators of air pollution. Droplet and Droplet Nuclei. Enumeration of bacteria from air, air sampling devices. Significance of air microflora, Outline of airborne diseases (Bacterial - Whooping cough, Diphtheria, Pneumonia; Fungal- Aspergillosis, Cryptococcosis; Viral- Chickenpox, Influenza, Measles). *Air sanitation*.	18
III	Aquatic Microbiology: Fresh and marine water zone. Microbial ecology of lakes, ponds, rivers, stream, ground water wetland, Factors affecting the microbial population. Techniques for the study of aquatic microbes. Eutrophication- *factors controlling eutrophication*. Water treatment: preliminary- aeration, sedimentation, coagulation and flocculation. Filtration- rapid and slow sand filters and Microfilters.	18
IV	Water Quality Measures: water purification methods- Small scale and large scale. Guideline, methods, identification and validation. Bacteriological techniques for the examination of water- MPN index. Indicators of faecal pollution. Waterborne disease: Enteric bacteria (indicators and pathogens) Opportunistic pathogens: <i>Legionella</i> , <i>Vibrio</i> and <i>Staphylococcus</i> . Viruses: <i>Polio</i> , <i>adenovirus</i> , and * <i>Rotavirus</i> *.	18
V	Extremophiles: Extreme Habitats-Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Thermophiles and Psychrophiles - Classification, habitats and ecological aspects. Extremely Thermophilic Archaeobacteria, Thermophily, commercial aspects of thermophiles. Applications of thermozymes. *Methanogens: Classification, Habitats, applications*.	18
VI	Current Trends (For CIA only) – <i>Escherichia coli</i> integrates chemotaxis and quorum sensing pathways.	

..... Self Study

Text Book(s):
1. J. Michael, J. R. Pelczar, E. C. S. Chan and N. R. Kreig, Microbiology, 5 th edition, McGraw Hill. Inc, New York, 1993.
2. S. S. Purohit and A. K. Saluja, H. N. Kakrani, Pharmaceutical Microbiology, Mrs.Sarwathi purohit for student edition, India, 2006.
3. K. S. Bilgrami and R. K. Sinha, Essentials of Microbiology, 1 st edition, SK Jain for CBS publishers and distributors, 2005.
4. P. S. Bisen Kavitha Verma, Hand book of Microbiology, 2004.
5. K. Vijaya Ramesh, Environmental Microbiology, 1 st edition, MJP publishers, 2005.

Reference Book(s):
1. J.G. Holt, N.R. Kreig, P.H.A. Sneath, and S.T. Williams, Bergey's Manual of Systematic Bacteriology, 9 th edition, Williams and Wilkins, Baltimore, 1994. 2. L. M. Prescott, J. P. Harley and D. AKlein, Microbiology, 7 th edition, Mc Grow Hill, 2007. 3. M.T. Madigan, J.M. Martinko and J.Parker, Brock Biology of microorganisms, 11 th edition, Pearson Education international, USA, 2006.
Web Resource(s):
1. https://nptel.ac.in/courses/102103015/ 2. https://courses.lumenlearning.com/suny-biology2xmaster/chapter/ecology-of-fungi/ 3. https://lifewater.org/blog/7-most-common-waterborne-diseases-and-how-to-prevent-them/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Classify the distribution and association of microorganisms in microbial environment.	K2
CO2	Determine the aerobic atmosphere, air sampling devices and airborne diseases.	K3
CO3	Explain the various techniques used to treat aquatic microbes.	K4
CO4	Measure the microbiological examination of water and indicator organism.	K5
CO5	Develop the application and relevance of extremophiles in climate change.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	1	2	2	3	2	2	2	2	2.1
CO2	2	2	3	2	1	2	3	2	2	1	2.0
CO3	2	3	1	2	2	3	2	3	2	2	2.2
CO4	3	2	2	2	1	1	2	1	2	2	1.8
CO5	2	2	2	1	2	3	2	2	2	1	1.9
Mean Overall Score											10/5 =2
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. H. Vajiha Banu

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PMB2DE2B	DSE - II	6	4	25	75	100
Course Title		BIOREMEDIATION AND BIODEGRADATION					

SYLLABUS		
Unit	Contents	Hours
I	Bioremediation: Introduction, in situ and ex situ bioremediation, constraints and priorities of bioremediation, *Evaluating Bioremediation*, Bioremediation of polycyclic aromatic hydrocarbons (PAHs) and Volatile organic compounds (VOCs).	18
II	Microbial Bioremediation: Types and approaches of bioremediation – Microbes for bioremediation – Bioremediation techniques – Parameters for bioremediation monitoring -* Bioremediation of phenols*, PCBS dyes, crude oil and petrol. Recent Advances in the field of Bioremediation.	18
III	Molecular approaches in bioremediation: Genetically engineered microorganisms for environmental remediation – role of plasmids in bioremediation – enhancement of microbial abilities – genetics and gene manipulation strategies – *metagenomics in bioremediation*.	18
IV	Biodegradation of natural polymers: Biodegradation and heterotrophic microbial population in aquatic, terrestrial and arid ecosystems – Degradation of natural polymers - Cellulose, lignin and hemicelluloses. Global environment problems: *The Green house effect*, Ozone depletion, UV radiation and Acid rain.	18
V	Biodegradation of xenobiotic compounds: organic contaminants - Hydrocarbon, halogenated organic solvents, herbicides, pesticides – *Treatment of solid and liquid wastes* – Vermicomposting – Biopackages for biodegradation.	18
VI	Current Trends (For CIA only) – Bio-remediation of soils and water bodies in arid environments, Biodegradable and compostable alternatives to conventional plastics.	

..... Self Study

Text Book(s):
1. D.Alsopp, K.J.Seal and C.Gaylarde, An introduction to Bioremediation, 2 nd edition, Cambridge Univ. Press. 2004.
2. P.Rajendran and P.Gunasekharan, Microbial bioremediation, 1 st edition, MJP Publishers, Chennai, 2000.
3. M.Alexander, Biodegradation and Bioremediation, 1 st edition, Academic Press, 1999.
Reference Book(s):
1. D.Karrelly, K.Chakrabarty, and G.S.Omen, Biotechnology and Biodegradation – Advances in Applied Biotechnology, 4 th edition, Gulf Publications Co. London. 1989.
2. J.T.Cookson, Bioremediation Engineering – Design and Application, 1 st edition, McGraw Hill Inc. 1995.
3. S.N.Jogdand, Environmental Biotechnology, 1 st edition, Himalaya Publishing Company Ltd, 2007.
4. W.C.Baker. and D.S. Herson, Bioremediation, 1 st edition, McGraw Hill, New York, 1994.
Web Resource(s):
1. https://earthclipse.com/energy/bioremediation-types-uses-techniques.html
2. https://microbewiki.kenyon.edu/index.php/Bioremediation
3. https://www.studocu.com/in/document/kannur-university/environmental-biotechnology/biodegradation-of-xenobiotics/29711759

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Describe the in situ and ex situ bioremediation	K2
CO2	Examine the microbes for bioremediation techniques	K3
CO3	Analyze the role of plasmids in bioremediation	K4
CO4	Assess the global environment problems	K5
CO5	Formulate the biodegradation of xenobiotic compounds	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	1	2	2	1	1	1	3	3	1.9
CO2	3	2	2	2	2	2	2	1	2	2	2.0
CO3	3	3	3	3	2	2	3	2	3	2	2.6
CO4	3	3	3	3	3	1	1	1	3	2	2.3
CO5	3	2	1	2	2	1	1	1	2	2	1.7
Mean Overall Score											10.5/5= 2.1
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. N. Packialakshmi

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PMB3CC9	Core - IX	6	5	25	75	100
Course Title		CLINICAL MICROBIOLOGY					

SYLLABUS		
Unit	Contents	Hours
I	Pathological patterns: Mile stones in Clinical Microbiology- Microbial flora of the human body- *Factors responsible for Microbial pathogen* – Host-parasite relationship, Infectious disease process- modes of transmission, factors predisposing to microbial pathogenicity, stages, pathological patterns, virulence, virulence factor, toxin production and infectivity. Epidemiological markers, different carries and sources of infection.	18
II	Bacterial diseases: Description of the infection, pathogenesis, laboratory diagnosis and prophylaxis of the following diseases- Leptospirosis, <i>H. pylori</i> , Pneumonia, *Spotted and typhus fever*, enteric fever, Meningitis, Diphtheria, Tuberculosis, Leprosy, Tetanus, Cholera infection and Syphilis. Antibiotic Resistance – types and mechanisms.	18
III	Fungal diseases: Clinical features, laboratory diagnosis and prophylaxis of following infection: Superficial Mycoses: Ring worm, Candidiasis and Pityriasis versicolor. Subcutaneous mycoses: Mycetoma, Chromoblastomycosis and Sporotrichosis. Systemic mycoses: Coccidioidomycosis, Histoplasmosis, Blastomycosis and Systemic candidiasis. *Fungal keratitis and OHS*.	18
IV	Viral diseases: Description of the viral infections, Vectors, pathogenesis and laboratory diagnosis of following diseases-Reovirus, Hepatitis A, B and C, Papilloma virus, Varicella Zoster virus, Rubella virus, SARS and Swine Flu, Dengue, Ebola, Corona Zika virus and Nipah virus. Oncogenic viruses: DNA containing oncogenic viruses (papova, human adenovirus), RNA containing oncogenic viruses (Human T- cell lymphotropic virus-1). *Anti viral drugs and vaccines*.	18
V	Protozoan diseases: Description of the infections and sample collection. Life cycle, laboratory diagnosis and the treatment of following diseases- <i>Plasmodium vivax</i> , <i>Wuchereria bancrofti</i> , <i>E.hiastolytica</i> , <i>Leishmania donovani</i> , <i>Giardia lamblia</i> , <i>A.lumbricoides</i> , <i>Toxoplasma gondii</i> , <i>Trichomonas vaginalis</i> and * <i>Fasciola hepatica</i> *.	18
VI	Current Trends (For CIA only) – Daily news and research paper collection and recording of recent outbreak of bacterial, fungal, viral, protozoan diseases. Making awareness and celebration of world AIDS day, World TB, Cancer Day, etc., awareness programme on personal hygiene and vaccination.	

** Self Study

Text Book(s):
1. D. Greenwood, R. Slack and J. Peutherer, Medical Microbiology, ChurchHill Living stone Publication, 15 th edition, 2012. 2. Anathanarayanan and C.K. Jayaram Paniker, Text book of Microbiology, University Press, Hyderabad, 8 th edition, 2009. 3. Kenneth J. Ryan, C. George Ray Sherris, Medical Microbiology, McGraw-Hill Medical Publishing Division, New York, 4 th edition, 2014.

Reference Book(s):
1. S.J. Flint, L.W. Enquist, R. Krung, V.R. Racaniello and A.M. Skalka, Principles of Virology, Molecular Biology, Pathogenesis and control, ASM Press, Washinton, 2000. 2. Jawetz, Melnick and Adelberg's, Medical Microbiology, McGraw Hill Medical Publication division, 22 nd edition, 2001. 3. Subhas Chandra Parija. Text book of Medical Parasitology, 2 nd edition, 2004.
Web Resource(s):
1. https://www.healthgrades.com/right-care/infections-and-contagious-diseases/bacterial-diseases 2. www.cdc.gov › fungal › diseases 3. https://www.healthline.com/health/viral-diseases

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Describe the knowledge on infectious diseases and its mode of transmission to various stages of infectivity.	K2
CO2	Identify the study of pathogenic bacteria and its significant factors for causing diseases.	K3
CO3	Examine the knowledge on medically important fungi and its diagnosis methods.	K4
CO4	Determine the disease pathogenesis, lab diagnosis, prophylaxis, control of viral diseases.	K5
CO5	Report the life cycle of protozoan diseases.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	1	3	1	3	2	1	2	3	2.2
CO2	3	2	1	3	1	1	3	2	2	3	2.1
CO3	3	3	3	2	2	3	2	3	3	2	2.6
CO4	3	3	3	2	2	2	3	2	3	2	2.5
CO5	2	3	3	2	2	3	2	3	3	2	2.5
Mean Overall Score											11.9/5= 2.38
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. N.Reehana

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PMB3CC10	Core - X	6	5	25	75	100
Course Title		PRINCIPLES OF IMMUNOLOGY					

SYLLABUS		
Unit	Contents	Hours
I	Immune system: Properties of Immune system- Innate, adaptive and mucosal immunity. Haematopoiesis- T cells, B cells, NK cells, Monocytes, Macrophages, eosinophils, neutrophils, basophils, mast cell, dendritic cells. Lymphoid organs of immune system. Humoral and cell mediated immunity. Induction of immune response- Cytokines, lymphokines and *chemokines*.	18
II	Antigens and Immunoglobulins: Antigens- properties and types. Haptens, adjuvants, *Mitogen (superantigens)*. T dependent and independent antigens. Antigenic determinants. Immunogens and chemical nature. Immunoglobulins- structure, properties, types and subtypes. Monoclonal antibody: production and their applications. Complement- Classical, Alternate and Membrane attack pathways.	18
III	Immune cell activation: B- cell activation, Differentiation and receptor. T cell- Generation, Activation, Differentiation and receptors. Clonal selection Theory and process. Immune regulation mechanisms – immuno-induction, immuno-suppression, immuno-tolerance, immuno-potential, Immunomodulation. Autoimmune disorders and Immunology of infectious diseases – Viral, Bacterial and protozoan and Immunodeficiencies.	18
IV	Regulation of Immune response: MHC genome- Structure, types and function of HLA antigen. MHC antigen processing. History of organ Transplantation and types. HLA typing methods. Graft rejection mechanism. *Graft disease (GVHD)* and immunosuppressive drugs. Hypersensitivity reactions and types. (I to V)	18
V	Immunological techniques: Antigen antibody interaction- Affinity, Avidity and epitope mapping. Theories of Ag-Ab interaction. In vitro immunological methods- Neutralization- VDRL and RPR test. Types and application of agglutination- Ascoli test, coombs test and widal test, Precipitation reaction, Immunodiffusion methods- SRID, ODD, Immunoelectrophoresis- CCIE, RIE. FISH, Viral neutralization test, Immunofluorescent antibody technique. ELISA, Radio immunoassays (RIA) and Flow cytometry. Impact of vaccines, Health, Economic and Social benefits.	18
VI	Current Trends (For CIA only) – Immunomics - Introduction and Applications. Antigen engineering for better immunogenicity and use for vaccine development- multi-epitope vaccines.	

** Self Study

Text Book(s):
1. I. Kannan, Immunology, MJP publications, 2007. 2. S.C. Rastogi, Elements of Immunology, 3rd edition, CBS Publishers & Distributors Pvt. Ltd, 2006. 3. E. J. Gardner M. J. Simmons and D.P. Snusted. Principles of Genetics. (8th Edition). Wiley India Pvt. Ltd. 2006. 4. F.C. Hay and O.M.R. Westwood. Practical Immunology (4th Edition). Wiley-Blackwell 2002.

Reference Book(s):
1. I. M. Roit, Essential Immunology, Blackwell Scientific Publications, Oxford, 2017. 2. J. Kuby, Immunology, 4th edition, WH Freeman and Company, New York, 2013. 3. M Richard Hyde, Immunology, 3rd edition, National Medical series, Williams and Wilkins, Harward Publishing company, 2005.
Web Resource(s):
1. https://nptel.ac.in/courses/102103038/2 2. https://www.microbiologybook.org/mobile/m.immuno-4.htm 3. https://www.amboss.com/us/knowledge/Hypersensitivity_reactions

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Discuss the physiology of the immune system and its biological mechanism that prevent diseases.	K2
CO2	Illustrate the antigen and antibody reaction and its effect on the organisms.	K3
CO3	Classify the immune reaction of B-cell, T-cell and immune regulation mechanisms.	K4
CO4	Predict the process of MHC, hypersensitivity reaction, transplantation.	K5
CO5	Compile the antigen and antibody interaction by using various Immunological techniques.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	1	2	2	2	2	1	2	3	1	2	1.8
CO2	2	2	3	2	2	2	3	3	2	1	2.2
CO3	2	2	2	3	2	3	1	2	1	2	2.0
CO4	2	2	2	2	3	3	1	3	2	2	2.2
CO5	2	2	2	3	3	1	2	2	2	3	2.2
Mean Overall Score											10.4/5=2.08
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. H. Vajiha Banu

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PMB3CC11	Core – XI	6	5	25	75	100
Course Title		ENZYMOLGY					

SYLLABUS		
Unit	Contents	Hours
I	Enzymes and assay: Introduction to Enzymes- Concept of convergent and divergent evolution of enzymes. Nomenclature and classification of enzymes. *Specificity and active site- Lock & key model, Induced fit model*. Fundamentals of enzyme assay – enzyme Units, coupled kinetic assay, immobilized enzymes. Enzyme localization. Criteria of purity of enzymes. Monomeric and oligomeric enzymes- Monomeric enzymes; serine proteases, zymogen activation, multifunctional enzymes, oligomeric enzymes and multi-enzyme complexes	18
II	Mechanism of Enzymes Action: Theories of mechanisms of enzyme action- Enzyme specificity- Active site- Study of Mechanism of enzyme reaction. Pathway of enzyme catalyzed reactions. Enzyme Kinetics. Mechanism of action of lysozyme, chymotrypsin and ribonuclease. *Enzyme inhibition and regulation*.	18
III	Enzyme kinetics: Importance of enzyme kinetics, factors affecting rates of enzyme mediated reactions (pH, temperature, substrate concentration, enzyme concentration and reaction time). Derivation of Michaelis - Menton equation and its significance in enzyme kinetic studies. Lineweaver - Burke plot, Haldane- *Briggs relationship*	18
IV	Enzyme Preparation and Use: Sources of enzymes, Microbial production of enzymes, Media for enzyme production, Preparation of enzymes- Centrifugation, filtration, Cell breakage and Chromatography. Safety and regulatory aspects of enzyme uses. *Industrial application of microbial enzymes*.	18
V	Clinical Application of Enzymes: Enzymes as thrombolytic agents, Anti-inflammatory agents, streptokinase, urokinase, asparaginase, Isoenzymes like creatine kinase and lactate dehydrogenase, aspartate transaminase, alanine transaminases, cholinesterases, phosphatases. Immobilization of enzymes. Biosensors. Enzyme Engineering and site directed mutagenesis, *Designer enzymes*.	18
VI	Current Trends (For CIA only) – Immobilization of Therapeutic Enzymes and application.	

..... Self Study

Text Book(s):
1. S. Shanmugam and T. Sathiskumar, Enzyme Technology, International Pvt Ltd, 2009. 2. L.M. Prescott, J.P. Harley, D.A. Klein, Microbiology, WCB Mc Graw Hill, 2008. 3. S.M. Bhatt, Enzymology and Enzyme Technology. S. Chand Publication, 2011. 4. Trevor Palmer and Philip Bonner, Enzymes: Biochemistry, Biotechnology, Clinical Chemistry, 2nd Edition, East-west Press Pvt Ltd, India, 2008.
Reference Book(s):
1. Athel Cornish Bowden, Principles of Enzyme Kinetics, Portland press, 2004. 2. M.F. Chaplin and C. Bucke, Enzyme Technology, Cambridge University press, 2007 3. Malcolm Dixon and Edwin Clifford Webb. Enzymes. 3rd Edition Academic Press, New York, 2008
Web Resource(s):
1. https://chem.libretexts.org/Bookshelves/Biological_Chemistry/Supplemental_Modules_(Biological_Chemistry)/Enzymes/Enzymatic_Kinetics/Enzyme_Assays 2. https://www.inf.ed.ac.uk/teaching/courses/csb/CSB_lecture_enzyme_kinetics.pdf 3. https://www.easybiologyclass.com/enzyme-cell-immobilization-techniques/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Outline the concept, evolution, classification and purification of enzymes.	K2
CO2	Apply the knowledge on enzyme action and its mechanisms.	K3
CO3	Analyse the importance of enzyme mediated reactions.	K4
CO4	Explain the microbial preparation, use and Industrial application of Enzymes.	K5
CO5	Compile the principle and application of clinical enzymes.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	1	2	2	2	2	1	2	3	1	2	1.8
CO2	2	2	3	2	2	2	3	3	2	1	2.2
CO3	2	2	2	3	2	3	1	2	1	2	2.0
CO4	2	2	2	2	3	3	1	3	2	2	2.2
CO5	2	2	2	3	3	1	2	2	2	3	2.2
Mean Overall Score											10.4/5 = 2.08
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. M. Mohamed Mahroop Raja

Semester	Course Code	Course Category	Hours/Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PMB3CC12P	Core - XII	6	4	20	80	100
Course Title		CLINICAL MICROBIOLOGY, PRINCIPLES OF IMMUNOLOGY AND ENZYMOLOGY - PRACTICAL					

SYLLABUS		
S.No	Contents	Hours
1.	Isolation and identification of pathogenic bacteria from – pus and urine	90
2.	Testing sensitivity of bacteria to antibiotics.	
3.	Assessing Minimum Inhibitory concentration	
4.	Germ tube test	
5.	KOH mount for fungal pathogen	
6.	Haemagglutination slide method- Blood grouping and Rh typing	
7.	Tube agglutination method-WIDAL test	
8.	Latex agglutination- ASO test for RA.	
9.	Double immunodiffusion- identity pattern	
10.	Purification of Immunoglobulins: Ammonium sulphate precipitation.	
11.	Qualitative ELISA-HcG Test demonstration	
12.	Estimation of Alkaline phosphatase from patient's serum	
13.	Alkaline protease Enzyme assay	
14.	Immobilization of enzyme by alginate beads	

Text Book(s):
1. A.Balows, K.L. Hauser Jr, H.D. Isenberg, H.J. Shalomy, Manual of Clinical Microbiology, ASM, Washington, 2007. 2.G.James Cappuccino and N. Sherman, Microbiology: A Laboratory manual, 7 th edition, Benjamin cummings publications, 2004. 3. P.Gerhardt, R.G. Murray, W.A. Wood and N.R. Kruz, Methods for General and Molecular Bacteriology, ASM, Washington, 2008.
Reference Book(s):
1. Karen E. Messley, Microbiology Lab manual, 2 nd Edition, Benjamin cummings Publisher, 2003. 2. V. Lorian, Antibiotics in laboratory medicine, 3 rd edition, Williams and Wilkins, Baltimore, 2011. 3. Eric E. Conn, Paul K. Stumpf, George Bruening and Roy H. Doi, Outlines of Biochemistry, 5th edition, Wiley India Publisher, 2006.
Web Resource(s):
1. https://www.biologydiscussion.com/organism/culture-organism/obtaining-pure-culture-of-microorganisms-6-methods/55042 . 2. https://microbeonline.com/overview-of-biochemical-tests-used-to-identify-bacteria-in-microbiology-laboratory/ 3. https://microbiologyinfo.com/techniques-of-virus-cultivation/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Interpret the isolation and identification of pathogenic bacteria.	K2
CO2	Collect the drug resistant and sensitive bacteria.	K3
CO3	Analyze the antigen and antibody interaction.	K4
CO4	Estimate presence of an enzyme, investigation of specific enzyme kinetics or the activity of inhibition within a sample.	K5
CO5	Report bounding of the enzyme to the matrix in enzyme immobilization.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	2	2	2	3	2	2	2	2	2.2
CO2	2	1	2	3	2	1	2	3	2	2	2.0
CO3	2	2	2	2	2	3	2	2	3	2	2.2
CO4	3	2	1	2	2	2	1	3	2	3	2.1
CO5	2	2	2	2	1	2	2	1	2	2	1.8
Mean Overall Score											10.3/5 = 2.06
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator : Dr. H. Vajiha Banu

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PMB3DE3A	Discipline Specific Elective - III	6	4	25	75	100
Course Title		BIOINFORMATICS					

SYLLABUS		
Unit	Contents	Hours
I	Introduction to Bioinformatics - Definition, History, Web servers, computer systems, languages - machine, high level and assembly. Basics of computers – types, servers, operating systems, UNIX, Linux. Internet basics – internet connection, web browsing and URL. *Finding scientific articles – Pubmed*. Biological databases NCBI, EMBL, DDBJ and Protein Data Bank- Swiss- prot, PIR, SCOP and CATH.	18
II	Sequence Alignments: Pairwise alignment – local, global, dotplot and dynamic programming. Heuristic method- BLAST - blastn, blastp, blastx PSI, PHI and FASTA. Sequence alignment Score – E-Value and P-Value. *Scoring Matrix- BLOSUM, PAM and GAP PENALTY*. Multiple sequence alignment- Progressive, Iterative and block based alignment- Clustalw2.	18
III	Phylogenetic analysis: Phylogenetic tree – Phenetics, Cladistics- rooted, unrooted and Bifurcating. Phylogenetic Tree Construction - Concept of Dendrograms. Evolutionary Trees - Distance Based Tree Reconstruction - Ultrametric trees and Ultrametric distances- Phylogenetic analysis – Neighbor – Joining, Maximum parsimony, minimum likelihood and *UPGMA*.	18
IV	Protein analysis: Primary structure prediction- ProtParam, Secondary structure prediction – Chou and Fassman, GOR method. Protein tertiary structure Prediction- protein modeling and Abinitio. Visualization of protein structure- RASMOL and *SWISS PDB*. Ramachandran plot.	18
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*.	18
VI	Current Trends (For CIA only) – Genome to drug discovery – Subtractive Genomics – Principles of Immunoinformatics and Vaccine Development	

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Text Book(s):
1. D. Higgins and W. Taylor. Bioinformatics: Sequence, structure and databanks, Oxford University Press, 2002.
2. Rastogi S. C., Mendiratta N. and Rastogi P. Bioinformatics - Methods and Applications (Genomics, Proteomics and Drug Discovery). Prentice-Hall of India Pvt. Ltd. 4 th Edition, 2014.
3. J.Ramsden, Bioinformatics an introduction, Springer Publisher, 2006.
Reference Book(s):
1. R. Singh and R. Sharma, Bioinformatics: Basics, algorithms and applications, Universities Press, (India) Pvt. Ltd, Hyderabad, India, 2010.
2. D. Mount, Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, New York, 2004
3. J. Xiong , Essential bioinformatics, Cambridge University Press. First south Indian Edition, 2011.

Web Resource(s):

1. www.bioinformaticssoftwareandtools.co.in.
2. www.bioinformaticsweb.net/datalink.html
3. <https://www.hsls.pitt.edu/obrc/>

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Describe the basic computer and its mode of operation.	K2
CO2	Introspect the knowledge on the various sequence alignment with scoring matrix	K3
CO3	Acquire the knowledge on phylogenetic analysis	K4
CO4	Determine the knowledge of protein structure prediction	K5
CO5	Analyze the concept of Molecular Docking	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	2	2	2	2	1	2	2.0
CO2	2	1	1	2	2	2	2	2	2	2	1.8
CO3	2	2	1	2	3	3	2	2	2	3	2.2
CO4	2	2	2	2	2	2	2	2	2	2	2.0
CO5	3	2	2	2	3	3	2	2	2	2	2.3
Mean Overall Score											10.3/5 = 2.06
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. N.Reehana

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PMB3DE3B	Discipline Specific Elective - III	6	4	25	75	100
Course Title		BIOSAFETY AND IPR					

SYLLABUS		
Unit	Contents	Hours
I	Biosafety: Historical background. Blood borne pathogens (BBP) and laboratory - acquired infections. Introduction to biological safety cabinets. Primary containment for biohazards. Biosafety levels of specific microorganisms. Recommended biosafety. Levels for infectious agents and infected animals.*Case studies - Safe working, hand hygiene*.Laboratory instruments, packing, sending, transport, import and export of biological agents. Hygiene, disinfection, decontamination, sterilization.	18
II	Biosafety Guidelines: Biosafety guidelines and regulation(National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), for GMO applications in food and agriculture; *Environmental release of GMOs*; Risk Analysis, Assessment, different levels, management and communication.	18
III	Bioethics: Definition: Ethical considerations during research; animal testing; xenotransplantation; Embryonic and adult stem cell research. *Informed Consent*, Independent Ethics Committee, Constitution of institutional ethics committee, Conflicts of Interest. General Ethical Concerns for Recombinant Research. Human rights- Ethical guidelines for genetically modified foods.	18
IV	Intellectual Property Rights (IPRs): Concepts of IPR; Types of IP: *patents*; Trademarks, copyright and related rights, industrial design, traditional knowledge, geographical indications. Plagiarism and open access publishing. World Intellectual Property Rights Organization (WIPO).	18
V	Patenting: Basics of Patents. Patent application - forms and guidelines. Patent filing in India and abroad. Filing of a patent application. Patent Co-operation Treaty (PCT); *Gene patent*, Patenting of Living Organisms.	18
VI	Current Trends (For CIA only) – International conventions, Trade agreements, Implication of TRIPS for developing countries.	

**Self Study

Text Book(s):
1. Rajmohan Joshi, Biosafety and Bioethics, Isha Books, New Delhi, 2006. 2. M. K. Sateesh Bioethics and Biosafety, IK International Pvt Ltd. ISBN : 8190675702, 2013. 3. M.Muthuraj and B. Usharani, Biosafety in Microbiological Laboratories. Notion Press. (1 st Edition). (2019). 4. Biosafety in Microbiological and Biomedical Laboratories - U.S. Health Department and Human Services (5 th Edition) Lulu.com. (2016).
Reference Book(s):
1. World Health Organization, Biosafety programme management. (4 th Edition). WHO Publications 2010. 2. Rashid N.. Manual of Laboratory Safety (Chemical, Radioactive, and Biosafety with Biocides) (1 st Edition) 2013. 3 Dayuan X. Biosafety and Regulation for Genetically Modified Organisms, Alpha Science International Ltd, 2015.

Web Resource(s):

1. <https://consteril.com/biosafety-levels-difference/>
2. <https://www.cdc.gov/labs/pdf/CDC-BiosafetymicrobiologicalBiomedicalLaboratories-2009-P.pdf>
3. <https://www.britannica.com/topic/World-Intellectual-Property-Organization>

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Explain the biosafety strategies in laboratory.	K2
CO2	Illustrate the importance of biosafety guidelines.	K3
CO3	Analyze the ethical approaches during animal and human research.	K4
CO4	Summarize the role of IPR, Patent, Trademarks and its importance.	K5
CO5	Construct patent procedure, patent filling and its mapping.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	1	2	2	3	3	2	2	1	2.1
CO2	2	2	2	2	1	2	3	2	2	1	1.9
CO3	1	3	2	2	2	2	2	3	2	2	2.1
CO4	3	2	3	2	1	2	2	1	2	2	2.0
CO5	2	3	2	1	2	3	2	2	2	1	2.0
Mean Overall Score											10.1/5 =2.02
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator : **Dr. H. Vajiha Banu**

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23PMB4CC13	Core - XIII	6	6	25	75	100
Course Title		FOOD MICROBIOLOGY AND FOOD SAFETY					

SYLLABUS		
Unit	Contents	Hours
I	Food Microbiology: Microorganisms important in food microbiology- *Molds, yeasts and Bacteria*- General characteristics- classification and importance. Enumeration of microorganisms in food. Principles of food preservation-physical, chemical preservatives and food additives. Intrinsic factors and Extrinsic affecting microbial growth and survival in food.	18
II	Food contamination and spoilage: Cereals, sugar products, vegetables, fruits, meat and meat products, milk and milk products- fish and fish products- spoilage of canned foods, bakery and *egg products*. Detection and characterization of spoilage. Methods for controlling spoilage of food. Food colour and agents flavouring agents.	18
III	Food-borne infection and intoxications: Bacterial and non-bacterial- with examples of infective and toxic types- <i>Clostridium, Salmonella, Shigella, Staphylococcus, Campylobacter, Listeria</i> , general control measures for prevention of food borne diseases. Non-bacterial: mycotoxins, *viruses*, rickettsia, food-borne parasites, seafood toxicants, poisoning by chemicals, preventive measures.	18
IV	Microbiology of fermented products: Starter cultures and their biochemical activities. Probiotics and Prebiotics use of Lactobacilli, homo and heterolactic fermentations and their therapeutic and nutritional value. Fermented products - acidophilus milk, yoghurt, cheese, kefir, koumiss *breads and idli*. Soy sauce fermentation by Moulds - Fermented vegetables – Sauerkraut - Fermented Meat – Sausages.	18
V	Food Safety: Indicators of food microbial quality and safety - Sanitation, control and inspections. Food adulteration and types. Food safety objectives (FSO), Food safety laws and Food legislation: Principles and guidelines for conducting microbiological risk of food. *Principles and applications of hurdle technology in food industry*. Enforcement and Government Regulatory practices and policies. FDA, BIS, HACCP, FSSAI, 2014.	18
VI	Current Trends (For CIA only) – Develop new strategies for controlling food-borne pathogen in foods by CRISPR technology.	

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Text Book(s):
<ol style="list-style-type: none"> 1. SFrazier and D.C. Westhoff, Food microbiology, TATA McGraw Hill Publishing Company Ltd. New Delhi, 2004. 2. M.R. Adams and M.O. Moss, Food Microbiology, The Royal Society of Chemistry, Cambridge, 2007. 3. Neelima Rajvaidya, Dilip Kumar Markandey, Industrial applications of Microbiology, APH Publishing Corporation, 2006. 4. J.M. Jay, M.J. Loessner and D.A. Golden DA, Modern Food Microbiology, 7th edition, CBS Publishers and Distributors, Delhi, India,2005.

Reference Book(s):
1. G.J. Banwart, Basic food microbiology, Chapman & Hall, New York., 2014. 2. T.J. Montville, K.R. Matthews and K.E. Kniel, Food microbiology an introduction. 3rd edition, ASM Press, 2012. 3. B.M. Lund, A.C. Baird Parker and G.W. Gould, The Microbiological Safety and Quality of Foods, ASPEN Publication, 2000.
Web Resource(s):
1. https://foodsafetyhelpline.com/what-are-the-different-methods-of-food-preservation/ 2. https://www.fightbac.org/food-poisoning/foodborne-pathogens/ 3. https://www.fao.org/3/y5307e/y5307e05.htm

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Understand the principles of preservative agents in food.	K2
CO2	Apply the knowledge on control of contamination and spoilage in food.	K3
CO3	Analyse the bacterial and non-bacterial food borne infection and intoxication.	K4
CO4	Conclude the knowledge on microbes associated fermented products.	K5
CO5	Compile the principles and guidelines for conducting Food safety and quality management system.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	1	2	2	1	2	2	1	3	2	1.8
CO2	3	2	2	3	2	3	2	3	2	3	2.5
CO3	2	2	2	2	3	3	2	2	2	3	2.3
CO4	2	2	2	1	2	2	2	1	3	2	1.9
CO5	1	2	1	2	2	2	1	2	2	2	1.7
Mean Overall Score											10.2/5 = 2.04
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. M. Mohamed Mahroop Raja

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23PMB4CC14	Core - XIV	6	6	25	75	100

Course Title | **INDUSTRIAL MICROBIOLOGY**

SYLLABUS

Unit	Contents	Hours
I	Bioprocess: Concepts and design. History and scope of industrial microbiology. Isolation, primary and secondary screening, preservation and strains improvement of industrially important microorganisms. Design and layout of sterile manufacturing unit. Contamination and Spoilage of Pharmaceutical products - sterile injectable and non-injectable, *ophthalmologic preparation and implants*.	18
II	Bioreactor: Hyper performance bioreactors, industrial bioreactors, fermentor types-mass and energy transfer in bioreactor, rheology, mass transfer and liquid mixing. Performance of standard bioreactors- temperature control-aeration and agitation system, sterilization, oxygen transfer. *Anaerobic fermentor -sampling methods*. Classification of fermentor-stirred aerated fermentor, tower fermentor, airlift fermentor and bubble cap fermentor.	18
III	Upstream Processing: Development of inoculums for fermentation process. Media for industrial fermentation - Formulation, optimization. Sterilization. Stages of upstream - Growth of inoculums, fermenter pre-culture and production fermentation. Maintenance of sterility at critical points during fermentation. *Inoculum preparation*. Types of fermentation- Batch, continuous, dual or multiple, surface, submerged, aerobic and anaerobic.	18
IV	Downstream Processing: Recovery and purification of intracellular and extracellular products. Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration - Physical, chemical and enzymatic methods. Extraction - Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods. Concentration by precipitation, ultra-filtration, *reverse osmosis*. Drying and crystallization.	18
V	Industrial production: Raw material, organism and process involved in the alcohol production -Production of organic acids – Vinegar, Lactic acid, citric acid- Alcoholic beverages- Beer and *Wine production*. Production of antibiotics and applications- Penicillin and Streptomycin, amino acid – L- Glutamic acid and L- Lysine. Enzymes production – Amylase, Pectinase and Protease. Vitamins – Cyanocobalamine and *Riboflavin*.	18
VI	Current Trends (For CIA only) – Production of therapeutically important bio molecules from commercial fungal and bacterial sources.	

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Text Book(s):

1. L.E. Casida, Industrial Microbiology, Wiley Eastern Limited, New Delhi, 2007.
2. A.H. Patel, Industrial Microbiology, 2nd edition, Laxmi Publications, New Delhi, 2016.
3. E.M.T.El-Mansi, C.F.A. Bryce, A.L. Demain, A.R. Allman, Fermentation Microbiology and Biotechnology, 2008.
4. W.Crueger, A.Crueger, Thomas D. Brock. Biotechnology: A Textbook of Industrial Microbiology, 2011.

Reference Book(s):
1. S. Baumberg, I.S. Hunter and P.M. Rhodes, Microbial Products- New approaches, Cambridge Univ. Press, 2001.
2. S.C. Prescott, and C.C. Dunn, Industrial Microbiology, Tata McGraw-Hill Publishing Company limited, New Delhi, 2001.
3. W.B.Hugo and A.D. Russell, Pharmaceutical Microbiology, 7 th edition Blackwell Scientific Publication, Oxford, 2004.
4. P.F. Stanbury, A. Whitaker and S.J. Hall, Principles of Fermentation Technology, 7 th edition, Elsevier Science limited Aditya Books Private Limited, New Delhi, 2001
Web Resource(s):
1. http://www.biologydiscussion.com/biotechnology/bioprocess-technology/bioreactorstypes-6-types-of-bioreactors-used-in-bioprocess-technology/10090-classification/
2. https://www.biologydiscussion.com/industrial-microbiology-2/strain-improvement-of-microorganisms-microbiology/66010
3. https://www.biologydiscussion.com/industrial-microbiology-2/industrial-fermentation-processes-microbiology/55742

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Summarize the concepts studied in isolation, screening, preservation and strain improvement of industrially important microorganisms.	K2
CO2	Apply the knowledge on fermentation media formulation, optimization and types of fermentations.	K3
CO3	Analyse the importance of various types of bioreactor and its control system.	K4
CO4	Explain the process of intra and extracellular product formation.	K5
CO5	Compile the raw material, microorganism and industrial process involved in the production of primary and secondary metabolites	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	2	2	2	2	1	2	2.0
CO2	2	1	1	2	2	2	2	2	2	2	1.8
CO3	2	2	1	2	3	3	2	2	2	3	2.2
CO4	2	2	2	2	2	2	2	2	2	2	2.0
CO5	3	2	2	2	3	3	2	2	2	3	2.4
Mean Overall Score											10.4/5 = 2.08
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. M. Mohamed Mahroop Raja

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23PMB4CC15	Core - XV	6	5	25	75	100
Course Title		BIOFERTILIZER AND BIOPESTICIDES					

SYLLABUS		
Unit	Contents	Hours
I	Introduction to Biofertilizers: Definition, types, advantages and future perspective. Structure and characteristic features of bacterial biofertilizers- <i>Azospirillum</i> , <i>Azotobacter</i> , <i>Bacillus</i> , <i>Pseudomonas</i> , <i>Rhizobium</i> and * <i>Frankia</i> *.	18
II	Cyanobacterial and Fungal biofertilizers: <i>Anabaena</i> , <i>Azolla</i> , <i>Nostoc</i> and * <i>Hapalosiphon</i> *. Fungal biofertilizers- AM mycorrhiza and ectomycorrhiza. Nitrogen fixation- Free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilization and phosphate mobilization, potassium solubilization.	18
III	Biofertilizers production: Strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid bio-fertilizers. FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers. Biofertilizers - Storage, shelf life, quality control and marketing. *Factors influencing the efficacy of biofertilizers*.	18
IV	Biopesticides: History, Importance, scope and potential of biopesticide. Classification -botanicals, bacterial, fungal and viral based bio pesticides. Mechanism of action of <i>Bacillus thuringiensis</i> and <i>Trichoderma viridae</i> as bio-control agents. Virulence, pathogenicity and symptoms of entomopathogenic nematodes.	18
V	Bio-pesticides production: Bacteria, fungi and viruses. Methods of application of biopesticides. Methods of quality control and techniques of biopesticides. Impediments and limitation in production and application of biopesticide.	18
VI	Current Trends (For CIA only) – Current global status of biofertilizers and biopesticides and its policy recommendations.	

..... Self Study

Text Book(s):
1. P.Hyma, Biofertilizers: Commercial Production Technology and Quality Control, First Edition, 2017. 2.N.S. Subba Rao, Bio-fertilizers in Agriculture and Forestry, Med Tech publisher, 4 th Edition, 2017. 3.Dwijendra Singh, Advances in plant biopesticides, SpringerIndia, 2021.
Reference Book(s):
1. S.Kaniyan, K.Kumar and K. Govindarajan, Biofertilizers Technology, Scientific Publishers, 2010. 2.Arun KSharma, Biofertilizers for Sustainable Agriculture, Agrobios (India), 1st edition, 2017 3.Ram Singh, VikasJindal and G.S.Dhaliwal, A Textbook of Integrated Pest Management, Kalyani Publishers, 2013.
Web Resource(s):
1. https://agriculture.nagaland.gov.in/bio-fertilizer/ 2. https://www.ccd.ngo/sustainable-agriculture.html?gclid=EAJaIQobChMI5a-KndCo-wIV2ZZLBR1ozQj9EAAYAiAAEgJW2_D_BwE 3. https://www.epa.gov/pesticides/biopesticides

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Explain the various types of biofertilizer and the scope in its production.	K2
CO2	Develop the cyanobacterial and fungal biofertilizers applications.	K3
CO3	Analyze the biofertilizer production and the quality of packaging, storage and bioefficacy of biofertilizers.	K4
CO4	Evaluate the history, scope, potential and classification of biopesticide.	K5
CO5	Formulate the biopesticides production on a large scale.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	2	3	2	3	2	2	2	2	2.3
CO2	2	2	2	2	1	2	2	1	2	2	1.8
CO3	2	2	2	2	2	3	2	2	3	2	2.2
CO4	3	3	2	2	2	2	2	3	2	3	2.4
CO5	2	3	2	3	2	2	2	3	2	2	2.3
Mean Overall Score											11/5 = 2.2
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. N. Reehana

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23PMB4PW	Project Work	12	8	-	200	200
Course Title Project Work							

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23PCNOC	Mandatory Online Course**	-	1	-	100	100
Course Title Online Course							

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23PMB4EC2	Extra Credit Course - II*	-	*	-	-	-
Course Title Online Course							