FYUGP
2024

DEPARTMENT OF MICROBIOLOGY

Syllabus for

Undergraduate Programmes (Honours)

Under Credit Semester System

Outcome Based Education

with Effect from 2024 Admissions

St Berchmans College
Founded 1922
AUTONOMOUS | College with Potential for Excellence | A+ in the Fifth Cycle of Reaccreditation by NAAC
Changanassery, Kerala, India 686101 | Affiliated to Mahatma Gandhi University, Kottayam

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ACKNOWLEDGEMENT

I extend my sincere appreciation to the esteemed members of Four Year Undergraduate Programme (FYUGP) syllabus development team, whose collective expertise and dedication have been instrumental in shaping the curriculum for the courses in Microbiology.

I extend heartfelt appreciation to all individuals who contributed significantly to the development of FYUGP syllabus. Special recognition goes to the college authorities and the curriculum revision committee for organizing various training programs in preparation for the integration of FYUGP into the curriculum. Sincere gratitude to Prof. Mohammed Hatha Abdulla, Dept. of Marine Biology, Microbiology and Biochemistry, CUSAT has provided invaluable leadership and scholarly insights throughout the syllabus development process. His wealth of experience and profound understanding of academic frameworks have greatly enriched the content of our syllabus. I express my gratitude to Prof. Jyothis Mathew, School of Bioscience, M.G University for his meticulous attention to detail and unwavering commitment to academic excellence. His expertise in the field of Microbiology has significantly contributed to the comprehensive nature of the syllabus.

My heartfelt thanks to Ms. Purnima Gopinathan, IQVIA, Associate Centralized Monitoring Lead, Bangalore for her scholarly contributions and thoughtful inputs. Her dedication to pedagogical innovation and student-centered learning has been invaluable in shaping the syllabus content to meet the diverse needs of our learners. I would like to acknowledge Mr.John Mathayi, Marketing & Business Development/IVDINDO-MIM for providing invaluable insights from a student's perspective. His feedback and recommendations have been instrumental in ensuring that the syllabus remains relevant and engaging for current and future students.

I acknowledge the dedication of our esteemed colleagues within the department for their invaluable contributions to drafting the FYUGP syllabus. We are confident that it will serve as a cornerstone for the intellectual and professional development of our students for years to come.

Dr. Jiji Jacob

Chairperson, Board of Studies

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Ms. Anju Yohanan
Ms. Vincy O Mathews

PROGRAMME OUTCOMES

PO1: Develop in-depth conceptual knowledge and skills in the discipline for vertical growth and scholarly pursuits

PO2: Integrate and apply interdisciplinary knowledge incorporating historical, theoretical, scientific, technological, economic, philosophical, cultural, aesthetic and ethical perspectives to address complex challenges in diverse settings

PO3: Demonstrate communication skills promoting adaptability, collaboration and resilience in global and local contexts

PO4: Develop problem solving skills to transfer the knowledge of methods and systems of different disciplines for a sustainable and egalitarian world order

PO5: Cultivate research skills and innovative and critical thinking to contribute to societal development through the creation of sustainable solutions and advancements in the respective fields

PROGRAMME SPECIFIC OUTCOMES

PSO1: Acquire knowledge on the basics of the microbial world, its significance and current trends in microbiology.

PSO2: Understand the importance of microbiology in environmental, industrial, agricultural, food, pharmaceutical, space, nanotechnology.

PSO3: Extend a sound knowledge in the field of medical microbiology, Immunology, Forensics, Genetics, Molecular biology and Genetic engineering

PSO4: Acquire skills on bioinstrumentation techniques, apply Biostatistics, Bioinformatics and rigorous research methodology, navigate intellectual property rights, and demonstrate ethical conduct in biomedical and public health research.

PSO5: Illustrate the practical knowledge on microbiological techniques and interpret experimental data and develop research skills and ethical principles and preparing them for careers in research, healthcare, industry and environmental management.

OUTLINE OF DISCIPLINE SPECIFIC COURSES

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester I (Course Level: 100 - 199)					
SBU24MB1DSC100	Major/Minor	Microbial Life: Seeing The Unseen	5	75	4
SBU24MB1DSC101	Minor	Biomolecules	5	75	4
Semester II (Course Level: 100 - 199)					
SBU24MB2DSC100	Major/Minor	Perspectives of Microbiology	5	75	4
SBU24MB2DSC101	Minor	Enzymology	5	75	4
Semester III (Course Level: 200 - 299)					
SBU24MB3DSC200	Major	General Microbiology	5	75	4
SBU24MB3DSC201	Major	Microbial Physiology	5	75	4
SBU24MB3DSC202	Minor	Bioinstrumentation and Techniques	5	75	4
Semester IV (Course Level: 200 - 299)					
SBU24MB4DSC200	Major	Essentials of Immunology	5	75	4
SBU24MB4DSC201	Major	Microbial Genetics	5	75	4
SBU24MB4DSC202	Minor	Applied Microbiology	5	75	4
SBU24MB4INT200	Major	Internship	-	-	2
Semester V (Course Level: 300 - 399)					
SBU24MB5DSC300	Major/Minor	Medical Bacteriology	5	75	4
SBU24MB5DSC301	Major/Minor	Industrial Microbiology	5	75	4
Semester VI (Course Level: 300 - 399)					
SBU24MB6DSC300	Major/Minor	Food Microbiology	5	75	4
SBU24MB6DSC301	Major/Minor	Agricultural Microbiology	5	75	4
SBU24MB6DSC302	Major/Minor	Environmental Microbiology	5	75	4
Semester VII (Course Level: 400 - 499)					
SBU24MB7DSC400	Major/Minor	Advanced Immunology	5	75	4
SBU24MB7DSC401	Major/Minor	Molecular Biology and Genetic Engineering	4	60	4
SBU24MB7DSC402	Major/Minor	Microbial Nanotechnology	4	60	4
SBU24MB7DSC403	Major/Minor	Research Methodology and Biostatistics	4	60	4
SBU24MB7DSC404	Major/Minor	IPR and Bioethics	4	60	4
SBU24MB7DSC405	Major/Minor	AMR and One Health Approach	4	60	4
Semester VIII (Course Level: 400 - 499)					
SBU24MB8DSC400	Major	Clinical Microbiology	5	75	4
SBU24MB8DSC401	Major	Pharmaceutical Microbiology	5	75	4
SBU24MB8DSC402	Major	Forensic Biology	5	75	4
SBU24MB8PRJ400	Major	Project			12

OUTLINE OF DISCIPLINE SPECIFIC ELECTIVE COURSES

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester III (Course Level: 200 - 299)					
SBU24MB3DSE200	Elective	Medical Mycology	4	60	4
SBU24MB3DSE201	Elective	Extremophiles, Geo and Astromicrobiology	4	60	4
Semester IV (Course Level: 200 - 299)					
SBU24MB4DSE200	Elective	Medical Parasitology	4	60	4
SBU24MB4DSE201	Elective	Bioinformatics	4	60	4
Semester V (Course Level: 300 - 399)					
SBU24MB5DSE300	Elective	Medical Virology	4	60	4
SBU24MB5DSE301	Elective	Bioprocess Technology	4	60	4
SBU24MB5DSE302	Elective	Emerging and Re-emerging Infections	4	60	4

SBU24MB5DSE303	Elective	Dairy Microbiology	4	60	4
SBU24MB5DSE304	Elective	Microbial Bioremediation	4	60	4
Semester VI (Course Level: 300 - 399)					
SBU24MB6DSE300	Elective	Microbial Quality Control Testing	4	60	4
SBU24MB6DSE301	Elective	Food Safety Management	4	60	4

OUTLINE OF MULTIDISCIPLINARY COURSES (MDC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester I (Course Level: 100 - 199)					
SBU24MB1MDC100	MDC	Fascinating World of Microbes	4	60	3
Semester II (Course Level: 100 - 199)					
SBU24MB2MDC100	MDC	Microbiology in Daily Life	4	60	3
Semester III (Course Level: 200 - 299)					
SBU24MB3MDC200	MDC	Public Health and Emerging Microbial Diseases	3	45	3

OUTLINE OF SKILL ENHANCEMENT COURSES (SEC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester IV (Course Level: 200 - 299)					
SBU24MB4SEC200	SEC	Solid Waste Management	3	45	3
Semester V (Course Level: 300 - 399)					
SBU24MB5SEC300	SEC	Diagnostic Microbiology	3	45	3
Semester VI (Course Level: 300 - 399)					
SBU24MB6SEC300	SEC	Sanitation Microbiology	3	45	3

OUTLINE OF VALUE ADDITION COURSES (VAC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester III (Course Level: 200 - 299)					
SBU24MB3VAC200	VAC	Microbial Products	3	45	3
Semester IV (Course Level: 300 - 399)					
SBU24MB4VAC200	VAC	Microbial Inoculants and Mushroom Cultivation	3	45	3
Semester VI (Course Level: 300 - 399)					
SBU24MB6VAC300	VAC	Environmental Biology and Human Rights	3	45	3

SEMESTER I

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24MB1DSC100	Major/Minor	Microbial Life: Seeing the Unseen	5	75	4
SBU24MB1DSC101	Minor	Biomolecules	5	75	4
SBU24MB1MDC100	MDC	Fascinating World of Microbes	4	60	3

SBU24MB1DSC100: MICROBIAL LIFE: SEEING THE UNSEEN

Type of Course	Major/Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Extend the knowledge on scope and the contributions made by prominent scientist in the field of microbiology	U
CO2	Acquire knowledge on the vast diversity of microorganisms including Bacteria, Archaea, Fungi, Algae, Protozoa and Viruses	U
CO3	Describe the different groups of microorganisms and its beneficial and harmful effects	U
CO4	Acquire knowledge on different instruments used in microbiology laboratory.	U
CO5	Develop the practical skill in microscopy and basic staining techniques	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	1	1	-	-	-	1	-	-	-	-
CO3	-	1	1	-	-	1	-	-	-	-
CO4	1	1	1	1	-	1	-	-	1	-
CO5	-	-	-	-	1	1	-	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	MCQ	Exam 1	Exam 2	
CO1	-	x		x	-	x
CO2	-	x	x	x	-	x
CO3	x	-	x	-	x	x
CO4	-	-	-	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab involvement	Lab test	
CO1	-	-	-	-	-
CO2	-	-	-	-	-
CO3	-	-	-	-	-
CO4	-	-	-	-	-
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Origin and History of Microbiology (13 Hrs)				
Definition and scope of microbiology	1.1	1	3	Lecture with PPT
History of Microbiology-Spontaneous generation. Biogenesis versus abiogenesis	1.2	1	3	Lecture with PPT
Contributions of Antony van Leeuwenhoek, Louis Pasteur	1.3	1	3	Lecture with PPT
Contributions of Robert Koch, Alexander Fleming, Joseph Lister and Edward Jenner	1.4	1	4	Lecture with PPT
Module 2: Diversity of microbial world (8 Hrs)				
Difference between prokaryote and eukaryote.	2.1	2	1	Lecture with PPT
Brief Description of different groups of Microorganisms– Bacteria, Archae, Fungi, Algae, Protozoa and Virus	2.2	2	7	Lecture with PPT
Module 3: Microbiology in daily life (19 Hrs)				
Beneficial Roles: Food industry - bread, Cheese, vinegar, Pharmaceutical industry-Vaccines, Agriculture-biofertilizer, -Rhizobium, Azotobacter and biopesticide-*Bacillus thuringensis*	3.1	3	9	Lecture with PPT
Harmful Roles: Bacterial diseases -*E.coli*, Salmonella , Mycobacterium, Viral diseases-Chicken pox, Nipah, Dengue,Fungal diseases-Candida sp.,Tinea sp., Food spoilage -milk ,fish and meat	3.2	3	5	Lecture with PPT
Neutraceuticals, Probiotics, Prebiotics, Synbiotics	3.3	3	5	Lecture with PPT
Module 4: Bioinstrumentation (5 Hrs)				
Autoclave	4.1	4	1	Lecture with PPT
Hot air oven	4.2	4	1	Lecture with PPT
Laminar air flow, Quebec colony counter,	4.3	4	1	Lecture with PPT
Incubator, Deep freezer, pH meter	4.4	4	1	Lecture with PPT
Water bath, Vortex mixer	4.5	4	1	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Black, J. G. Microbiology: Principles and Explorations. 6th Edition, John Wiley and Sons, Inc., 2013.
2. Ingraham, J. L. and Ingraham, C. A. Introduction to Microbiology: A case history approach. 3rd Edition, Thomson Brooks/Cole, Pacific Grove, Ca, 2004.
3. Lim, D. Microbiology. 3rd Edition; Kendall/Hunt Publishing Co., U.S., 2002.
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9. Salle, A. J. Fundamental Principles of Bacteriology. Dodo Press, 2007.
10. Atlas, R. M. Principles of Microbiology. 2nd Edition. McGraw Hill Education; 2014.
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12. Willey, J. M., Sherwood, L. M. and Woolverton, C. J. Prescott's Microbiology. 8th Edition, McGraw-Hill Higher Education, 2013.
13. Singh, R. P. General Microbiology. Kalyani Publishers, 2021.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Staining Techniques (30 Hrs)				
General rules in microbiology lab	1.1	5	3	Hands on Training
Introduction to laboratory practices.	1.2	5	8	Hands on Training
Preparation of smears for staining.	1.3	5	2	Hands on Training
Introducing the working of bright field microscope	2.1	5	3	Hands on Training
Simple staining	2.2	5	4	Hands on Training
Negative Staining.	2.3	5	4	Hands on Training
LPCB staining of any fungus	2.4	5	4	Hands on Training
Staining of Yeast	2.5	5	2	Hands on Training

Reference

1. Aneja, K. R. Experiments in microbiology, plant pathology, tissue culture and mushroom production technology. 3rd Edition. New Age International (P) Limited, 2001.
2. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. New Age International (P) Limited, New Delhi, 2007.
3. Cappuccino, J. and Sherman, N. Microbiology: A Laboratory Manual. 10th Edition. Benjamin-Cummings Publishing Company, Subs of Addison Wesley Longman, Inc., 2013.
4. Chakraborty, P. and Chakraborty, G. Practical pathology. Vol. 33. Kolkata: New Central Book Agency (P) Ltd., 2005.
5. Dubey, R. C. and Maheswari, D. K. Practical Microbiology. 2nd Edition, S. Chand & Co., New Delhi, 2002.
6. Goldman, E. and Green, L. H. Practical Handbook of Microbiology. 2nd Edition. CRP Press, 2008.
7. Gunasekaran, P. Laboratory manual in microbiology. 2nd Edition, New Age International (P) Limited, New Delhi, 2002.
8. Kalaichelvan, P. T. Microbiology and Biotechnology Laboratory manual. MJP Publishers, Chennai, 2005.
9. Kannan, N. Laboratory manual in general microbiology. 2nd Edition, Panima Publishing Co., New Delhi, 2002.
10. Lammert, J. M. Techniques for Microbiology: A Student Handbook. Benjamin Cummings, 2006.
11. Murugalatha, N., Growther, L., Hena, J. V., Shenpagam, N. H., Anitha, R., Devi, D. K., Rajalakshmi, G. Microbiological techniques. MJP Publishers, Chennai, 2012.

SBU24MB1DSC101: BIOMOLECULES

Type of Course	Major/Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Possess a comprehensive understanding of the structures, functions, and significance of carbohydrates in biological systems.	U
CO2	Understanding of the diverse structures, functions, and biological roles of lipids, encompassing energy storage, membrane structure.	U
CO3	Acquire a profound knowledge of protein structure, function and crucial role in various biological processes.	U
CO4	Acquire a comprehensive knowledge of the structures and functions of DNA and RNA, understanding their pivotal roles in genetic information storage	U
CO5	Skill in employing various chemical tests and techniques to identify the presence of specific types of carbohydrates.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	1	-	-	1
CO2	1	-	-	-	-	1	1	-	-	1
CO3	1	-	1	-	-	1	1	-	-	1
CO4	1	-	1	-	-	1	1	-	-	1
CO5	1	-		-	1	1	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Exam1	Exam 2	
CO1	-	x	x	x	-	x
CO2	-	x	x	x	-	x
CO3	x	x	-	-	x	x
CO4	-	x	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab Involvement	Lab Test	
CO1	-	-	-	-	-
CO2	-	-	-	-	-
CO3	-	-	-	-	-
CO4	-	-	-	-	-
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Carbohydrates (13 Hrs)				
Classification of Carbohydrates. Monosaccharides: D and L forms of glyceraldehyde, Isomerism of carbohydrate	1.1	1	3	Lecture with PPT
Structure (linear and cyclic structures) of glucose, galactose, mannose and fructose.	1.2	1	2	Lecture with PPT
Epimers and Anomers with examples	1.3	1	2	Lecture with PPT
Structure and biological importance of disaccharides- sucrose, lactose, maltose.	1.4	1	2	Lecture with PPT
Structure and important properties of the following structural polysaccharides (cellulose, chitin, pectin).	1.5	1	3	Lecture with PPT
Structure and important properties of the following storage polysaccharides (starch, inulin, glycogen).	1.6	1	1	Lecture with PPT
Module 2: Lipids (9 Hrs)				
Fatty acids: Classification, Physical and chemical properties.	2.1	2	2	Lecture with PPT
Structure of the following fatty acids- stearic acid and oleic acid, Palmitic acid, Saponification number, acid number and iodine number of fats.	2.2	2	2	Lecture with PPT
Lipids: Classification of lipids with examples. Structure of triacylglycerol.	2.3	2	2	Lecture with PPT
Phospholipids: phosphatidyl choline and phosphatidyl ethanolamine and Glycolipids (outline study)	2.4	2	2	Lecture with PPT
Steroids: Structure and functions of cholesterol ergosterol	2.5	2	1	Lecture with PPT
Module 3: Proteins (13 Hrs)				
Structure of 20 standard amino acids – single letter abbreviations of amino acids, non-standard amino acids	3.1	3	3	Lecture with PPT
Classification of amino acids based on charge and polarity. Essential and non-essential amino acids.	3.2	3	2	Lecture with PPT
Ionization of amino acids- zwitter ions.	3.3	3	1	Lecture with PPT
Elementary study of primary, secondary, tertiary and quaternary structure of proteins. Forces stabilizing the structure of protein.	3.4	3	4	Lecture with PPT
Classification of proteins.	3.5	3	3	Lecture with PPT
Module 3: Nucleic acids (10 Hrs)				
Nature of nucleic acids: Structure of purines and pyrimidines. Nucleosides, nucleotides.	4.1	4	3	Lecture with PPT
Structure of Nucleic acids- Watson-Crick DNA double helix structure	4.2	4	3	Lecture with PPT
Types of RNA. Types of DNA	4.3	4	4	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Nelson, David L., Cox, Lehninger. Principles of Biochemistry. Fourth Edition, W. H. Freeman, 2004.
2. West, E.S., Todd, W.R., Mason, H.S., van Bruggen, T. A Textbook of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 2017.
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5. Berg, Jeremy M., Tymoczko, John L., Stryer, Lubert. Biochemistry. 6th Edition, B.I Publications Pvt. Ltd, 2007.
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7. Garrett, Reginald H., Grisham, Charles M. Biochemistry. 5th Edition, Cengage, 2012.
8. Murray, Robert, Bender, David, Botham, Kathleen M., Kennelly, Peter J., Rodwell, Victor, Weil, P. Anthony. Harpers Illustrated Biochemistry. 29th Edition, 2012.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Reactions of Carbohydrates (30 Hrs)				
Reactions of carbohydrate: Molisch's test, Iodine test	1.1	5	4	Hands on Training
Test for reducing sugars (Fehling's test, Benedict's test, Barfoed's test	1.2	5	4	Hands on Training
Seliwanoff's test, Osazone test (only demonstration) for Glucose, Fructose, Lactose, Maltose, xylulose	1.3	5	4	Hands on Training, Demonstration
Polysaccharides-iodine test Starch Dextrin, full saturation and half saturation,	1.4	5	4	Hands on Training
Identification of monosaccharides, disaccharides, polysaccharides, following systematic scheme of analysis	2.1	5	10	Hands on Training
Reactions of carbohydrate: Molisch's test, Iodine test	1.1	5	4	Hands on Training

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1. Hawk, P.B., and B.L. Oser. Hawk's Physiological Chemistry, 14th ed., McGraw Hill Book Company Ltd, New York, 1986.
2. Rao, Beedu Sasidhar, and Vijay Deshpande, editors. Experimental Biochemistry: A Student Companion, I.K International Pvt. Ltd, New Delhi, 2005.
3. Sawhney, S.K., and Randhir Singh, editors. Introductory Practical Biochemistry, Narosa Publishing House, New Delhi, 2005, pp. 15-23, 33-35, 50-57.
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5. Sadasivam, S., and A. Manickam. Biochemical Methods, New Age International (P) Limited, 2008.

SBU24MB1MDC100: FASCINATING WORLD OF MICROBES

Type of Course	MDC		
Course Level	100-199		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	30	30	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Extend knowledge on the history of Microbiology and important personalities who contributed to the development of Microbiology	U
CO2	Describe the diversity of the microbial world and explain the sterilization methods	U
CO3	Explain about the beneficial and harmful role of bacteria.	U
CO4	Acquire skills to identify bacteria, fungi and also examine the quality of milk	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	1	-	-	-	-	1	-	-	-	-
CO3	1	1	1	-	-	1	-	-	-	-
CO4	1	1	-	-	1	1	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	MCQ	Exam 1	Exam 2	
CO1	-		x	x	-	x
CO2	-	x	x	x	x	x
CO3	x	-	-	-	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab Involvement	Lab Test	
CO1	-	-	-	-	-
CO2	-	-	-	-	-
CO3	-	-	-	-	-
CO4	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: History and development of microbiology (13 Hrs)				
History and development of microbiology	1.1	1	4	Lecture with PPT

Spontaneous generation, Biogenesis Vs abiogenesis	1.2	1	5	Lecture with PPT
Contributions of Anton Van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming and Edward Jenner	1.3	1	4	Lecture with PPT
Module 2: Types of microorganisms and sterilization methods (12 Hrs)				
Types of microorganisms -bacteria, fungi, algae, protozoa and virus: A brief description	2.1	2	5	Lecture with PPT
Sterilization -Physical methods- UV radiation, Pasteurization and its types, Hot air oven, Autoclave Disinfectants- Alcohol, Halogens	2.2	2	7	Lecture with PPT
Module 3: Beneficial and harmful role of microbes (20 Hrs)				
Beneficial Roles: Food industry -bread, Cheese, vinegar	3.1	3	3	Lecture with PPT
Pharmaceutical industry -Antibiotics, vaccines,	3.2	3	3	Lecture with PPT
Agriculture – biofertilizer-Rhizobium, Azotobacter Biopesticide-Bacillus thuringensis	3.3	3	3	Lecture with PPT
Harmful Roles: Bacterial diseases -*E.coli* , Salmonella , Mycobacterium	3.5	3	3	Lecture with PPT
Viral diseases -Chicken pox, Nipah, Dengue	3.6	3	3	Lecture with PPT
Fungal diseases -Candida sp., Tinea sp.	3.7	3	3	Lecture with PPT
Food Spoilage-milk, egg	3.8	3	2	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Black, J. G. Microbiology: Principles and Explorations. 6th Edition, John Wiley and Sons, Inc., 2013.
2. Ingraham, J. L. and Ingraham, C. A. Introduction to Microbiology: A case history approach. 3rd Edition, Thomson Brooks/Cole, Pacific Grove, Ca, 2004.
3. Lim, D. Microbiology. 3rd Edition; Kendall/Hunt Publishing Co., U.S., 2002.
4. Madigan, M. T. and Martinko, J. M. Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc., 2006.
5. Pelczar, M. J., Chan, E. C. S. and Kreig, N. R. Microbiology. 5th Edition, Tata McGraw-Hill, New Delhi, 2002.
6. Prescott, L. M., Harley, J. P. and Klein, D. A. Microbiology. 6th Edition. Edition, McGraw Hill Higher Education, 2006.
7. Reed G. Prescott and Dunns Industrial Microbiology. 4th Edition. CBS Publishers and Distributors Pvt Ltd., New Delhi, 2020.
8. Russell A. D., Hugo W. B. Ayliffe G. A. J., Fraise A. P., Lambert P. A. and Maillard J-Y. Principles and practice of disinfection, preservation, and sterilization, 4th Edition. Blackwell Publishing, 2004.
9. Salle, A. J. Fundamental Principles of Bacteriology. Dodo Press, 2007.
10. Atlas, R. M. Principles of Microbiology. 2nd Edition. McGraw Hill Education; 2014.
11. Tortora G. J., Funke B. R. and Case C. L. Microbiology: An Introduction. 12th Edition. Pearson Education Inc., 2016.
12. Willey, J. M., Sherwood, L. M. and Woolverton, C. J. Prescott's Microbiology. 8th Edition, McGraw-Hill Higher Education, 2013.
13. Singh, R. P. General Microbiology. Kalyani Publishers, 2021.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Staining Techniques (30 Hrs)				
Demonstration of Lactobacilli from curd	1.1	4	6	Hands on Training
Demonstration of Gram staining	1.2	4	6	Hands on Training
Lactophenol cotton blue mounting of fungi	1.3	4	6	Hands on Training
Testing the quality of milk (MBRT)	1.4	4	6	Hands on Training
Microscopic demonstration of Nitrogen fixing bacteria – Rhizobium	1.5	4	6	Hands on Training

Reference

1. Aneja, K. R. Experiments in microbiology, plant pathology, tissue culture and mushroom production technology. 3rd Edition. New Age International (P) Limited, 2001.
2. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. New Age International (P) Limited, New Delhi, 2007.
3. Cappuccino, J. and Sherman, N. Microbiology: A Laboratory Manual. 10th Edition. Benjamin-Cummings Publishing Company, Subs of Addison Wesley Longman, Inc., 2013.
4. Chakraborty, P. and Chakraborty, G. Practical pathology. Vol. 33. Kolkata: New Central Book Agency (P) Ltd., 2005.
5. Dubey, R. C. and Maheswari, D. K. Practical Microbiology. 2nd Edition, S. Chand & Co., New Delhi, 2002.
6. Goldman, E. and Green, L. H. Practical Handbook of Microbiology. 2nd Edition. CRP Press, 2008.
7. Gunasekaran, P. Laboratory manual in microbiology. 2nd Edition, New Age International (P) Limited, New Delhi, 2002.
8. Kalaichelvan, P. T. Microbiology and Biotechnology Laboratory manual. MJP Publishers, Chennai, 2005.
9. Kannan, N. Laboratory manual in general microbiology. 2nd Edition, Panima Publishing Co., New Delhi, 2002.
10. Lammert, J. M. Techniques for Microbiology: A Student Handbook. Benjamin Cummings, 2006.
11. Murugalatha, N., Growther, L., Hena, J. V., Shenpagam, N. H., Anitha, R., Devi, D. K., Rajalakshmi, G. Microbiological techniques. MJP Publishers, Chennai, 2012.

SEMESTER II

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24MB2DSC100	Major/Minor	Perspectives of Microbiology	5	75	4
SBU24MB2DSC101	Minor	Enzymology	5	75	4
SBU24MB2MDC100	MDC	Microbiology in Daily Life	4	60	3

SBU24MB2DSC100: PERSPECTIVES OF MICROBIOLOGY

Type of Course	Major/Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe bacterial cell structure and their functions.	U
CO2	Discuss the various methods of sterilization	U
CO3	Classify various types of culture media.	U
CO4	Describe culture methods and preservation techniques	U
CO5	Demonstrate aseptic methods, preparation of media and different isolation methods.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	1	-	-	-
CO2	1	1	-	-	-	1	1	-	-	-
CO3	1	-	-	-	-	1	1	-	-	-
CO4	1	-	-	-	1	1	1	-	-	-
CO5	-	-	-	-	1	-	-	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	MCQ	Exam 1	Exam 2	
CO1	-	x	x	x	-	x
CO2	-	x	-	-	x	x
CO3	-	x	x	x	-	x
CO4	x	-	x		x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab involvement	Lab Test	
CO1	-	-	-	-	
CO2	-	-	-	-	
CO3	-	-	-	-	
CO4	-	-	-	-	
CO5	x	x	x	x	

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Ultrastructure of a bacterial cell (12 Hrs)				
Structure and composition of gram positive and gram negative cell wall, protoplast, spheroplast	1.1	1	4	Lecture with PPT
Structures internal to cell wall- cytoplasmic membrane, mesosomes, ribosomes, plasmids, nuclear material, cell inclusion and endospore.	1.2	1	4	Lecture with PPT
Structure external to cell wall- bacterial flagella-Structure and arrangement, pili, fimbriae, capsule, slime layer and glycocalyx	1.3	1	4	Lecture with PPT
Module 2: Control of Microorganisms (11 Hrs)				
Physical methods- Sunlight, Desiccation,	2.1	2	1	Lecture with PPT
Dry heat-Incineration, Red heat, Flaming, Hot air Oven,	2.2	2	2	Lecture with PPT
Moist heat-Pasteurization, Inspissation, Tyndallization, Autoclave	2.3	2	2	Lecture with PPT
Filtration and Radiation	2.4	2	2	Lecture with PPT
Chemical methods-Alcohol, Aldehydes, Phenols, Halogens, Surface active agent, Metallic salt, Ethylene oxide, Beta Propiolactone	2.6	2	4	Lecture with PPT
Module 3: Culture media (7 Hrs)				
Components of media	3.1	3	1	Lecture with PPT
Classification based on (a) consistency-solid, liquid, semisolid (b) function- Simple media, Complex media, Defined media	3.2	3	2	Lecture with PPT
Special media- Enriched, Enrichment, Selective, Differential, Indicator, Sugar media, Transport and Anaerobic media. (three examples for each media)	3.3	3	4	Lecture with PPT
Module 4: Culture Methods and Preservation (15 Hrs)				
Aerobic culture methods-Streak, Stroke, Stab, Lawn, Serial dilution, Spread plate ,Pour plate	4.1	4	4	Lecture with PPT
Anaerobic culture methods - MacIntosh, Anaerobic chamber, Anaerobic gas Pak, Candle jar method, Pre reduced media.	4.2	4	4	Lecture with PPT
Preservation methods-Short term storage-Mineral oil, serial subculturing, Glycerol stock	4.3	4	2	Lecture with PPT
Long term storage-Lyophilisation, Liquid nitrogen	4.4	4	4	Lecture with PPT
Fungal preservation method	4.5	4	1	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Black, J. G. Microbiology: Principles and Explorations. 6th Edition, John Wiley and Sons, Inc., 2013.

2. Ingraham, J. L. and Ingraham, C. A. Introduction to Microbiology: A case history approach. 3rd Edition, Thomson Brooks/Cole, Pacific Grove, Ca, 2004.
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8. Russell A. D., Hugo W. B. Ayliffe G. A. J., Fraise A. P., Lambert P. A. and Maillard J-Y. Principles and practice of disinfection, preservation, and sterilization, 4th Edition. Blackwell Publishing, 2004.
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11. Tortora G. J., Funke B. R. and Case C. L. Microbiology: An Introduction. 12th Edition. Pearson Education Inc., 2016.
12. Willey, J. M., Sherwood, L. M. and Woolverton, C. J. Prescott's Microbiology. 8th Edition, McGraw-Hill Higher Education, 2013.
13. Singh, R. P. General Microbiology. Kalyani Publishers, 2021.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Culture media (15 Hrs)				
Basal media – Nutrient broth, nutrient agar	1.1	5	3	Hands on Training
Differential media- MacConkey agar.	1.2	5	3	Hands on Training
Enriched media- Blood agar, chocolate agar.	1.3	5	3	Hands on Training
Dispensing media in test tubes and petridish	1.4	5	3	Hands on Training
Preparation of agar slants, agar deeps and agar plates	1.5	5	3	Hands on Training
Module 7: Culture methods (15 Hrs)				
Streak Plate method	2.1	5	5	Hands on Training
Stab, Stroke, Lawn	2.2	5	5	Hands on Training
Spread plate, Pour plate	2.3	5	5	Hands on Training

Reference

1. Aneja, K. R. Experiments in microbiology, plant pathology, tissue culture and mushroom production technology. 3rd Edition. New Age International (P) Limited, 2001.
2. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. New Age International (P) Limited, New Delhi, 2007.
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5. Dubey, R. C. and Maheswari, D. K. Practical Microbiology. 2nd Edition, S. Chand & Co., New Delhi, 2002.
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11. Murugalatha, N., Growther, L., Hena, J. V., Shenpagam, N. H., Anitha, R., Devi, D. K., Rajalakshmi, G. Microbiological techniques. MJP Publishers, Chennai, 2012

SBU24MB2DSC101: ENZYMOLOGY

Type of Course	Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Acquire knowledge on enzyme function, kinetics, and their diverse roles in biological systems.	U
CO2	Discuss the quantitative aspects of enzyme-catalyzed reactions, including understanding the Michaelis-Menten equation, enzyme inhibition, and kinetic parameters.	U
CO3	Demonstrate a comprehensive understanding of the diverse mechanisms of enzymes	U
CO4	Discuss the regulatory mechanisms governing enzyme activity.	U
CO5	Develop the skill in isolation of enzymes and estimate the enzyme activity.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	1	-	1	1	-	1	1
CO2	1	-	-	1	-	1	1	-	1	1
CO3	1	-	-	1	-	1	1	-	1	1
CO4	1	-	-	1	-	1	1	-	1	1
CO5	1	-	-	1	1	1	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	Viva voce	Exam 1	Exam 2	
CO1	-	x	x	x	-	x
CO2	-	-	x	-	x	x
CO3	-	x	x	x	-	x
CO4	-	x	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab Involvement	Lab Test	
CO1	-	-	-	-	
CO2	-	-	-	-	
CO3	-	-	-	-	
CO4	-	-	-	-	
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to enzymes (15 Hrs)				
Classification and nomenclature of enzymes.	1.1	1	4	Lecture with PPT
Activation energy, Transition state stabilization, Features of the active site.	1.2	1	3	Lecture with PPT
Interaction between enzyme and substrate- Lock and Key model, induced fit model. enzyme specificity	1.3	1	3	Lecture with PPT
Coenzymes and their functions- NAD, FAD, FMN, TPP, PLP.	1.4	1	4	Lecture with PPT
Definition of IU, katal, enzyme turnover number and specific activity.	1.5	1	1	Lecture with PPT
Module 2: Enzyme Kinetics (10 Hrs)				
Factors affecting the velocity of enzyme-catalysed reaction (explanation with graphical representation)	2.1	2	3	Lecture with PPT
Michaelis- Menten equation, Vmax, Km value, and its significance. (without derivation)	2.2	2	4	Lecture with PPT
Lineweaver - Burk double reciprocal plot	2.3	2	3	Lecture with PPT
Module 3: Enzyme Inhibition (8 Hrs)				
Enzyme inhibition- Introduction, Reversible and irreversible, Reversible- Competitive, noncompetitive and uncompetitive.	3.1	3	7	Lecture with PPT
Feedback inhibition.	3.2	3	1	Lecture with PPT
Module 4: Allosteric Enzymes, Isoenzymes and Application of enzymes (12 hrs)				
Allosteric enzymes; allosteric regulation: example of aspartate transcarbamylase.	4.1	4	5	Lecture with PPT
Isoenzymes- lactate dehydrogenase and creatine phosphokinase	4.2	4	3	Lecture with PPT
Immobilized enzymes.	4.3	4	2	Lecture with PPT
Industrial uses of enzymes	4.4	4	2	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Palmer, T., & Bonner, P. Enzymes: Biotechnology, Clinical Chemistry. 2nd ed., Horwood Publishing Limited.
2. Price, N. C., & Stevens, L. Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins. Oxford University Press.
3. Voet, D., & Voet, J. G. Biochemistry. John Wiley & Sons Inc.
4. Nelson, D. L., & Cox, M. M. Lehninger Principles of Biochemistry. W. H. Freeman, 2017.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Isolation and Estimation of Enzymes (30 Hrs)				
Acid phosphatase from Fresh Potato (*Solanum tuberosum*)	1.1	5	10	Hands on Training
β- amylase from Sweet potato (*Ipomoea batatas*)	1.2	5	10	Hands on Training
Assay of β- amylase	1.3	5	10	Hands on Training

Reference

1. Seedu Sasidhar Rao (author) & Vijay Deshpande (ed). Experimental Biochemistry: A Student Companion. I.K International Pvt. Ltd, 2005. ISBN 81-88237-41-8.
2. S. K. Sawhney & Randhir Singh (eds). Introductory Practical Biochemistry. Narosa Publishing House, 2001. ISBN 81-7319-302-9, pp. 110-155.
3. S. K. Thimmaiah (ed). Standard Methods of Biochemical Analysis. Kalyani Publishers, 2016. ISBN 81-7663-067-5, pp. 184-255.
4. S. Sadasivam and A. Manickam. Biochemical Methods. New Age International (P) Limited, 2008. ISBN 9788122421407.

SBU24MB2MDC100: MICROBIOLOGY IN DAILY LIFE

Type of Course	MDC		
Course Level	100-199		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	30	30	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the basic concepts of food microbiology.	U
CO2	Describe water enumeration methods, water borne diseases and water sanitation.	U
CO3	Acquire knowledge on types and transmission of infectious diseases and immunoprophylaxis	U
CO4	Acquire skill on production of wine, mushroom and bacteriological examination of potable water.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	-	-	-	1	-	-	-	-
CO2	1	1	-	-	-	1	1	-	-	-
CO3	1	-	1	-	-	1	1	-	-	1
CO4	1	1	-	-	1	1	-	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	MCQ	Exam 1	Exam 2	
CO1	x	-	x	x	-	x
CO2	x	x	x	x	x	x
CO3	-	x	x	-	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab Involvement	Lab Test	
CO1	-	-	-	-	-
CO2	-	-	-	-	-
CO3	-	-	-	-	-
CO4	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Food Microbiology (14 Hrs)				
Production of Single Cell Protein -Spirullina	1.1	1	2	Lecture with PPT

Production of Mushroom	1.2	1	3	Lecture with PPT
Production of Wine and Beer	1.3	1	3	Lecture with PPT
Prebiotics, Probiotics and Synbiotics	1.4	1	3	Lecture with PPT
Food borne illness- Botulism and Salmonellosis	1.5	1	3	Lecture with PPT
Module 2: Water Microbiology (15 Hrs)				
Water borne diseases-Cholera, Typhoid, Shigella dysentery	2.1	2	5	Lecture with PPT
Viral diseases -Hepatitis A, Rotavirus	2.2	2	3	Lecture with PPT
Faecal Indicators of water pollution, Bacteriological Examination of water- MPN, SPC	2.3	2	3	Lecture with PPT
Sanitation of Water	2.4	2	4	Lecture with PPT
Module 3: Medical Microbiology (16 Hrs)				
Infections-Classification of infections, Sources of infections	3.1	3	6	Lecture with PPT
Methods of transmission and types of infectious diseases	3.2	3	5	Lecture with PPT
Vaccines- types, toxoids and adjuvants. Immunoprophylaxis	3.3	3	5	Lecture with PPT
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Black, J. G. Microbiology: Principles and Explorations. 6th Edition, John Wiley and Sons, Inc., 2013.
2. Ingraham, J. L. and Ingraham, C. A. Introduction to Microbiology: A case history approach. 3rd Edition, Thomson Brooks/Cole, Pacific Grove, Ca, 2004.
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4. Madigan, M. T. and Martinko, J. M. Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc., 2006.
5. Pelczar, M. J., Chan, E. C. S. and Kreig, N. R. Microbiology. 5th Edition, Tata McGraw-Hill, New Delhi, 2002.
6. Prescott, L. M., Harley, J. P. and Klein, D. A. Microbiology. 6th Edition. Edition, McGraw Hill Higher Education, 2006.
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8. Russell A. D., Hugo W. B. Ayliffe G. A. J., Fraise A. P., Lambert P. A. and Maillard J-Y. Principles and practice of disinfection, preservation, and sterilization, 4th Edition. Blackwell Publishing, 2004.
9. Salle, A. J. Fundamental Principles of Bacteriology. Dodo Press, 2007.
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13. Singh, R. P. General Microbiology. Kalyani Publishers, 2021.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: (30 Hrs)				
Production of Mushroom	1.1	4	8	Hands on training
Production of Wine	1.2	4	7	Hands on training
Bacteriological analysis of potable water-MPN	1.3	4	10	Hands on training
Demonstration of *E coli* on EMB agar	1.4	4	5	Hands on training

Reference

1. Aneja, K. R. Experiments in microbiology, plant pathology, tissue culture and mushroom production technology. 3rd Edition. New Age International (P) Limited, 2001.
2. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. New Age International (P) Limited, New Delhi, 2007.
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6. Goldman, E. and Green, L. H. Practical Handbook of Microbiology. 2nd Edition. CRP Press, 2008.
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SEMESTER III

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24MB3DSC200	Major	General Microbiology	5	75	4
SBU24MB3DSC201	Major	Microbial Physiology	5	75	4
SBU24MB3DSC202	Minor	Bioinstrumentation and Techniques	5	75	4
SBU24MB3DSE200	Elective	Medical Mycology	4	60	4
SBU24MB3DSE201	Elective	Extremophiles, Geo and Astromicrobiology	4	60	4
SBU24MB3MDC200	MDC	Public Health and Emerging Microbial Disease	3	45	3
SBU24MB3VAC200	VAC	Microbial Products	3	45	3

SBU24MB3DSC200: GENERAL MICROBIOLOGY

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the working principles of different microscopes and its applications.	U
CO2	Explain different staining techniques.	U
CO3	Describe the taxonomy and identification of bacteria by cultural, physiological and biochemical methods.	U
CO4	Discuss the classification and mode of action of antibiotics	U
CO5	Perform basic experiments in the laboratory to characterize microorganisms	A

Cognitive Levels R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	1	--	1	-	-	-	-
CO2	1	-	-	-	1	1	-	-	-	-
CO3	1	-	-	-	1	1	-	-	-	-
CO4	1	-	-	-	-	1	-	-	-	-
CO5	1	-	-	-	1	1	-	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Viva voce	Work Book	Exam 1	Exam 2	
CO1	x	x	x	x	-	x
CO2	x	x	x	-	x	x
CO3	-	x	-	x	x	x
CO4	-	x	-	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab involvement	Lab Test	
CO1	-	-	-	-	
CO2	-	-	-	-	
CO3	-	-	-	-	
CO4	-	-	-	-	
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Microscopy (13 Hrs)				
Principles and applications of Bright field and dark field microscope	1.1	1	3	Lecture with PPT
Phase contrast, Fluorescence, confocal microscope, Atomic Force microscopy	1.2	1	4	Lecture with PPT
Electron Microscope-SEM & TEM	1.3	1	4	Lecture with PPT
Specimen preparation of electron microscopy-ultra sectioning, shadowing, negative staining and Freeze etching	1.4	1	2	Lecture with PPT
Module 2: Staining Techniques (12 Hrs)				
Stains- Acidic, basic and neutral stains	2.1	2	3	Lecture with PPT
Staining techniques-simple staining, differential staining-Gram staining and Acid fast staining	2.2	2	4	Lecture with PPT
Structural staining- endospore, flagella, capsule, granule and negative staining	2.3	2	3	Lecture with PPT
Motility of bacteria-Wet mount and hanging drop method	2.4	2	2	Lecture with PPT
Module 3: Principles of bacterial taxonomy and Identification of bacteria (15 Hrs)				
Cultural and Physiological characterization	3.1	3	2	Lecture with PPT
Biochemical reactions- IMViC, TSI, Urease, Catalase, Oxidase, Amylase production test	3.2	3	3	Lecture with PPT
Elements of Taxonomy-Binomial Nomenclature	3.3	3	2	Lecture with PPT
Brief account on Identification -classical and molecular characteristics.	3.4	3	3	Lecture with PPT
Levels of classification – Classification system, Polyphasic Taxonomy, Taxonomic Ranks. Brief description of Bergeys Manual.	3.5	3	5	Lecture with PPT
Module 4: Antibiotics and classification (5 Hrs)				
Antibiotics-Classification and brief account on mechanism of action with one example each	4.1	4	3	Lecture with PPT
Drug resistance mechanisms and antibiotic sensitivity tests.	4.2	4	2	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Black, J. G. Microbiology: Principles and Explorations. 6th Edition, John Wiley and Sons, Inc., 2013.
2. Ingraham, J. L. and Ingraham, C. A. Introduction to Microbiology: A case history approach. 3rd Edition, Thomson Brooks/Cole, Pacific Grove, Ca, 2004.
3. Lim, D. Microbiology. 3rd Edition; Kendall/Hunt Publishing Co., U.S., 2002.
4. Madigan, M. T. and Martinko, J. M. Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc., 2006.

5. Pelczar, M. J., Chan, E. C. S. and Kreig, N. R. Microbiology. 5th Edition, Tata McGraw-Hill, New Delhi, 2002.
6. Prescott, L. M., Harley, J. P. and Klein, D. A. Microbiology. 6th Edition. Edition, McGraw Hill Higher Education, 2006.
7. Reed G. Prescott and Dunns Industrial Microbiology. 4th Edition. CBS Publishers and Distributors Pvt Ltd., New Delhi, 2020.
8. Russell A. D., Hugo W. B. Ayliffe G. A. J., Fraise A. P., Lambert P. A. and Maillard J-Y. Principles and practice of disinfection, preservation, and sterilization, 4th Edition. Blackwell Publishing, 2004.
9. Salle, A. J. Fundamental Principles of Bacteriology. Dodo Press, 2007.
10. Atlas, R. M. Principles of Microbiology. 2nd Edition. McGraw Hill Education; 2014.
11. Tortora G. J., Funke B. R. and Case C. L. Microbiology: An Introduction. 12th Edition. Pearson Education Inc., 2016.
12. Willey, J. M., Sherwood, L. M. and Woolverton, C. J. Prescott's Microbiology. 8th Edition, McGraw-Hill Higher Education, 2013.
13. Singh, R. P. General Microbiology. Kalyani Publishers, 2021.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Staining and Biochemicals (30 Hrs)				
Grams stain	1.1	5	2	Hands on Training
Negative stain	1.2	5	2	Hands on Training
Capsule stain (Maneval method)	1.3	5	2	Hands on Training
Granule stain (Alberts method)	1.4	5	2	Hands on Training
Endospore staining	1.5	5	2	Hands on Training
Motility test- Hanging drop technique	1.6	5	2	Hands on Training
Fungal staining- Lactophenol cotton blue	1.7	5	3	Hands on Training
IMViC test	2.1	5	3	Hands on Training
Triple sugar iron agar test	2.2	5	2	Hands on Training
Urease test	2.3	5	2	Hands on Training
Catalase test	2.4	5	3	Hands on Training
Oxidase test	2.5	5	3	Hands on Training
Amylase production test	2.6	5	2	Hands on Training

Reference

1. Aneja, K. R. Experiments in microbiology, plant pathology, tissue culture and mushroom production technology. 3rd Edition. New Age International (P) Limited, 2001.
2. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. New Age International (P) Limited, New Delhi, 2007.
3. Cappuccino, J. and Sherman, N. Microbiology: A Laboratory Manual. 10th Edition. Benjamin-Cummings Publishing Company, Subs Of Addison Wesley Longman, Inc., 2013.
4. Chakraborty, P. and Chakraborty, G. Practical pathology. Vol. 33. Kolkata: New Central Book Agency (P) Ltd., 2005.
5. Dubey, R. C. and Maheswari, D. K. Practical Microbiology. 2nd Edition, S. Chand & Co., New Delhi, 2002.
6. Goldman, E. and Green, L. H. Practical Handbook of Microbiology. 2nd Edition. CRP Press,

2008.
7. Gunasekaran, P. Laboratory manual in microbiology. 2nd Edition, New Age International (P) Limited, New Delhi, 2002.
8. Kalaichelvan, P. T. Microbiology and Biotechnology Laboratory manual. MJP Publishers, Chennai, 2005.
9. Kannan, N. Laboratory manual in general microbiology. 2nd Edition, Panima Publishing Co., New Delhi, 2002.
10. Lammert, J. M. Techniques for Microbiology: A Student Handbook. Benjamin Cummings, 2006.
11. Murugalatha, N., Growther, L., Hena, J. V., Shenpagam, N. H., Anitha, R., Devi, D. K., Rajalakshmi, G. Microbiological techniques. MJP Publishers, Chennai, 2012

SBU24MB3DSC201: MICROBIAL PHYSIOLOGY

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Illustrate nutritional requirements and different mechanisms used for uptake of nutrients.	U
CO2	Explain the bacterial reproduction, growth pattern, enumeration methods and the effect of environmental parameters on bacterial growth.	U
CO3	Interpret the concepts of aerobic and anaerobic respiration and mechanism of energy conservation in microbial metabolism.	U
CO4	Describe the concepts of photosynthesis in prokaryotes	U
CO5	Practice different isolation and enumeration methods.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	-	-	-	1	-	-	-	1
CO2	1	1	-	-	1	1	-	-	-	1
CO3	1	1	-	-	-	1	-	-	-	1
CO4	1	1	-	-	-	1	-	-	-	1
CO5	1	1	-	-	1	1	-	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Viva voce	Work Book	Exam 1	Exam 2	
CO1	x	x	x	x	-	x
CO2	x	x	-	x	x	x
CO3		x	-	-	x	x
CO4		x	x	-	-	x
CO5	-	-		-	-	

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab involvement	Lab Test	
CO1	-	-	-	-	
CO2	-	-	-	-	
CO3	-	-	-	-	
CO4	-	-	-	-	
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Nutritional requirements and uptake of nutrients in bacteria (5 Hrs)				
Nutritional requirements – Physical factors and chemical factors - Macronutrients, micronutrients and growth factors.	1.1	1	1	Lecture with PPT
Uptake of nutrients in bacteria-Passive diffusion facilitated diffusion	1.2	1	1	Lecture with PPT
Nutritional Types – based on carbon, energy and electron source.	1.3	1	2	Lecture with PPT
Active transport and group translocation, Siderophores	1.2	1	1	Lecture with PPT
Module 2: Growth and reproduction in bacteria (14 Hrs)				
Modes of cell division in bacteria - binary fission	2.1	2	3	Lecture with PPT
Bacterial growth curve and generation time- Batch culture	2.2	2	2	Lecture with PPT
Continuous culturing methods in bacteria – Chemostat and Turbidostat	2.3	2	3	Lecture with PPT
Enumeration methods in bacteria- SPC, Direct microscopic count and turbidometric estimation	2.4	2	2	Lecture with PPT
Effect of environmental factors on bacterial growth - temperature, pH, salinity, oxygen, water activity, radiation.	2.5	2	4	Lecture with PPT
Module 3: Microbial metabolism (16 Hrs)				
Microbial metabolism- Glycolysis, Kreb's cycle	3.1	3	3	Lecture with PPT
Pentose Phosphate Pathway, gluconeogenesis, ED pathway.	3.2	3	4	Lecture with PPT
Substrate level phosphorylation	3.3	3	1	Lecture with PPT
Electron Transport chain	3.4	3	3	Lecture with PPT
Oxidative phosphorylation	3.5	3	1	Lecture with PPT
Fermentation- alcoholic fermentation, homo and hetero-lactic acid fermentation	3.6	3	3	Lecture with PPT
Mixed acid fermentation	3.7	3	1	Lecture with PPT
Module 4: Photosynthetic prokaryotes (10 Hrs)				
Photosynthetic microorganisms	4.1	4	2	Lecture with PPT
Photosynthetic pigments and apparatus in prokaryotes	4.2	4	3	Lecture with PPT
Photosynthetic mechanism- cyclic and non-cyclic photophosphorylation	4.3	4	3	Lecture with PPT
Calvin cycle	4.4	4	2	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. 1.Black, J. G. Microbiology: Principles and Explorations. 6th Edition, John Wiley and Sons, Inc., 2013.
2. 2.Ingraham, J. L. and Ingraham, C. A. Introduction to Microbiology: A case history approach. 3rd Edition, Thomson Brooks/Cole, Pacific Grove, Ca, 2004.

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4. 4.Madigan, M. T. and Martinko, J. M. Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc., 2006.
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6. 6.Prescott, L. M., Harley, J. P. and Klein, D. A. Microbiology. 6th Edition. Edition, McGraw Hill Higher Education, 2006.
7. 7.Reed G. Prescott and Dunns Industrial Microbiology. 4th Edition. CBS Publishers and Distributors Pvt Ltd., New Delhi, 2020.
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9. 9.Salle, A. J. Fundamental Principles of Bacteriology. Dodo Press, 2007.
10. 10.Atlas, R. M. Principles of Microbiology. 2nd Edition. McGraw Hill Education; 2014.
11. 11.Tortora G. J., Funke B. R. and Case C. L. Microbiology: An Introduction. 12th Edition. Pearson Education Inc., 2016.
12. 12.Willey, J. M., Sherwood, L. M. and Woolverton, C. J. Prescott's Microbiology. 8th Edition, McGraw-Hill Higher Education, 2013.
13. 13.Singh, R. P. General Microbiology. Kalyani Publishers, 2021.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Microbiological Techniques (30 Hrs)				
Serial dilution	1.1	5	3	Hands on Training
Spread plate	1.2	5	3	Hands on Training
Pour plate	1.3	5	3	Hands on Training
Streak plate.	1.4	5	2	Hands on Training
Stroke culture	1.5	5	1	Hands on Training
Lawn culture	1.6	5	2	Hands on Training
Stab culture	1.7	5	1	Hands on Training
Haemocytometer	2.1	5	8	Hands on Training
Determination of growth curve of *E. coli*	2.2	5	7	Hands on Training

Reference

1. Aneja, K. R. Experiments in microbiology, plant pathology, tissue culture and mushroom production technology. 3rd Edition. New Age International (P) Limited, 2001.
2. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. New Age International (P) Limited, New Delhi, 2007.
3. Cappuccino, J. and Sherman, N. Microbiology: A Laboratory Manual. 10th Edition. Benjamin-Cummings Publishing Company, Subs Of Addison Wesley Longman, Inc., 2013.
4. Chakraborty, P. and Chakraborty, G. Practical pathology. Vol. 33. Kolkata: New Central Book Agency (P) Ltd., 2005.
5. Dubey, R. C. and Maheswari, D. K. Practical Microbiology. 2nd Edition, S. Chand & Co., New Delhi, 2002.
6. Goldman, E. and Green, L. H. Practical Handbook of Microbiology. 2nd Edition. CRP Press, 2008.

7. Gunasekaran, P. Laboratory manual in microbiology. 2nd Edition, New Age International (P) Limited, New Delhi, 2002.
8. Kalaichelvan, P. T. Microbiology and Biotechnology Laboratory manual. MJP Publishers, Chennai, 2005.
9. Kannan, N. Laboratory manual in general microbiology. 2nd Edition, Panima Publishing Co., New Delhi, 2002.
10. Lammert, J. M. Techniques for Microbiology: A Student Handbook. Benjamin Cummings, 2006.
11. Murugalatha, N., Growther, L., Hena, J. V., Shenpagam, N. H., Anitha, R., Devi, D. K., Rajalakshmi, G. Microbiological techniques. MJP Publishers, Chennai, 2012

SBU24MB3DSC202: BIOINSTRUMENTATION AND TECHNIQUES

Type of Course	Minor		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain different separation techniques.	U
CO2	Describe the principle and applications of colorimetric and spectrophotometric techniques.	U
CO3	Illustrate various blotting techniques.	U
CO4	Discuss on basic concepts of different molecular techniques and its applications.	U
CO5	Acquire skills in various instrumentation techniques.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	1	1	1	-	-	-	1
CO2	-	-	-	1	1	1	-	-	-	1
CO3	-	-	-	1	1	1	-	-	-	1
CO4	-	-	-	1	1	1	-	-	-	1
CO5	-	-	-	-	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Viva voce	Work Book	Exam 1	Exam 2	
CO1		x	x	x		x
CO2	x	x			x	x
CO3		x	x	x		x
CO4	x	x			x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab involvement	Lab Test	
CO1	-	-	-	-	
CO2	-	-	-	-	
CO3	-	-	-	-	
CO4	-	-	-	-	
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Separation Techniques (12 Hrs)				
Chromatography-Paper, TLC	1.1	1	3	Lecture with PPT
Centrifugation -differential and density gradient centrifugation	1.2	1	4	Lecture with PPT
Electrophoresis- Principle and methods of AGE, PAGE and SDS PAGE	1.3	1	5	Lecture with PPT
Module 2: Spectrophotometric Techniques (14 Hrs)				
Basic principles and application of colorimetry and turbidometry. Beer Lambert's Law.	2.1	2	6	Lecture with PPT
Spectrophotometry: Principles, working and application – UV Visible Spectrophotometry	2.2	2	8	Lecture with PPT
Module 3: Blotting Techniques (5 Hrs)				
Southern blotting	3.1	3	2	Lecture with PPT
Northern blotting	3.2	3	1	Lecture with PPT
Western blotting	3.3	3	2	Lecture with PPT
Module 4: Introduction to molecular techniques (14 Hrs)				
PCR, RT PCR- Steps and application. Gel documentation system.	4.1	4	6	Lecture with PPT
Molecular markers - RFLP, RAPD, VNTR.	4.2	4	4	Lecture with PPT
DNA sequencing- Maxam and Gilbert method, Sanger chain termination method	4.3	4	4	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference:

1. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. Prescott, Harley, and Klein's Microbiology. McGraw-Hill, 2008.
2. Mohan P. Arora. Biophysics. Himalaya Publishing House.
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4. Wilson, K., & Walker, J. M., editors. Practical Biochemistry: Principles and Techniques. Cambridge University Press, 2000.
5. Boyer, R. Modern Experimental Biochemistry. Pearson Education India, 2000.
6. Singh, B. D. Biotechnology. Campus Books International, 2005.
7. Karp, G. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons, 2009.
8. Jogdand, S. N. Gene Biotechnology. Himalaya Publishing House, 2009.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Separation of Aminoacids and Estimation of DNA (30 Hrs)				
Separation of aminoacids- Paper Chromatography	1.1	5	5	Hands on Training
Estimation of DNA by colorimetric method.	1.2	5	10	Hands on Training
DNA Isolation	1.3	5	10	Hands on Training
Agarose Gel Electrophoresis	1.4	5	5	Hands on Training

Reference

1. Rao, Beedu Sasidhar, and Vijay Deshpande, eds. Experimental Biochemistry: A Student Companion. I.K International Pvt. LTD, 2005.
2. Sawhney, S. K., and Randhir Singh, eds. Introductory Practical Biochemistry. Narosa Publishing House, 2001.
3. Thimmaiah, S. K., ed. Standard Methods of Biochemical Analysis. Kalyani Publishers, 2016.
4. Sadasivam, S., and A. Manickam. Biochemical Methods. New Age International (P) Limited, 2008.

SBU24MB3DSE200: MEDICAL MYCOLOGY

Type of Course	DSE		
Course Level	200 -299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Acquire knowledge on general characteristics, reproduction and economic importance of fungi	U
CO2	Extend knowledge on isolation and identification methods used in mycology	U
CO3	Discuss on mycotoxins and action of antifungal agents.	U
CO4	Describe about etiological agents, clinical manifestations, laboratory diagnosis and treatment of fungal diseases.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	1	-	1	1	-	-	-	-
CO2	1	-	1	-	1	1	1	-	-	-
CO3	1	-	1	-	1	1	-	-	-	-
CO4	1	-	1	-	1	1	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Research paper Review	Review paper Presentation	Seminar	Exam 1	Exam 2	
CO1	x	x	x	x	-	x
CO2	x	x	x	-	x	x
CO3	x	x	x	x	-	x
CO4	x	x	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Mycology. (15Hrs)				
General characteristics of fungi – yeast and mold, Cell structure, vegetative structure (yeast and mold).	1.1	1	3	Lecture with PPT
Reproduction in fungi – asexual and sexual (yeast and mold). Classification of fungi principles and approaches.	1.2	1	5	Lecture with PPT
Fungal dimorphism. Economic importance of fungi	1.3	1	7	Lecture with PPT

Module 2: Isolation and Identification of Fungi. (15Hrs)				
Cultivation of fungi – culture media and cultural characteristics	2.1	2	8	Lecture with PPT
Routine mycological techniques- Germ tube test, hair perforation test, hair bait technique, slide culture technique, LPCB mount. Staining methods used in mycology- wet mount and differential stain.	2.2	2	7	Lecture with PPT
Module 3: Mycotoxins and Antifungal Agents (10 Hrs)				
Mycotoxins and Mycetismus.	3.1	3	4	Lecture with PPT
Antifungal agents – Action of antifungal agents.	3.2	3	6	Lecture with PPT
Module 4: Fungal Diseases (20 Hrs)				
Etiological agent, clinical manifestations, laboratory diagnosis and treatment - Superficial mycoses – Pityriasis versicolor, Piedra. Cutaneous mycoses- Dermatophytoses.	4.1	4	6	Lecture with PPT
Subcutaneous mycoses- Mycetoma, Rhinosporidiosis, Sporotrichosis	4.2	4	6	Lecture with PPT
Systemic mycoses- Histoplasmosis, Blastomycosis. Opportunistic mycoses-Aspergillosis, Candidiasis.	4.3	4	8	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Ahrens, Wolfgang, and Iris Pigeot. Handbook of Epidemiology. 2nd ed., Springer-Verlag New York, 2014.
2. Ananthanarayan, R., C. K. J. Panicker, and R. Kanungo. Ananthanarayan and Paniker's Textbook of Microbiology. 11th ed., Universities Press (India) Pvt. Ltd., 2020.
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SBU24MB3DSE201: EXTREMOPHILES, GEO & ASTRO MICROBIOLOGY

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the extreme environments, types of extremophiles and their adaptations to the extreme conditions.	U
CO2	Explain the role of extremophiles in biogeochemical cycles and bioprocessing.	U
CO3	Discuss on astrobiological implications in space missions.	U
CO4	Discuss the applications of extremophiles in biotechnology and human health.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	-	-	-	1	-	-	-	1
CO2	1	1	-	-	1	1	-	-	-	1
CO3	1	2	-	-	1	1	1	-	-	1
CO4	1	1	-	-	1	1	1	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Viva voce	Work Book	Exam 1	Exam 2	
CO1	-	x	x	x	-	x
CO2	-	x	x	-	x	x
CO3	x	x	-	x	-	x
CO4	x	x	-	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Extreme Environments (21 Hrs)				
Introduction to extremophiles-Classification of extreme environments- Deep-sea hydrothermal vents, Acidic and alkaline environments, High-temperature environments- Hot springs, sulfer springs. Low temperature- Polar environments, Permafrost	1.1	1	8	Lecture with PPT
Archaebacteria-Types of extremophiles-thermophiles, psychrophiles, halophiles, acidophiles, alkalophiles, methanogens, extremophiles.	1.2	1	8	Lecture with PPT

Microbial Adaptations to Extreme Conditions - Molecular and physiological adaptations	1.3	1	5	Lecture with PPT
Module 2: Role of Extremophiles in Environment (10 Hrs)				
Role of Extremophiles in Geochemical cycles– C, S, P	2.1	2	4	Lecture with PPT
Role of microorganisms in mineral weathering, biocorrosion, bioleaching, biomining	2.2	2	6	Lecture with PPT
Module 3: Astrobiology (18 Hrs)				
Overview of astrobiology: Search for life beyond Earth, Exo microbiology. Brief account on space mission (Mars missions, Chandrayaan mission) and their astrobiological implications	3.1	3	5	Lecture with PPT
Microbial survival in space -Contamination concerns in space exploration Spacecraft sterilization techniques.	3.2	3	5	Lecture with PPT
Techniques to detect life in Space: brief account of Instruments for life detection, Challenges in detecting microbial life, biowaste management in space craft or space stations.	3.3	3	8	Lecture with PPT
Module 4: Extremophiles in Biotechnology & Human health (11 Hrs)				
Industrial applications of extremophiles Enzymes from extremophiles -Thermostable and cold active enzymes	4.1	4	5	Lecture with PPT
Bioremediation using extremophiles	4.2	4	2	Lecture with PPT
Extremophiles and medicine, biopharmaceuticals, Agriculture	4.3	4	4	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. 1. Tortora, Gerard J., Berdell R. Funke, and Christine L. Case. *Microbiology: An Introduction.*
2. Plaxco, Kevin W., and Michael Gross. *Astrobiology: An Introduction.*
3. Horikoshi, Koki, and Garabed Antranikian. *Extremophiles: Microbial Life in Extreme Environments.*
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8. Costa, Francisco J. de Jesus Benevides, Fabiano Jares Contesini, and Laura Montes de Oca Naranjo. *Extremophiles and Their Applications in Medical Processes.*
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SBU24MB3MDC200: PUBLIC HEALTH AND EMERGING MICROBIAL DISEASES

Type of Course	MDC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain about public health in relation to pollution	U
CO2	Explain about the concept of Aero microbiology	U
CO3	Discuss about vectors and microbial disease.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	1	-	1	-	1	1	-	-	-
CO2	-	1	-	-	-	1	-	-	-	-
CO3	1	-	-	-	-	1	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Viva voce	Work Book	Exam 1	Exam 2	
CO1	-	x	x	x	-	x
CO2	x	x	-	-	x	x
CO3	x	x	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Public Health in relation to pollution (14 hrs)				
Definition, concept and importance of public health	1.1	1	5	Lecture with PPT
Roles of microbiologist in public health, Concept of health and disease.	1.2	1	3	Lecture with PPT
Basic concept on pollution -air, water, noise, radiation and waste pollution	1.3	1	3	Lecture with PPT
Public health hazard in the community	1.4	1	3	Lecture with PPT
Module 2: Aero microbiology (24 Hrs)				
Introduction: Air and its composition, Sources of microbial air pollution & control, Microbial Indicator of air pollution	3.1	2	4	Lecture with PPT
Air borne diseases: Viral- Nipah, SARS	3.2	2	5	Lecture with PPT
Bacteria -Pneumonia, tuberculosis.	3.3	2	5	Lecture with PPT
Fungal-Aspergillosis, Histoplasmosis	3.4	2	5	Lecture with PPT
Sources, transmission and control of infection.	3.5	2	5	Lecture with PPT

Module 3: Vectors and microbial diseases (7 Hrs)				
Definition of vectors and transmission of disease by vectors	4.1	3	2	Lecture with PPT
Vector borne diseases- Malaria, Trypanosoma, Leishmania, Rickettsia	4.2	3	5	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Ahrens, Wolfgang, and Iris Pigeot. Handbook of Epidemiology. 2nd ed., Springer-Verlag New York, 2014.
2. Ananthanarayan, R., C. K. Jayaram Panicker, and R. Kanungo. Ananthanarayan and Paniker's Textbook of Microbiology. 11th ed., Universities Press (India) Pvt. Ltd., 2020.
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SBU24MB3VAC200: MICROBIAL PRODUCTS

Type of Course	VAC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total**
	45	-	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss on different types of Fermented foods	U
CO2	Discuss on food Ingredients as the fermentation products and their application.	U
CO3	Acquire knowledge on Nutraceuticals, cosmeceuticals and skinceuticals and understand the effective applications of these products in Health	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	-	-	1	1	-	-	-	-
CO2	1	1	-	-	-	1	-	-	-	-
CO3	1	1	-	-	-	1	-	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment		Summative Assessment		ESE
	Assignment	Quiz	Exam 1	Exam 2	
CO1	x	x	x	-	x
CO2	-	x	x	x	x
CO3	-	x	-	x	x
CO4	-	-	-	-	-
CO5	-	-		-	-

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Fermented foods (16 Hrs)				
General concepts of value addition – Nutritional profile of microbes	1.1	1	6	Lecture with PPT
Fermented milk – Acidophilus milk, Yoghurt, Kefir Fermented vegetables – Kanji. Gundruk, Soy sauce	1.2	1	5	Lecture with PPT
Fermented fruit drinks – beer, wine Fruit vinegar: Amla Cider, Guava Cider	1.3	1	5	Lecture with PPT
Module 2: Food Ingredients as the Fermentation Products and their application (11 Hrs)				
Enzymes – protease, Amylase	2.1	2	6	Lecture with PPT
Antimicrobials - Nisin, Lysozyme, Vitamins – B 2, B12, K, Sweeteners, Stabilizers	2.2	2	5	Lecture with PPT

Module 3: Microbes in Health (18 Hrs)				
Neutraceuticals: Synbiotics, prebiotics, probiotics, Health benefits, Challenges for probiotic formulations.	3.1	3	6	Lecture with PPT
Cosmeceuticals - Definition, Role of microbes in the cosmetic industry, major pigments and their applications in cosmetics.	3.2	3	6	Lecture with PPT
Skinceuticals – Normal flora of skin- bacteria, fungi and their role, Skin prebiotics and skin probiotics and their effect. benefits of skinceuticals.	3.3	3	6	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

References

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15. Liu, D. Handbook of Foodborne Diseases, 1st ed., CRC Press, 2018.
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17. Adam, M., & Dick, M. Food Microbiology. Medtech, 2014.
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19. Holzapfel, W. Advances in Fermented Foods and Beverages - Improving Quality, Technologies and Health Benefits, 1st ed., Woodhead Publishing, 2014.
20. Adams, M. R., Moss, M. O., & McClure, P. Food Microbiology, Royal Society of Chemistry, 2015.

SEMESTER IV

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24MB4DSC200	Major	Essentials of Immunology	5	75	4
SBU24MB4DSC201	Major	Microbial Genetics	5	75	4
SBU24MB4DSC202	Minor	Applied Microbiology	5	75	4
SBU24MB4DSE200	Elective	Medical Parasitology	4	60	4
SBU24MB4DSE201	Elective	Bioinformatics	4	60	4
SBU24MB4SEC200	SEC	Solid Waste Management	3	45	3
SBU24MB4VAC200	VAC	Microbial Inoculants and Mushroom Cultivation	3	45	3
SBU24MB4INT200		Internship			2

SBU24MB4DSC200: ESSENTIALS OF IMMUNOLOGY

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the types of immunity and the cells and organs involved in the immune system.	U
CO2	Describe the basic mechanisms of immune responses.	U
CO3	Explain the structure and functions of components involved in the immune response.	U
CO4	Discuss the role of immune response in health and disease.	U
CO5	Examine basic serological procedures for diagnosis.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	1	-	1	1	-	-	-	1
CO2	-	-	1	-	1	1	-	-	1	1
CO3	-	-	1	-	1	1	-	-	-	1
CO4	-	-	1	-	1	1	-	-	1	1
CO5	-	-	1	-	1	1	-	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	MCQ	Exam 1	Exam 2	
CO1	-	x	x	x	-	x
CO2	-		x	x	-	x
CO3	-	x	x	-	x	x
CO4	x	-	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab involvement	Lab Test	
CO1	-	-	-	-	
CO2	-	-	-	-	
CO3	-	-	-	-	
CO4	-	-	-	-	
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Fundamental Understanding of the Immune System (10 Hrs)				
Types of immunity-Innate and Acquired immunity	1.1	1	3	Lecture with PPT
Cells and organs of the immune system	1.2	1	7	Lecture with PPT
Module 2: Basic mechanisms of immune responses (12 Hrs)				
Primary and Secondary Immune Response	2.1	2	3	Lecture with PPT
Humoral Immune response- B cells, plasma cells and antibody secretion	2.2	2	3	Lecture with PPT
Cell-mediated immune response – Cells involved and their mechanism– T Cells, NK Cells, ADCC.	2.3	2	6	Lecture with PPT
Module 3: Structure and functions of components involved in the immune response (17 Hrs)				
Antigens- types, properties, Haptens, Adjuvants	3.1	3	2	Lecture with PPT
Immunoglobulins- Structure, types and properties.	3.2	3	5	Lecture with PPT
Complement- functions of complement components and Complement activation pathways,	3.3	3	4	Lecture with PPT
Antigen-Antibody Reactions – Precipitation Reaction-Precipitin test, Agglutination Reaction-ABO blood grouping, WIDAL test, ELISA	3.4	3	6	Lecture with PPT
Module 4: Role of immune response in health and disease (6 Hrs)				
Immunohaematology-Immunology of blood transfusion, erythroblastosis foetalis	4.1	4	2	Lecture with PPT
Autoimmune disease-a brief account on any two diseases	4.2	4	2	Lecture with PPT
Hypersensitivity reactions-Type I	4.3	4	2	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Abbas, Abul K., Andrew H. Lichtman, and Shiv Pillai. Cellular and Molecular Immunology. 10th ed., Elsevier, 2021.
2. Abbas, Abul K., Andrew H. Lichtman, and Shiv Pillai. Basic Immunology: Functions and Disorders of the Immune System. 6th ed., Elsevier India, 2019.
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Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Serological Techniques (30 Hrs)				
Blood Grouping	1.1	5	6	Hands On Training
ASO test	1.2	5	6	Hands On Training
Widal Test (Qualitative)	1.3	5	6	Hands On Training
RPR test	1.4	5	6	Hands On Training
ELISA (Demonstration)	1.5	5	6	Hands On Training

Reference

1. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 5th ed., New Age International (P) Limited, New Delhi, 2017.
2. Cappuccino, J., and N. Sherman. Microbiology: A Laboratory Manual. 10th ed., Benjamin-Cummings Publishing Company, Subs Of Addison Wesley Longman, Inc., 2013.
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SBU24MB4DSC201: MICROBIAL GENETICS

Type of Course	Major/ Minor		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss on bacterial chromosome, mechanism of replication and the significance of plasmids.	U
CO2	Discuss the gene expression and mobile genetic elements in prokaryotes.	U
CO3	Illustrate the gene transfer mechanism in prokaryotes.	U
CO4	Extend the knowledge on mutation and DNA repair mechanisms in bacteria.	U
CO5	Develop skills in DNA isolation, estimation and acquire knowledge on the effect of mutation.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	1	-	-	1	1	-	-	1
CO2	1	-	1	-	-	1	1	-	-	1
CO3	1	-	1	-	-	1	1	-	-	1
CO4	1	-	1	-	-	1	1	-	-	1
CO5	1	-	1	-	1	1	1	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Seminar	Viva	Group Discussion	Exam 1	Exam 2	
CO1	x	x	-	x	-	x
CO2	x	x	x	-	x	x
CO3	x	x	-	x	-	x
CO4	x	x	x		x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab involvement	Lab Test	
CO1	-	-	-	-	
CO2	-	-	-	-	
CO3	-	-	-	-	
CO4	-	-	-	-	
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: DNA as a Genetic Material (11 Hrs)				
Bacterial Chromosome- structure, function, organization.	1.1	1	3	Lecture with PPT
Experiments to prove DNA as a genetic material- Griffith Experiment, Avery – Mac Leod- Mc Carty, Hershey- Chase experiment.	1.2	1	2	Lecture with PPT
Mechanism of DNA replication in bacteria, Rolling circle replication and Theta mode replication	1.3	1	5	Lecture with PPT
Extra chromosomal genetic material in bacteria- Plasmids- F, R, Col, Virulence and Degradative plasmids.	1.4	1	1	Lecture with PPT
Module 2: Gene expression in Prokaryotes (14 Hrs)				
Central Dogma, Transcription,	2.1	2	3	Lecture with PPT
Translation.	2.2	2	3	Lecture with PPT
Regulation of gene expression in prokaryotes (Lac and trp operon)	2.3	2	4	Lecture with PPT
Mobile genetic elements and their significance- Transposons, Transposition – cut and paste mechanism, IS elements, Composite Transposons.	2.4	2	4	Lecture with PPT
Module 3: Gene transfer mechanism in prokaryotes (10 Hrs)				
Transformation	3.1	3	2	Lecture with PPT
Transduction	3.2	3	4	Lecture with PPT
Conjugation	3.3	3	4	Lecture with PPT
Module 4: Mutations and Repair Mechanisms (10 Hrs)				
Mutation- Spontaneous and induced mutagenesis, transition, transversion	4.1	4	1	Lecture with PPT
Silent, missense, non-sense Mutations	4.2	4	1	Lecture with PPT
Neutral, frame shift and conditional mutations	4.3	4	2	Lecture with PPT
Forward and reverse mutations. Detection and isolation of mutants.	4.4	4	3	Lecture with PPT
Carcinogenicity testing –Ames test	4.5	4	1	Lecture with PPT
DNA Repair in bacteria- Photoreactivation and Excision Repair	4.6	4	2	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

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Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6 (30 Hrs)				
Isolation of bacterial DNA	1.1	5	6	Hands On Training
Estimation of DNA	1.2	5	6	Hands On Training
Agarose Gel Electrophoresis	1.3	5	6	Hands On Training
To determine the bacterial mutagenesis with UV radiation-loss of pigmentation, Reduced viability Changes in the cell wall nature	2.1	5	6	Hands On Training
Isolation of streptomycin resistant mutant in a prototrophic bacterial population.	2.2	5	6	Hands On Training

Reference

1. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition, New Age International (P) Limited, 2007.
2. Cappuccino, J. G. and Sherman, N. Microbiology: A Laboratory Manual. 9th Edition, Pearson/Benjamin Cummings, 2008.
3. Chakraborty, P. and Chakraborty, G. Practical Pathology. Vol. 33, New Central Book Agency (P) Ltd., 2005.
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SBU24MB4DSC202: APPLIED MICROBIOLOGY

Type of Course	Minor		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss the role of microbes in food industry and fermented products	U
CO2	Acquire knowledge on soil microbes and its interactions	U
CO3	Explain about aquatic environments, microbial communities and factors affecting microbial population in natural water	U
CO4	Discuss about aero microbiology with air borne diseases	U
CO5	Acquire skills in microbiological examination of water, soil and food	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	-	-	-	1	1	-	-	-
CO2	1	1	-	-	-	1	1	-	-	1
CO3	1	1	-	-	-	1	1	-	-	1
CO4	1	1	-	-	-	1	1	-	-	-
CO5	1	1	-	-	-	1	1	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Viva voce	Work Book	Exam 1	Exam 2	
CO1	-	-	x	x	-	x
CO2	x	x	-	x	-	x
CO3	x	-	-	-	x	x
CO4	-	x	-	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab involvement	Lab Test	
CO1	-	-	-	-	
CO2	-	-	-	-	
CO3	-	-	-	-	
CO4	-	-	-	-	
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Food Microbiology (12 Hrs)				
Role of microbes in food industry	1.1	1	2	Lecture with PPT
Fermented milk products- Dahi, Yoghurt, butter, Lassie, Kumiss, Kefir	1.2	1	5	Lecture with PPT
Fermented Vegetable-Sauerkraut, Oriental fermented foods	1.3	1	5	Lecture with PPT
Module 2: Soil Microbiology (15 Hrs)				
Soil microbes and its interactions- positive, negative and neutral interactions	2.1	2	4	Lecture with PPT
Biological nitrogen fixation- Symbiotic and non-symbiotic Nitrogen fixation	2.2	2	4	Lecture with PPT
Biofertilizers - Rhizobium, phosphate solubilizing bacteria	2.3	2	4	Lecture with PPT
Biopesticide	2.4	2	3	Lecture with PPT
Module 3: Aquatic Microbiology (12 Hrs)				
Microbial communities in aquatic environment	3.1	3	2	Lecture with PPT
Factors affecting the microbial population in natural water	3.2	3	2	Lecture with PPT
Aquatic Ecosystem- freshwater -ponds, lakes, rivers and streams	3.3	3	3	Lecture with PPT
Ground water Microbiology	3.4	3	3	Lecture with PPT
Marine Ecosystems- Estuaries, Ocean and Sea	3.5	3	2	Lecture with PPT
Module 4: **Aeromicrobiology (6 Hrs)**				
Definition, Microbiological assessment of air quality and sanitation	4.1	4	4	Lecture with PPT
Air borne diseases	4.2	4	2	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Barthwal, R. R. Environmental Impact Assessment. New Age International Publishers, 2012.
2. Glasson, J., Therivel, R., & Chadwick, A. Introduction to Environmental Impact Assessment. 4th Edition, Routledge, 2012.
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Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Isolation and enumeration of organism from water, food and soil (30 Hrs)				
MPN-Water	1.1	5	6	Hands on Training
SPC - raw and spoiled food	1.2	5	6	Hands on Training
Serial dilution and plating of rhizosphere and non-rhizosphere soil	1.3	5	6	Hands on Training
Isolation of Rhizobium	1.4	5	6	Hands on Training
Air exposure plates	1.5	5	6	Hands on Training

Reference

1. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 5th Edition, New Age International (P) Limited, 2017.
2. Cappuccino, J., & Sherman, N. Microbiology: A Laboratory Manual. 10th Edition, Benjamin-Cummings Publishing Company, Subs Of Addison Wesley Longman, Inc., 2013.
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SBU24MB4DSE200: MEDICAL PARASITOLOGY

Type of Course	Elective		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss the general concepts of parasitology and host – parasite relationship.	U
CO2	Explain the life cycle, pathogenesis, disease transmission and laboratory diagnosis of medically important protozoans.	U
CO3	Explain the life cycle, pathogenesis, disease transmission and laboratory diagnosis of medically important helminths.	U
CO4	Describe the laboratory techniques in parasitology.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	1	-	-	1	-	-	-	-
CO2	1	-	1	1	1	1	-	-	-	-
CO3	1	-	1	1	1	1	-	-	-	-
CO4	1	-	1	-	1	1	-	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	MCQ	Exam 1	Exam 2	
CO1	-	x	-	x	-	x
CO2	-	-	x	-	x	x
CO3	x	x	-	x	-	x
CO4	-	-	x	-	x	x
CO5	-	-	-	-	-	-

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: General concepts in parasitology (7 Hrs)				
Parasitology – General Concepts	1.1	1	2	Lecture with PPT
Introduction to Parasitology – Protozoology and helminthology	1.2	1	2	Lecture with PPT
Classification – Host-parasite relationship.	1.3	1	3	Lecture with PPT
Module 2: Clinical characterisation of protozoans (27 Hrs)				
Pathogenic mechanisms, disease transmission, life cycles and lab diagnosis of *Entamoeba histolytica, Giardia lamblia, Trichomonas vaginalis, Leishmania donovani,*	2.1	2	9	Lecture with PPT

Plasmodium vivax, Plasmodium falciparum	2.3	2	8	Lecture with PPT
Balantidium coli, Toxoplasma gondii, Cryptosporidium parvum and Naegleria fowleri	2.4	2	10	Lecture with PPT
Module 3: Clinical Characterisation of Helminths (23 Hrs)				
Helminthology: Classification. Life cycle, Transmission, pathogenicity and Lab Diagnosis of Cestodes-*Taenia solium, T saginata, T echinococcus*	3.1	3	8	Lecture with PPT
Trematodes –*Schistosoma haematobium, Fasciola hepatica*	3.3	3	6	Lecture with PPT
Nematodes – *Ascaris, Ancylostoma, Trichuris, Enterobius and Wuchereria*	3.4	3	9	Lecture with PPT
Module 4: Laboratory techniques in parasitology (3 Hrs)				
Laboratory techniques in parasitology Blood –Thick and thin smear	4.1	4	2	Lecture with PPT
Faeces –Examination for ova and cyst.	4.2	4	1	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Chatterjee, K. D. Parasitology Protozoology and Helminthology. 13th Edition, CBS Publishers & Distributors, 2009.
2. Paniker, C. Textbook of Medical Parasitology. Jaypee Brothers: Medical Publishers, 2002.
3. Parija, Subhash Chandra. Textbook of Medical Parasitology: Protozoology & Helminthology. 4th Edition, 1 January 2013.

SBU24MB4DSE201: BIOINFORMATICS

Type of Course	Elective		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Acquire knowledge of the principles and concept underlying bioinformatics.	U
CO2	Learn how to design, develop and implement biological databases using appropriate data modelling techniques.	U
CO3	Students gain knowledge in using bioinformatics software tools and databases for sequence alignment.	U
CO4	Explore real world application of bioinformatics in areas such as drug discovery, personalized medicine, evolutionary biology and agriculture.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	1	-	1	1	-	-	1
CO2	-	-	-	1	-	1	1	-	-	1
CO3	-	-	-	1	-	1	1	-	1	1
CO4	-	-	-	1	-	1	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	MCQ	Exam 1	Exam 2	
CO1	-	x	-	x	-	x
CO2	-	-	x	-	x	x
CO3	-	x	x	x	-	x
CO4	x	-	-	-	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Basics of Bioinformatics (11 Hrs)				
DNA, RNA and Proteins as information molecules, Sequence-structure -Function relationship. .	1.1	1	5	Lecture with PPT
Concept of gene, genome and proteome	1.2	1	4	Lecture with PPT
Human genome project	1.3	1	2	Lecture with PPT

Module 2: Biological Database (16 Hrs)				
Storing and accessing sequence data, FASTA sequence, Role of database.	2.1	2	5	Lecture with PPT
Types of database-Primary, Secondary and composite database, Nucleotides sequence database-NCBI GenBank.	2.2	2	6	Lecture with PPT
Protein Sequence Database-Uniprot-KB, Structure database-PDB.	2.3	2	5	Lecture with PPT
Module 3: Biosequence Analysis (20 Hrs)				
Sequence alignment-Global and Local alignments	3.1	3	4	Lecture with PPT
Homology modelling	3.2	3	2	Lecture with PPT
Methods of sequence alignment: Pair-wise alignment-BLAST	3.3	3	5	Lecture with PPT
Multiple sequence alignment-CLUSTAL W, Gaps and Gap penalties	3.4	3	5	Lecture with PPT
Scoring schemes: Basic concept of a scoring matrix, PAM and BLOSUM matrices.	3.5	3	4	Lecture with PPT
Module 4: Applications of Bioinformatics (13 Hrs)				
Application in evolutionary biology and agriculture.	4.1	4	4	Lecture with PPT
Drug Design: Applications of bioinformatics in target identification, Personalized medicine, validation and binding site prediction.	4.2	4	5	Lecture with PPT
Lead compound identification: Structure-based & ligand-based approaches; Molecular docking.	4.3	4	4	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Lesk, Arthur. Introduction to Bioinformatics. Oxford University Press, 2019.
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SBU24MB4SEC200: SOLID WASTE MANAGEMENT

Type of Course	SEC		
Course Level	200 -299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain waste disposal methods and the principles of waste management solutions.	U
CO2	Explain the Bioprocessing of organic wastes and its implementation.	U
CO3	Explain the process of Composting in effective organic waste management.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	1	-	-	-	1	-	-	-	-
CO2	1	1	-	-	1	1	1	-	-	-
CO3	1	1	-	-	1	1	-	-	1	-
CO4	1	1	-	-	1	1	1	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment		Summative Assessment		ESE
	Assignment	Quiz	Exam 1	Exam 2	
CO1	-	x	x	-	x
CO2	-	x	x	x	x
CO3	x	x	-	x	x
CO4	-	-	-		-
CO5	-	-	-		-

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Solid Waste Management (15 Hrs)				
Waste management by Refuse, Reuse, Recycle, and Reduce	1.1	1	3	Lecture with PPT
Generation of solid waste – Sources	1.2	1	2	Lecture with PPT
Types of solid wastes, Sampling and onsite handling.	1.3	1	4	Lecture with PPT
Disposal methods for solid waste- Open dumping, Sanitary dumping, Landfilling, Incineration, Biogas, Pyrolysis.	1.4	1	6	Lecture with PPT

Module 2: Bioprocessing of organic waste (15 Hrs)				
Anaerobic digestion- Hydrolysis, Acidogenesis, Acetogenesis, Methanogenesis. Products of anaerobic digestion - biogas, digestate and slurry.	2.1	2	6	Lecture with PPT
Vermicomposting- methods. Earthworm species used in vermicomposting,	2.2	2	6	Lecture with PPT
Factors affecting vermicomposting	2.3	2	3	Lecture with PPT
Module 3: Composting (15 Hrs)				
Types of composting: anaerobic and aerobic composting.	3.1	3	4	Lecture with PPT
Methods of composting.	3.2	3	4	Lecture with PPT
Advantages and disadvantages of composting.	3.3	3	4	Lecture with PPT
End product- Compost. Parameters for good compost.	3.4	3	3	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

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1. Barthwal, R. R. Environmental Impact Assessment. New Age International Publishers, 2012.
2. Glasson, J., Therivel, R., & Chadwick, A. Introduction to Environmental Impact Assessment. 4th Edition, Routledge, 2012.
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SBU24MB4VAC200: MICROBIAL INOCULANTS AND MUSHROOM CULTIVATION

Type of Course	VAC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss the production of bacterial biofertilizers and its applications	U
CO2	Explain Fungal and Algal biofertilizers and its applications	U
CO3	Acquire knowledge on Mushroom Cultivation and its nutritive value	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	1	-	-	1	1	-	-	-	-
CO2	-	1	-	-	1	1	-	-	-	-
CO3	-	1	-	-	1	1	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment		Summative Assessment		ESE
	Assignment	Quiz	Exam 1	Exam 2	
CO1	x	x	x	-	x
CO2	-	x	x	x	x
CO3	-	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Bacterial Biofertilizers (15 Hrs)				
Introduction to biofertilizers, types, advantages and applications.	1.1	1	7	Lecture with PPT
Bacterial biofertilizers- free-living forms- *Azotobacter*, *Azospirillum*, symbiotic- *Rhizobium* legume association (production and application)	1.2	1	8	Lecture with PPT
Module 2: Fungal and Algal Biofertilizers (15 Hrs)				
Fungal biofertilizers- VAM Fungi (production and application)	2.1	2	8	Lecture with PPT
Blue-green algae biofertilizers	2.2	2	7	Lecture with PPT
Module 3: Mushroom Technology (15 Hrs)				
Edible and non-edible mushrooms Nutritive value and effect on human health	3.1	3	7	Lecture with PPT

Cultivation of button mushroom, raising a pure culture and spawn preparation, preparation of compost. Cultivation of oyster, paddy straw and button mushroom	3.2	3	8	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Biswas, S., Datta, M., & Ngachan, S. V. Mushrooms: A Manual for Cultivation. PHI Learning Private Limited, 2012.
2. Dhar, & Kaul. Biology and Cultivation of Edible Mushrooms. Westville Publishing House, 2007.
3. Rai, Mahendra. Handbook of Microbial Biofertilizers. CRC Press, 2008.
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5. Totawat, K. L., Somani, L. L., Sharma, R. A., & Maloo, S. R. Biofertilizers Technology. Agrotech Publishing Academy, 2008.

SEMESTER V

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24MB5DSC300	Major/Minor	Medical Bacteriology	5	75	4
SBU24MB5DSC301	Major/Minor	Industrial Microbiology	5	75	4
SBU24MB5DSE300	Elective	Medical Virology	4	60	4
SBU24MB5DSE301	Elective	Bioprocess Technology	4	60	4
SBU24MB5DSE302	Elective	Emerging and Re-emerging Infections	4	60	4
SBU24MB5DSE303	Elective	Dairy Microbiology	4	60	4
SBU24MB5DSE304	Elective	Microbial Bioremediation	4	60	4
SBU24MB5SEC300	SEC	Diagnostic Microbiology	3	45	3

SBU24MB5DSC300: MEDICAL BACTERIOLOGY

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss the normal flora and the biology and epidemiology of pathogenic cocci in humans.	U
CO2	Explain the systemic study of gram-positive bacilli.	U
CO3	Explain the pathogenesis, laboratory diagnosis, treatment of medically important gram-negative bacilli	U
CO4	Explain the pathogenesis, laboratory diagnosis, treatment of medically important Mycobacterium and Spirochete.	U
CO5	Develop skills to isolate and characterize human pathogens from clinical samples.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	1	-	-	1	-	-	-	-
CO2	1	-	1	-	-	1	-	-	-	-
CO3	1	-	1	-	-	1	-	-	-	-
CO4	1	-	1	-	-	1	-	-	-	-
CO5	1	-	1	-	1	1	-	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Quiz	MCQ	Exam 1	Exam 2	
CO1	x	-	-	x	-	x
CO2	-	x	-	x	-	x
CO3	-	x	x	-	x	x
CO4	-	-	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab involvement	Lab Test	
CO1	-	-	-	-	
CO2	-	-	-	-	
CO3	-	-	-	-	
CO4	-	-	-	-	
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Normal flora and Health Significant Bacteria in Human (12 Hrs)				
Normal micro flora of human body	1.1	1	2	Lecture with PPT
Gram positive cocci - Morphology, biochemical reactions, cultural characteristics, pathogenicity and lab diagnosis of Staphylococcus aureus, Streptococcus pyogenes, Streptococcus pneumoniae	1.2	1	6	Lecture with PPT
Gram Negative cocci – Neisseria meningitidis, N. gonorrhoeae	1.3	1	4	Lecture with PPT
Module 2: Gram positive Bacilli (7 Hrs)				
Corynebacterium diphtheriae	2.1	2	2	Lecture with PPT
Bacillus anthracis	2.2	2	2	Lecture with PPT
Clostridium perfringens, Cl. tetani	2.3	2	3	Lecture with PPT
Module 3: Gram negative Bacilli (17 Hrs)				
E.coli, Klebsiella	3.1	3	6	Lecture with PPT
Pseudomonas aeruginosa, Vibrio cholerae	3.2	3	4	Lecture with PPT
Shigella dysenteriae, Salmonella typhi	3.3	3	5	Lecture with PPT
Haemophilus influenzae	3.4	3	2	Lecture with PPT
Module 4: Mycobacterium and Spirochete (9 Hrs)				
Mycobacterium tuberculosis	4.1	4	3	Lecture with PPT
M. leprae	4.2	4	3	Lecture with PPT
Treponema pallidium, Leptospira	4.3	4	3	Lecture with PPT
Module 5: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) **This content will be evaluated internally**				

Reference

1. Ahrens, W., and I. Pigeot. Handbook of Epidemiology. 2nd ed., Springer-Verlag New York, 2014.
2. Ananthanarayan, R., et al. Ananthanarayan and Paniker's Textbook of Microbiology. 11th ed., Universities Press (India) Pvt. Ltd., 2020.
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30. Anaissie, E. J., et al. Clinical Mycology. 1st ed., Churchill Livingstone, 2002.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Morphological and Biochemical Identification of Bacteria (30 Hrs)				
Morphology- Gram staining	1.1	5	5	Hands on Training
Colony characteristics – Nutrient Agar, Mac Conkey Agar, Blood Agar, EMB Agar.	1.2	5	5	Hands on Training
Biochemical Reactions of Bacteria- IMViC, TSI, Urease, Catalase, Oxidase, Mannitol motility, Nitrate reduction	1.3	5	5	Hands on Training
Identification of *Staphylococcus aureus*	2.1	5	3	Hands on Training
Identification of *E.coli*	2.2	5	3	Hands on Training
Identification of *Klebsiella*	2.3	5	3	Hands on Training
Identification of *Salmonella*	2.4	5	3	Hands on Training
Identification of *Pseudomonas*	2.5	5	3	Hands on Training

Reference

1. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition, New Age International (P) Limited, 2007.
2. Cappuccino, J. G. and Sherman, N. Microbiology: A Laboratory Manual. 9th Edition, Pearson/Benjamin Cummings, 2008.
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7. Janarthanan, S. and Vincent, S. Practical Biotechnology: Methods and Protocols, Orient BlackSwan/Universities Press, 2007.
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9. Kalaichelvan, P. T. Microbiology and Biotechnology Laboratory Manual, MJP Publishers, Chennai, 2005.
10. Kannan, N. Laboratory Manual in General Microbiology. 2nd Edition, Panima Publishing Co., New Delhi, 2002.
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12. Prince, C. P. Practical Manual of Medical Microbiology, Jaypee Brothers Medical Publishers (p) Ltd., New Delhi, 2009.
13. Cappuccino, J. G., and Sherman, N. Microbiology: A Laboratory Manual. 10th Edition, Pearson Education India, 2014.
14. Morello, J. A., Granato, P. A., and Morton, V. Lab Manual and Workbook in Microbiology: Applications to Patient Care. 12th Edition, McGraw Hill, 2018.
15. Brown, A. E., and Smith, H. R. Benson's Microbiological Applications, Laboratory Manual in General Microbiology. 14th Edition, McGraw-Hill College, 2016.

SBU24MB5DSC301: INDUSTRIAL MICROBIOLOGY

Type of Course	Major/Minor		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss the history, screening techniques and strain improvement of industrially important microbes.	U
CO2	Discuss the structure and design of different types of fermenters, types of fermentation and automated process control.	U
CO3	Summarize various upstream processes and industrial sterilization.	U
CO4	Describe the downstream processes.	U
CO5	Apply the use of microbes in the production of industrially valuable products and its volumetric estimation.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	-	-	-	1	-	-	-	1
CO2	1	1	-	-	-	1	1	-	-	-
CO3	1	1	-	-	-	1	-	-	-	-
CO4	1	1	-	-	-	1	1	-	-	-
CO5	1	1	-	-	1	1	-	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Seminar	Viva	Quiz	Exam 1	Exam 2	
CO1	x	x		x		x
CO2	x	x			x	x
CO3	x	x	x	x		x
CO4	x	x	x		x	x
CO5						

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab involvement	Lab Test	
CO1	-	-	-	-	
CO2	-	-	-	-	
CO3	-	-	-	-	
CO4	-	-	-	-	
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Screening and Strain Improvement of Industrially Important Microorganisms (11 Hrs)				
History, development and scope of industrial microbiology	1.1	1	3	Lecture with PPT
Screening of industrially important microorganisms - primary and secondary screening.	1.2	1	4	Lecture with PPT
Strain improvement – mutation, recombination, and protoplast fusion.	1.3	1	4	Lecture with PPT
Module 2. Structure and design of fermenters and Types of fermentation (14 Hrs)				
Structure of a typical batch fermenter.	2.1	2	2	Lecture with PPT
Types of fermenter-continuous stirred tank fermenter, Fluidized bed fermenter, Packed bed fermenter	2.2	2	3	Lecture with PPT
Solid state fermenter, Air lift fermenter and tubular fermenter	2.3	2	4	Lecture with PPT
Surface, submerged and continuous fermentation	2.4	2	2	Lecture with PPT
Computer control of fermentation process.	2.5	2	3	Lecture with PPT
Module 3: Upstream processes (9 Hrs)				
Development of inoculum for industrial fermentation	3.1	3	3	Lecture with PPT
Fermentation media -saccharine materials, starchy materials	3.2	3	1	Lecture with PPT
cellulosic materials, nitrogenous materials	3.3	3	1	Lecture with PPT
Enhancers and precursors, antifoam agents.	3.4	3	1	Lecture with PPT
Industrial sterilization –Batch and continuous sterilization	3.5	3	3	Lecture with PPT
Module 4: Downstream Processes (11 Hrs)				
Intra cellular and extra cellular product recovery	4.1	4	4	Lecture with PPT
Cell disruption -Physical and chemical methods	4.2	4	2	Lecture with PPT
Solvent extraction and purification	4.3	4	3	Lecture with PPT
Drying & crystallization.	4.4	4	2	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Enfors, Sven Olof, and Lars Häggström. Bioprocess Technology: Fundamentals and Applications. Royal Institute of Technology, Stockholm, Sweden, 2000.
2. Whitaker, Anthony, Peter F. Stanbury, and Stephen J. Hall. Principles of Fermentation Techniques. Elsevier, 2009.
3. Okafor, Nduka. Modern Industrial Microbiology and Biotechnology. CRC Press, 2007.
4. Casida, L. E. J. Industrial Microbiology. New Age International Private Limited, 2019.
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6. Bull, Alan T., et al. Manual of Industrial Microbiology and Biotechnology. 3rd ed., ASM Press, 2010.

7. Baltz, Richard H., et al. Manual of Industrial Microbiology and Biotechnology. American Society for Microbiology, 2010.
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9. Wilson, David B., et al. Industrial Microbiology. Wiley-VCH, 2019.
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Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Basic experiments of Industrial Microbiology (30 Hrs)				
Production of citric acid by *Aspergillus niger*	1.1	5	5	Hands on Training
Estimation of citric acid	1.2	5	5	Hands on Training
Estimation of Lactic acid from milk	1.3	5	5	Hands on Training
Crowded plate technique for screening microbial production of antibiotics	1.4	5	5	Hands on Training
Immobilization of yeast cell by sodium alginate method	1.5	5	5	Hands on Training
Solid state fermentation- Production of mushroom	1.6	5	5	Hands on Training

Reference

1. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th ed., New Age International (P) Limited, New Delhi, 2007.
2. Baltz, Richard H., et al. Manual of Industrial Microbiology and Biotechnology. 3rd ed., American Society of Microbiology, 2012.
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5. Gunasekaran, P. Laboratory Manual in Microbiology. 2nd ed., New Age International (P) Limited, New Delhi, 2002.
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11. Morello, Joseph A., Paul A. Granato, and Verna Morton. Lab Manual and Workbook in Microbiology: Applications to Patient Care. 12th ed., McGraw Hill, 2018.
12. Brown, Alfred E., and Heidi R. Smith. Benson's Microbiological Applications, Laboratory Manual in General Microbiology. 14th ed., McGraw-Hill College, 2016.

SBU24MB5DSE300: MEDICAL VIROLOGY

Type of Course	Elective		
Course Level	300 -399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss the characteristic features of viruses and bacteriophages.	U
CO2	Describe the significance of pathogenic DNA viruses	U
CO3	Describe the significance of pathogenic RNA viruses	U
CO4	Extend the knowledge on emerging and reemerging viral infections.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	1	2	-	-	-	1
CO2	2	-	2	-	1	2	-	-	1	1
CO3	2	-	2	-	1	2	-	-	1	1
CO4	2	-	2	-	1	2	-	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Seminar	Quiz	Workbook	Exam 1	Exam 2	
CO1	x	x	-	x	-	x
CO2	x	x	x	x	-	x
CO3	x	x	-	-	x	x
CO4	x	x	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Virology (18 Hrs)				
General properties, structure, symmetry and cultivation of viruses.	1.1	1	5	Lecture with PPT
Classification of medically important viruses	1.2	1	4	Lecture with PPT
Viral replication, viroids and prions	1.3	1	4	Lecture with PPT
Bacteriophage structure and replication	1.4	1	5	Lecture with PPT
Module 2: Pathogenic DNA viruses (13 Hrs)				
Herpesvirus-HSV, Herpes zoster, Varicella zoster, CMV, EBV,	2.1	2	6	Lecture with PPT
Poxvirus-Variola and Vaccinia	2.2	2	4	Lecture with PPT
Hepatitis B Virus	2.3	2	3	Lecture with PPT
Module 3: Pathogenic RNA Viruses (24 Hrs)				
Picornavirus- polio virus.	3.1	3	3	Lecture with PPT

Myxovirus -Influenza virus, Mumps, Measles	3.2	3	5	Lecture with PPT
Arbovirus-Togavirus and Flavivirus	3.3	3	4	Lecture with PPT
Rhabdovirus.	3.4	3	4	Lecture with PPT
Hepatitis Virus	3.5	3	4	Lecture with PPT
Retrovirus -HIV	3.6	3	4	Lecture with PPT
Module 4: Emerging and re-emerging viruses (5 Hrs)				
Epidemiology, Symptoms, Prevention and Prophylaxis of SARS	4.1	4	2	Lecture with PPT
Nipah and Zika virus	4.2	4	2	Lecture with PPT
Coronavirus (Covid-19)	4.3	4	1	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Ahrens, Wolfgang, and Iris Pigeot. Handbook of Epidemiology. 2nd ed., Springer-Verlag New York, 2014.
2. Ananthanarayan, R., C. K. J. Panicker, and R. Kanungo. Ananthanarayan and Paniker's Textbook of Microbiology. 11th ed., Universities Press (India) Pvt. Ltd., 2020.
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4. Apurba, Sastry S. and Sandhya Bhat. Essentials of Medical Microbiology: (Revised Edition), Jaypee Brothers Medical Publishers, 2020.
5. Cann, Alan J. Principles of Molecular Virology. 6th ed., Elsevier Academic Press, 2015.
6. Carter, John, and Venetia Saunders. Virology: Principles and Applications. 2nd ed., John Wiley and Sons Ltd., 2013.
7. Daw, Mohamed A. Medical Microbiology Laboratory Manual. 2nd ed., Publisher: ISBN: 978-9959-53-052-3, 2009.
8. Dimmock, Nigel J., et al. Introduction to Modern Virology. 6th ed., Blackwell Publishing, 2007.
9. Steele, James C. H. Emerging Infections and their causative agents. Clinics in laboratory medicine, vol. 24, no. 3, 2004, pp. 559-848.
10. Reiss, Errol, Herbert J. Shadomy, and Gail M. Lyon. Fundamental Medical Mycology. Wiley-Blackwell, 2011.

SBU24MB5DSE301: BIOPROCESS TECHNOLOGY

Type of Course	Elective		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Extend knowledge on production of microbial products by industrial fermentation.	U
CO2	Comprehensive knowledge in the production of biofuels, bioplastics, beverages, and SCP.	U
CO3	Extend knowledge on immobilization of enzymes and its applications and solid state fermentation.	U
CO4	Discuss about microorganisms used in oil recovery and leaching and the importance of IPR	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	-	-	1	1	-	-	-	1
CO2	1	1	-	-	1	1	-	-	-	1
CO3	1	1	-	-	1	1	-	-	-	1
CO4	1	1	-	1	1	1	-	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Oral Presentation	PPT presentation	Group Discussion	Exam 1	Exam 2	
CO1	x	x		x		x
CO2	x	x	x		x	x
CO3	x	x	x	x		x
CO4	x	x	x		x	x
CO5						

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Fermentative production of Antibiotics, Vitamins and Growth stimulant (21Hrs)				
Fermentative production of antibiotics-Penicillin and Streptomycin	1.1	1	4	Lecture with PPT
Production of Vitamins-riboflavin, Cyanocobalamins and Vitamin C	1.2	1	6	Lecture with PPT
Production of gibberellins	1.3	1	1	Lecture with PPT

Fermentative production of organic acids-acetic acid, citric acid, lactic acid	1.4	1	5	Lecture with PPT
Production of amino acids-Lysine and glutamic acid	1.5	1	2	Lecture with PPT
Production of solvents-ethanol and glycerol	1.6	1	3	Lecture with PPT
Module 2: Production of Biofuels, Bioplastics, Beverages and Single cell protein (14 Hrs)				
Production of biofuels-hydrogen and methane	2.1	2	4	Lecture with PPT
Microbial production of bioplastics – PHA and PHB	2.2	2	4	Lecture with PPT
Production of beverages- beer and wine	2.3	2	3	Lecture with PPT
Production of single cell protein-Baker's yeast and spirullina	2.4	2	3	Lecture with PPT
Module 3: Enzyme Immobilization Techniques and its Application (7 Hrs)				
Industrial importance of enzymes	3.1	3	1	Lecture with PPT
Production of enzymes-protease and amylase	3.2	3	2	Lecture with PPT
Enzyme immobilization-methods and applications	3.3	3	2	Lecture with PPT
Solid state fermentation-Mushroom cultivation	3.4	3	2	Lecture with PPT
Module 4: **Microbially enhanced recovery of metals and oil, Novel Processing and Patenting (18 Hrs)**				
Microbial recovery of metals Bioleaching methods-copper, gold and uranium	4.1	4	3	Lecture with PPT
Microbially enhanced oil recovery (MEOR)	4.2	4	2	Lecture with PPT
Intellectual property rights and significance of patent development in bioprocess technology	4.3	4	3	Lecture with PPT
Industrial visit	4.4	4	10	Lecture with PPT

Reference

1. Enfors, S. O., & Häggström, L. Bioprocess Technology: Fundamentals and Applications. Royal Institute of Technology, Stockholm, Sweden, 2000.
2. Whitaker, A., Stanbury, P. F., & Hall, S. J. Principles of Fermentation Techniques. Elsevier, 2009.
3. Okafor, N. Modern Industrial Microbiology and Biotechnology. CRC Press, 2007.
4. Casida, L. E. J. R. Industrial Microbiology. New Age International Private Limited, 2019.
5. Reed, G. Prescott and Dunn's Industrial Microbiology. 4th Edition. CBS Publishers and Distributors Pvt Ltd., New Delhi, 2020.
6. Bull, A. T., Junker, B., Katz, L., Lynd, L. R., Masurekar, P., Reeves, C. D., & Zhao, H. Manual of Industrial Microbiology and Biotechnology. 3rd Edition. ASM Press, 2010.
7. Baltz, R. H., Demain, A. L., & Davies, J. E. Manual of Industrial Microbiology and Biotechnology. American Society for Microbiology, 2010.
8. Clarke, W. Biotechnology Industrial Microbiology. CBS Publishers and Distributors Pvt Ltd., 2018.
9. Wilson, D. B., Sahm, H., Stahmann, K-P., & Koffas, M. Industrial Microbiology. Wiley-VCH, 2019.
10. Waites, M. J., Morgan, N. L., Rockey, J. S., & Higton, G. Industrial Microbiology: An Introduction. Wiley-Blackwell, 2013.
11. Patel, A. H. Industrial Microbiology, 2nd Edition. Macmillian India Press, Chennai, 2012.
12. Stanbury, P. F., Whitaker, A., & Hall, S. J. Principles of Fermentation Technology. Elsevier, 2013.

SBU24MB5DSE302: EMERGING AND REEMERGING INFECTIONS

Type of Course	Elective		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss historical perspectives, classification and categorization of emerging and re-emerging infectious diseases.	U
CO2	Describe the role of Antimicrobial Resistance in disease evolution, and the complexities of bioterrorism.	U
CO3	Demonstrate comprehensive knowledge of major viral and bacterial diseases.	U
CO4	Comprehensive knowledge and skills in effectively implementing surveillance and response strategies of emerging and re-emerging infectious diseases	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	1	-	-	1		-	-	1
CO2	1	-	1	1	1	1	1	-	1	1
CO3	1	-	2	-	-	1		-	-	1
CO4	1	-	2	1	1	1	1	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Oral Presentation	PPT presentation	Group Discussion	Exam 1	Exam 2	
CO1	x	x	x	x		x
CO2	x	x	x		x	x
CO3	x	x		x		x
CO4	x	x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Historical Perspectives (21 Hrs)				
Introduction to Emerging infectious diseases (EIDs) and re-emerging infectious diseases (REIDs). Classification of Emerging and re-emerging disease	1.1	1	5	Lecture with PPT
Major epidemics and pandemics such as the bubonic plague, yellow fever, cholera, typhus, Coronavirus and Influenza	1.2	1	10	Lecture with PPT

Neglected tropical diseases (NTDs)	1.3	1	6	Lecture with PPT
Module 2: Epidemiology (16 Hrs)				
Epidemiological Triad of disease, Factors that precipitate the occurrence and transmission of EIDs and REIDs – microbial adaptation and change, ecological changes, human demographics and behavior, technology and health care, human susceptibility to infection, social/political/economic & lifestyle factors	2.1	2	10	Lecture with PPT
Role of Antimicrobial resistance in evolution of emerging and re-emerging disease	2.2	2	3	Lecture with PPT
Bioterrorism – agents and detection methods	2.3	2	3	Lecture with PPT
Module 3: Major diseases, etiological agent, transmission and prevention (10 Hrs)				
Viral diseases – Influenza, Ebola, SARS, MERS & COVID 19, Dengue, KFD, Nipah virus disease	3.1	3	5	Lecture with PPT
Bacterial – Lyme disease, Melioidosis, Buruli ulcer, Legionnaire's disease, TB, Bubonic plague	3.2	3	5	Lecture with PPT
Module 4: Combating emerging infections (13 Hrs)				
Surveillance and Response, Applied research, Infrastructure and training, Prevention and Control of EIDs and REIDs, Challenges in disease management	4.1	4	10	Lecture with PPT
Global collaboration and international initiatives-GOARN	4.2	4	3	Lecture with PPT

Reference

1. Ananthanarayan, R. Ananthanarayan and Paniker's Textbook of Microbiology. Orient Blackswan, 2006.
2. Bailey, W. E., & Scott, E. G. Diagnostic Microbiology. Diagnostic microbiology, 1962.
3. Beltz, L. A. Emerging Infectious Diseases: A Guide to Diseases, Causative Agents, and Surveillance. Vol. 10, John Wiley & Sons, 2011.
4. Dutta, T. K., Parija, S. C., & Dutta, J. K. Emerging and Re-Emerging Infectious Diseases. JP Medical Ltd, 2012.
5. Feldmann, H., Czub, M., Jones, S., Dick, D., Garbutt, M., Grolla, A., & Artsob, H. "Emerging and Re-Emerging Infectious Diseases." Medical Microbiology and Immunology, vol. 191, 2002, pp. 63-74.
6. Kayingo, G. (Ed.). Emerging and Re-Emerging Infectious Diseases, An Issue of Physician Assistant Clinics, E-Book. Vol. 8, No. 3, Elsevier Health Sciences, 2023.
7. Lashley, F. R., & Durham, J. D. (Eds.). Emerging Infectious Diseases: Trends and Issues. Springer Publishing Company, 2007.
8. Snowden, F. M. "Emerging and Reemerging Diseases: A Historical Perspective." Immunological Reviews, vol. 225, no. 1, 2008, pp. 9-26.
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SBU24MB5DSE303: DAIRY MICROBIOLOGY

Type of Course	Elective		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the properties of milk and demonstrating precise skills in managing dairy processing unit operations.	U
CO2	Discuss the milk contamination sources, spoilage principles, milk borne diseases and antimicrobial systems.	U
CO3	Explain the role of microbes in fermented dairy products.	U
CO4	Extend knowledge on milk hygiene.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	1	-	-	1	1	1	-	-	-
CO2	-	1	-	-	-	1	-	-	-	-
CO3	1	1	-	-	-	1	-	-	-	1
CO4	-	1	-	-	1	1	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Seminar	Viva	Quiz	Exam 1	Exam 2	
CO1	x	x	-	x	-	x
CO2	x	x	x	-	x	x
CO3	x	x	x	x	-	x
CO4	x	x	-	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to dairy microbiology (15 Hrs)				
Milk- Introduction, composition, nutritive value and types of milk- skimmed milk and toned milk.	1.1	1	5	Lecture With PPT
Microorganisms in milk-bacteria, yeast, mold	1.2	1	5	Lecture With PPT
Dairy processing unit operation- Clarification, separation, standardization, toning of milk and homogenisation	1.3	1	5	Lecture With PPT
Module 2: Sources of contamination of milk (12 Hrs)				
General principles underlying spoilage of milk and milk products	2.1	2	3	Lecture With PPT
Sources of contamination of milk	2.2	2	3	Lecture With PPT
Milk borne diseases- Q fever, Brucellosis	2.3	2	4	Lecture With PPT

Antimicrobial systems in milk	2.4	2	2	Lecture With PPT
Module 3: Fermented dairy products (21 Hrs)				
Starter culture and their biochemical activities- *Streptococcus thermophilus* and *Lactobacillus bulgaricus*, Starter culture preparation	3.1	3	9	Lecture With PPT
Fermented dairy products- Cultured butter milk, Bulgarian buttermilk, Lassie, Kumiss, Cheese, Low lactose milk	3.2	3	8	Lecture With PPT
Utilization and disposal of dairy by products - Whey	3.3	3	4	
Module 4 : Milk Hygiene and microbiological standards of milk (12 Hrs)				
Bacteriological standards of milk	4.1	4	5	Lecture With PPT
Hygiene in manufacturing milk products, cleaning of dairy equipments, dairy processing plant sanitation.	4.2	4	7	Lecture With PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Robinson, R. K. Dairy Microbiology Handbook: The Microbiology of Milk and Milk Products. Wiley-Interscience, 2002.
2. Britz, T., and R. K. Robinson. Advanced Dairy Science and Technology. Wiley-Blackwell, 2008.
3. Osei, G. Handbook of Dairy Microbiology. Agri Horti Press, 2017.
4. Ozer, B., and G. Akdemir-Evrendilek. Dairy Microbiology and Biochemistry - Recent Developments. CRC Press, 2014.
5. Mathews, G. Food and Dairy Microbiology. Ed - Tech Press, 2020.
6. Marth, E. H., and J. Steele. Applied Dairy Microbiology. 2nd ed., CRC Press, 2001.
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SBU24MB5DSE304: MICROBIAL BIOREMEDIATION

Type of Course	Elective		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the knowledge about various methods employed in solid waste treatment	U
CO2	Discuss the role of microbes and the methods employed in sewage treatment.	U
CO3	Express the knowledge on disinfection and disposal of treated sewage	U
CO4	Discuss the role of microbes in the production of biofuels and bioremediation of environmental pollutants	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	1	-	-	-	1	1	-	-	-
CO2	1	1	-	-	1	1	1	-	1	1
CO3	-	1	-	-	1	1	1	-	-	1
CO4	1	1	-	-	1	1	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Seminar	Viva	Quiz	Exam 1	Exam 2	
CO1	x	x	-	x	-	x
CO2	x	x	-	x	-	x
CO3	x	x	-	-	x	x
CO4	x	x	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Solid Waste Management (11 Hrs)				
Types and sources of solid waste, solid waste disposal – composting	1.1	1	4	Lecture with PPT
sanitary landfill- static pile, aerated pile, and feed reactor, biomethanation	1.2	1	7	Lecture with PPT
Module 2: Liquid Waste Management (18Hrs)				
Sources of liquid waste, components of industrial waste water and microbiology of municipal sewage	2.1	2	3	Lecture with PPT

Sewage treatment - primary treatment: screening, sedimentation, floatation, coagulation and flocculation	2.2	2	5	Lecture with PPT
Secondary treatment - trickling filter, RBC, activated sludge, oxidation pond and tertiary treatments	2.3	2	6	Lecture with PPT
Anaerobic sludge digestion process	2.4	2	4	Lecture with PPT
Module 3: Disinfection and Disposal of Treated Sewage (11 Hrs)				
Chlorination- break point chlorination, super chlorination, chloramines, treatment.	3.1	3	6	Lecture with PPT
Chlorine dioxide. UV and Ozone treatment	3.2	3	2	Lecture with PPT
Disposal of treated sewage	3.3	3	3	Lecture with PPT
Module 4: Bioremediation and Biofuels (20 Hrs)				
Bioremediation - in situ and ex- situ techniques, Bioaugmentation	4.1	4	8	Lecture with PPT
Bioremediation of xenobiotic compounds – oil, dyes, pesticides & plastics, biosorption.	4.2	4	6	Lecture with PPT
Biodiesel, Bioethanol, Biomethane	4.3	4	6	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Barthwal, R. R. Environmental Impact Assessment. New Age International Publishers, 2012.
2. Glasson, J., R. Therivel, and A. Chadwick. Introduction to Environmental Impact Assessment. 4th ed., Routledge, 2012.
3. Odum, E. P., and G. W. Barrett. Fundamentals of Ecology. 5th ed., Thomson Brooks/Cole, 2005.
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6. Maier, R., I. Pepper, and C. Gerba. Environmental Microbiology. Academic Press, 2008.
7. Prakash, S. Biotechnology for Water and Wastewater Treatment. Navyug Publishers & Distributors, 2009.
8. Rajendran, P., and P. Gunasekaran. Microbial Bioremediation. MJP Publishers, 2006.
9. Mitchel, R. Environmental Microbiology. 2nd ed., Wiley-Blackwell, 2009.
10. Jjemba, P. K. Environmental Microbiology: Principles and Applications. Science Publishing Inc., 2004.

SBU24MB5SEC300: DIAGNOSTIC MICROBIOLOGY

Type of Course	SEC		
Course Level	300-399		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the general safety principles in a microbiology laboratory	U
CO2	Acquire knowledge on general guidelines for the safe collection and transport of specimens	U
CO3	Understand the effectiveness of antimicrobial agents and serological techniques for the detection of microbial antigens and antibodies, enhancing diagnostic accuracy and specificity.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	1	-	1	1	1	-	-	-
CO2	1	-	1	1	-	1	1	-	-	-
CO3	1	1	1	1	1	1	1	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment		Summative Assessment		ESE
	Assignment	MCQ	Exam 1	Exam 2	
CO1		x	x		x
CO2	x	x	x	x	x
CO3		x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: **Microbiology Laboratory Safety (18 Hrs)**				
General safety principles in microbiology laboratory (WHO safe codes).	1.1	1	**5**	Lecture With PPT
Universal precautions for blood and body fluids, PPE.	1.2	1	5	Lecture With PPT
Biological safety cabinets, bio-safety levels, and classification of biological agents based on hazards.	1.3	1	4	Lecture With PPT
Laboratory-associated infections, Nosocomial infections.	1.4	1	4	Lecture With PPT
Module 2: Collection, Transport and Examination of specimens (15 Hrs)				
General guidelines for collection and transport of specimens (including mailing of biohazardous materials) and its disinfection and disposal.	2.1	2	7	Lecture With PPT

Scheme for collection, transport and microbiological examination of Sputum, CSF, blood, urine, stool, wound aspirates, urogenital specimens, throat swabs, nasal swabs and oral swabs.	2.2	2	8	Lecture With PPT
Module 3: Techniques in Diagnostics (12 Hrs)				
Antimicrobial susceptibility tests- MIC, MBC. Disc diffusion- Kirby Bauer test, Stokes method, Epsilometer test. Dilution test- Broth dilution and Agar dilution. Antibiotic assay in body fluids.	3.1	3	6	Lecture With PPT
Applications of serological and molecular techniques in diagnostic microbiology- agglutination, precipitation, immunofluorescence, ELISA, PCR**,** Automation in Clinical Microbiology.	3.2	3	6	Lecture With PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Black, Jacquelyn G. Microbiology: Principles and Explorations. 9th ed., Wiley, 2014.
2. Sood, Ramesh. Medical Laboratory Technology: Methods and Interpretations. Jaypee Brothers Medical Publishers, 2003.
3. Kindt, Thomas J., et al. Kuby Immunology. 6th ed., W. H. Freeman & Company, 2006.
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9. Kauffman, Carol A., et al. Essentials of Clinical Mycology. 2nd ed., Springer, 2011.
10. Reiss, Errol, et al. Fundamental Medical Mycology. Wiley-Blackwell, 2011.
11. Razzaghi-Abyaneh, Mehdi, et al. Medical Mycology: Current Trends and Future Prospects. CRC Press, 2015.
12. Cheesbrough, Monica. District Laboratory Practice in Tropical Countries. Vol. 2, 2nd ed., Cambridge University Press, 2006.

SEMESTER VI

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24MB6DSC300	Major/Minor	Food Microbiology	5	75	4
SBU24MB6DSC301	Major/Minor	Agricultural Microbiology	5	75	4
SBU24MB6DSC302	Major/Minor	Environmental Microbiology	5	75	4
SBU24MB6DSE300	Elective	Microbial Quality Control and Testing	4	60	4
SBU24MB6DSE301	Elective	Food Safety Management	4	60	4
SBU24MB6SEC300	SEC	Sanitation Microbiology	3	45	3
SBU24MB6VAC300	VAC	Environmental biology and Human Rights	3	45	3

SBU24MB6DSC300: FOOD MICROBIOLOGY

Type of Course	Major/Minor		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss the significance of microorganisms in food and extend the knowledge on various factors affecting growth of microorganisms	U
CO2	Explain the spoilage and principles of food preservation.	U
CO3	Extend the knowledge on the role of microorganisms in fermented foods.	U
CO4	Extend knowledge on HACCP and important food pathogens.	U
CO5	Record the isolation and identification of microorganism in food.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	1	-	-	-	1	-	-	-	-
CO2	-	1	-	-	-	1	1	-	1	-
CO3	-	1	-	-	-	1	1	-	-	-
CO4	-	1	-	-	-	1	1	-	1	-
CO5	-	1	-	-	1	1	1	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Seminar	Viva	Quiz	Exam 1	Exam 2	
CO1	x	x	-	x	-	x
CO2	x	x	x	x	-	x
CO3	x	x	x	-	x	x
CO4	x	x	-	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab involvement	Lab Test	
CO1	-	-	-	-	
CO2	-	-	-	-	
CO3	-	-	-	-	
CO4	-	-	-	-	
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Microorganisms Important in Food Industry (6 Hrs)				
Food as a substrate for microorganism- A brief account of microorganism important in food industry- molds, yeast and bacteria.	1.1	1	3	Lecture with PPT
Intrinsic and extrinsic factors affecting microbial growth	1.2	1	3	Lecture with PPT
Module 2: Spoilage and principles of food preservation (18 Hrs)				
Principles and preservation of food – High temperature, Low temperature, Drying, Radiation, Pascalization	2.1	2	8	Lecture with PPT
Chemical preservatives - Food additives	2.2	2	2	Lecture with PPT
Canning-principle and procedure, Spoilage of canned foods	2.3	2	3	Lecture with PPT
Spoilage of vegetables, fruits, milk, Egg, Fish, Meat	2.4	2	5	Lecture with PPT
Module 3: Production of Fermented Food (10 Hrs)				
Production of bread and sauerkraut	3.1	3	2	Lecture with PPT
Oriental fermented foods- Miso, Tempeh, Soya sauce and Nato, Tofu	3.2	3	2	Lecture with PPT
Fermented Dairy products- Cheese, butter, Yoghurt, Kefir	3.3	3	4	Lecture with PPT
Bacteriological examination of milk	3.5	3	2	Lecture with PPT
Module 4: Food borne Illnesses and Food Safety Management (11 Hrs)				
Food borne illnesses – food borne infection and intoxications - Salmonellosis, Botulism, Rota virus, Noro virus, E. coli toxins, Mycotoxin- Aflatoxin,	4.1	4	7	Lecture with PPT
Food borne parasites –Trichinosis	4.2	4	1	Lecture with PPT
Sea food toxicants-Ciguatera poisoning, Scromboid fish poisoning	4.3	4	2	Lecture with PPT
HACCP-Definition and principle (outline)	4.4	4	1	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

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Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Microbiological Examination of Food (20 Hrs)				
Study of microbial contaminants in food products- Vegetables, Fruits and Meat	1.1	5	10	Hands On Training
Isolation of Lactobacillus from curd	1.2	5	4	Hands On Training
Enumeration and isolation of microorganism from water	1.3	5	6	Hands On Training
Module 7: Bacteriological Examination of Milk (10 Hrs)				
Methylene blue reduction test	2.1	5	2	Hands On Training
Resazurin test	2.2	5	2	Hands On Training
Phosphatase test	2.3	5	2	Hands On Training
Standard plate count of milk	2.4	5	4	Hands On Training

Reference

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SBU24MB6DSC301: AGRICULTURAL MICROBIOLOGY

Type of Course	Major/Minor		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss on soil microbes, microbial interactions and the role of microbes in biogeochemical cycles.	U
CO2	Extend the knowledge on plant -microbe interactions and microbial plant diseases.	U
CO3	Discuss the potential of different microorganisms in agriculture as biofertilizers.	U
CO4	Discuss the potential of different microorganisms as biocontrol agents.	U
CO5	Establish knowledge on isolation and characterization of soil microbes and plant pathogens.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	1	-	-	-	1	1	-	-	1
CO2	-	1	-	-	-	1	1	-	-	1
CO3	1	1	-	-	-	1	1	-	1	1
CO4	1	1	-	-	-	1	1	-	1	1
CO5	1	1	-	-	1	1	1	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Seminar	Viva	Workbook	Exam 1	Exam 2	
CO1	x	x		x		x
CO2	x	x	x		x	x
CO3	x	x	x	x		x
CO4	x	x			x	x
CO5						

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab involvement	Lab Test	
CO1	-	-	-	-	
CO2	-	-	-	-	
CO3	-	-	-	-	
CO4	-	-	-	-	
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Soil microbes and microbial interactions (11 Hrs)				
Distribution of microorganisms in soil.	1.1	1	1	Lecture with PPT
Microbial interactions – Positive interactions -mutualism, synergism (protocooperation), commensalisms	1.2	1	3	Lecture with PPT
Negative interactions–Amensalism, competition, parasitism, predation Neutralism	1.3	1	4	Lecture with PPT
Role of microorganisms in biogeochemical cycles - nitrogen, carbon, sulfur and phosphorus cycles.	1.4	1	3	Lecture with PPT
Module 2: Plant- Microbe Interactions (16Hrs)				
Microorganisms of rhizosphere, rhizoplane, phylloplane PGPR, Endophytic microflora, siderophore producing microbes	2.1	2	5	Lecture with PPT
Myccorhizae - ectomycorrhizae, endomycorrhizae and vesicular arbuscular myccorrhizae	2.2	2	2	Lecture with PPT
Microbial diseases of plants-Bacterial diseases**:** Bacterial leaf blight of rice, Citrus canker,Root wilt of vegetable crops	2.3	2	3	Lecture with PPT
Fungal diseases: Downy mildew of grapes, and Tikka disease of groundnut.	2.4	2	4	Lecture with PPT
Viral Disease – TMV, Bunchy top disease of banana	2.5	2	2	Lecture with PPT
Module 3: Biofertilizers (8 Hrs)				
Biofertilizers: Types and importance. Production and quality control: *Rhizobium, Azotobacter,Azolla*	3.1	3	3	Lecture with PPT
Mycorrhizae - VAM	3.2	3	2	Lecture with PPT
Phosphate solubilizing bacteria	3.3	3	2	Lecture with PPT
Advantages & disadvantages over chemical fertilizers.	3.4	3	1	Lecture with PPT
Module 4: Biocontrol agents (10 Hrs)				
Bacterial, fungal and viral biopesticides (any two examples for each)	4.1	4	6	Lecture with PPT
Biological control of plant diseases.	4.2	4	2	Lecture with PPT
Integrated pest management	4.3	4	2	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

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1. Agrios, George. Plant Pathology. 5th ed., Academic Press, 2005.
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Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Isolation and enumeration of soil microbes (30 Hrs)				
Isolation and enumeration of soil microbes.	1.1	5	6	Hands on Training
Calculation of R:S ratio.	1.2	5	6	Hands on Training
Isolation of *Azotobacter* sps. from soil.	1.3	5	4	Hands on Training
Isolation of Rhizobium from root nodules.	1.4	5	5	Hands on Training
Isolation of bacterial plant pathogens.	1.5	5	5	Hands on Training
Isolation of Phosphate solubilizing bacteria	1.6	5	4	Hands on Training

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1. Aneja, K. R. Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology. 3rd ed., New Age International (P) Limited, 2001.
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SBU24MB6DSC302: ENVIRONMENTAL MICROBIOLOGY

Type of Course	Major/Minor		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss on microbial contamination of air contaminants in air and air sampling techniques.	U
CO2	Extent knowledge on microbiology of aquatic environment and sewage treatment methods.	U
CO3	Discuss on biodegradation of xenobiotics and the role of microorganisms in biocorrosion and oil recovery.	U
CO4	Discuss the role of microbes in waste recycling and Bioremediation.	U
CO5	Develop skills to examine the bacteriological quality of water and evaluate DO, BOD and COD of water.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	1	-	-	-	1	-	-	-	-
CO2	-	1	-	-	-	1	1	-	1	-
CO3	1	1	-	-	-	1	1	-	1	1
CO4	1	1	-	-	-	1	1	-	1	1
CO5	-	1	-	-	1	1		-		1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Seminar	Viva	Workbook	Exam 1	Exam 2	
CO1	x	x	-	x	-	x
CO2	x	x	-	-	x	x
CO3	x	x	x	x	-	x
CO4	x	x	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab involvement	Lab Test	
CO1	-	-	-	-	
CO2	-	-	-	-	
CO3	-	-	-	-	
CO4	-	-	-	-	
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Aerobiology (10 Hrs)				
Microbial contamination of air- Sources of contamination- Microbial indicators of pollution.	1.1	1	2	Lecture with PPT
Enumeration of bacteria in air, Air sampling devices	1.2	1	4	Lecture with PPT
Air sanitation, Health effects of pollution on humans.	1.3	1	4	Lecture with PPT
Module 2: Aquatic Microbiology (13 Hrs)				
Microbiology of aquatic environment-fresh water (ponds, lakes, streams) marine (estuaries, mangroves, deep sea)	2.1	2	3	Lecture with PPT
Water pollution and waterborne pathogens. Microbial indicators of faecal pollution of water-Faecal coliforms, Bacteriological examination, Purification and disinfection of water.	2.2	2	5	Lecture with PPT
Microbiology of sewage – Wastewater treatment-Primary, Secondary and tertiary treatment, Anaerobic sludge digestion Eutrophication, Algal bloom, BOD, COD	2.3	2	5	Lecture with PPT
Module 3: Biodegradation of Xenobiotic (12 Hrs.)				
Biodegradation of Oil, Pesticide, Dyes, Lignin. Microbial corrosion-Biofilms, Microbial Methylation	3.1	3	8	Lecture with PPT
Biomagnification, Microbial-enhanced oil recovery Microbial fuel cells	3.2	3	4	Lecture with PPT
Module 4: Applied Environmental Microbiology (10 Hrs.)				
Recycling of liquid and solid waste- Composting, Biogas	4.1	4	5	Lecture with PPT
Bioremediation –ex-situ and in-situ methods, Microbial bioremediation, Phytoremediation	4.2	4	5	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Barthwal, R. R. Environmental Impact Assessment. New Age International Publishers, 2012.
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26. Grant, William D., and Philip E. Long. Environmental Microbiology. SpringerLink, 2013.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Enumeration of bacteria from water and Estimation of BOD and COD				**(30 Hrs)**
Enumeration of coliforms in water-*E. coli* MPN- Presumptive, Confirmative, Completed tests	1.1	5	6	Hands on Training
SPC of water, soil and air	1.2	5	6	Hands on Training
Determination of DO	1.3	5	6	Hands on Training
Determination of BOD	1.4	5	6	Hands on Training
Determination of COD	1.5	5	6	Hands on Training

Reference

1. Aneja, K. R. Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology. 3rd ed., New Age International (P) Limited, 2001.

2. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th ed., New Age International (P) Limited, New Delhi, 2003.
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8. Kalaichelvan, P. T. Microbiology and Biotechnology Laboratory Manual. MJP Publishers, Chennai, 2005.
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SBU24MB6DSE300: MICROBIAL QUALITY CONTROL AND TESTING

Type of Course	DSE		
Course Level	300 -399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the important terms in quality control	U
CO2	Describe the essential safety procedures in laboratory	U
CO3	Discuss on the different microbial testing methods for quality assurance.	U
CO4	Comprehend different regulations in food control	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	2	-	-	1	1	-	-	-	1
CO2	1	2	-	1	1	1	-	-	-	1
CO3	1	2	-	1	1	1	-	-	-	1
CO4	-	2	-	-	1	1	-	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Seminar	Quiz	Workbook	Exam 1	Exam 2	
CO1	x	x	x	x	-	x
CO2	x	x	x	-	x	x
CO3	x	x	x	x	-	x
CO4	x	x	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to microbiological quality control(15Hrs)				
Definition –Quality Assurance (QA), Quality Control (QC), TQM, FSMS, SSOP and importance of quality control. Historical perspective and evolution of quality control standards	1.1	1	**5**	Lecture with PPT
Laboratory Sanitation, Good Manufacturing Practices (GMP), Good Hygiene Practices (GHP), Good Veterinary Practices (GVP), Good Laboratory Practices (GLP) HACCP guidelines in different food products, Risk assessment.	1.2	1	5	Lecture with PPT
Importance of sanitation and personal hygiene in quality assurance	1.3	1	5	Lecture with PPT
Module 2: Essential safety procedures in lab(15Hrs)				
Aseptic Techniques, Handling of infectious materials	2.1	2	5	Lecture with PPT

Primary containment devices-Biosafety cabinets, Personal protection equipment (PPE), Training of personnel.	2.2	2	5	Lecture with PPT
Emergency responses and Sharps protocol, Decontamination and disposal of hazardous waste	2.3	2	5	Lecture with PPT
Module 3: Microbial testing methods for quality assurance(15Hrs)				
Sterility testing, endotoxin testing, bioburden determination Control of equipment, and quality control of media. Internal quality control (IQC), External quality control (EQA),	3.1	3	8	Lecture with PPT
Statistical methods to monitor the accuracy of laboratory assays -Central tendency and standard deviations. Application of automation in quality control	3.2	3	7	Lecture with PPT
Module 4: Quality Assurance and Regulatory compliance (15 Hrs)				
National Agencies –AGMARK, FSSAI, EIA, EIC, BIS, FPO, EHO.	4.1	4	5	Lecture with PPT
International agencies- WHO, UDFDA, EFSA, FAO, ISO-Motives of ISO22001, ISO22002, ISO 22003, ISO 22004, ISO22005.	4.2	4	5	Lecture with PPT
Documentation, validation and Record keeping-audits, inspections and corrective actions. Applications of artificial intelligence in microbial control.	4.3	4	5	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

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SBU24MB6DSE301: FOOD SAFETY MANAGEMENT

Type of Course	Elective		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain food safety concepts and enabling them to ensure and maintain the safety of food products through industry-standard practices.	U
CO2	Summarize current food safety regulations in India and understanding of the key provisions of food safety regulations effectively in the Indian context.	U
CO3	Describe the relevance of international food safety norms and enabling them to understand and comply with international food safety standards.	U
CO4	Acquire the knowledge and skills to implement Hazard Analysis Critical Control Points (HACCP) effectively.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	1	-	-	-	1	-	-	-	-
CO2	-	1	-	-	-	1	-	-	-	-
CO3	-	1	-	-	-	1	-	-	-	-
CO4	-	1	-	-	1	1	-	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Seminar	Viva	Quiz	Exam 1	Exam 2	
CO1	x	x	-	x	-	x
CO2	x	x	-	x	-	x
CO3	x	x	-	-	x	x
CO4	x	x	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Concepts in Food safety (16 Hrs)				
Food safety, Food quality control system and assurance system. Comparison of Food Quality Control & Quality assurance, Food standards, Microbiological criteria, Traceability and Recalls	1.1	1	5	Lecture With PPT

Introduction to Hazards in food: Physical hazards, Biological hazards, and Chemical hazards Safety of Ready to Eat food (RTE)	1.2	1	5	Lecture With PPT
Safe handling of food & Good Hygiene Practices. Importance of accredited food testing laboratories like National Accreditation Board for Testing and Calibration of Laboratories (NABL)	1.3	1	6	Lecture With PPT
Module 2: Food Safety Regulations in India (15 Hrs)				
Highlights of Food Safety and Standards Act of 2006 & Food Safety Regulations, 2011	2.1	2	4	Lecture With PPT
Establishment of the Food Safety and Standards Authority of India (FSSAI); Functions of FSSAI - Brief account of *fssai* manual	2.2	2	5	Lecture With PPT
Role of National Food Quality Regulatory bodies: Agricultural and Processed Food Export Development Authority (APFEDA), Marine Product Export Development Authority (MPEDA), Export Inspection Council and Export Inspection Agency (EIA)	2.3	2	6	Lecture With PPT
Module 3: International food safety regulations (14 Hrs)				
Brief account on ISO Food Safety Management System (FSMS): ISO22000, TQM	3.1	3	5	Lecture With PPT
FAO-WHO norms: *Codex alimentarius*	3.2	3	4	Lecture With PPT
Highlights of US-FDA regulations and European Union (EU) regulations Introduction to Bacteriological Analytical Manual (BAM)	3.3	3	5	Lecture With PPT
Module 4: Quality Management system -Hazard Analysis Critical Control Points (15 Hrs)				
Introduction to HACCP; 'Farm-to-Table' concept; Advantages of implementing HACCP management system	4.1	4	5	Lecture With PPT
Pre requisites for implementation of HACCP	4.2	4	3	Lecture With PPT
Seven Principles of HACCP	4.3	4	5	Lecture With PPT
An example of HACCP process flow diagram	4.4	4	2	Lecture With PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Vasconcellos, J. Andres. Quality Assurance for the Food Industry - A Practical Approach. CRC Press, 2005.
2. Schmidt, Ronald H., and Gary E. Rodrick. Food Safety Handbook. Wiley Publishers, 2005.
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SBU24MB6SEC300: SANITATION MICROBIOLOGY

Type of Course	SEC		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total**
	45	-	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss on sanitation and safety measures in animal houses, industrial fermentation units, food processing units, hospitals, and laboratories.	U
CO2	Explain on aero microbiology and air sanitation methods	U
CO3	Explain wastewater treatment processes and disinfection of water.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	1	-	-	1	1	-	-	1	1
CO2	-	1	-	-	1	1	-	-	1	1
CO3	-	1	-	-	1	1	-	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment		Summative Assessment		ESE
	Assignment	MCQ	Exam 1	Exam 2	
CO1	-	x	x	x	x
CO2	-	x	-	x	x
CO3	x	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Sanitation and safety precautions (15 Hrs)				
General concept of sanitation and disinfection. Sanitation and Safety precautions - animal houses, industrial fermentation units, food processing units	1.1	1	10	Lecture with PPT
Sanitation and Safety precautions in hospitals and laboratories	1.2	1	5	Lecture with PPT
Module 2: Aeromicrobiology (15 Hrs)				
Airborne diseases- Influenza, Chickenpox, Covid 19, Tuberculosis (TB), and preventive measures	2.1	2	6	Lecture with PPT
Methods of air sampling - settling under gravity, Centrifugal action, filtration, impingement and electrostatic forces.	2.2	2	6	Lecture with PPT
Air sanitation techniques and applications	2.3	2	3	Lecture with PPT

Module 3: Water microbiology (15 Hrs)				
Waterborne diseases - Cholera, diarrhoea, Hepatitis A, Typhoid and preventive measures	3.1	3	7	Lecture with PPT
Microbiology of municipal sewage, Wastewater treatment- Primary, Secondary and Tertiary treatments	3.2	3	5	Lecture with PPT
Disinfection of water	3.3	3	3	Lecture with PPT

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1. Barthwal, R. R. Environmental Impact Assessment. New Age International Publishers, 2012.
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SBU24MB6VAC300: ENVIRONMENTAL BIOLOGY AND HUMAN RIGHTS

Type of Course	VAC		
Course Level	300 -399		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the importance of ecosystem components and its maintenance and management measures	U
CO2	Explain the Effects of pollutants and solid waste and management of Disasters	U
CO3	Discuss about Human rights and its protection	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	1	-	-	-	1	1	-	1	-
CO2	-	1	-	-	-	1	1	-	1	-
CO3	-	-	-	-	-	1	1	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment		Summative Assessment		ESE
	Assignment	MCQ	Exam 1	Exam 2	
CO1		x	x		x
CO2	x	x	x	x	x
CO3		x		x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Environmental Issues (15 Hrs)				
Global and local environmental issues: global warming and climate change (use case studies to illustrate the points)	1.1	1	**6**	Lecture with PPT
Ozone depletion; greenhouse effect; acid rain; carbon trading, carbon credit; carbon sequestration; IPCC/UNFCC	1.2	1	5	Lecture with PPT
Nuclear accidents and nuclear holocaust	1.3	1	4	Lecture with PPT
Module 2: Pollution and Disaster Management (17 Hrs)				
Pollution: air pollution; water pollution; soil pollution; noise pollution; pesticide pollution,	2.1	2	5	Lecture with PPT
Solid waste management: causes, effects and control measures of urban and industrial waste- biodegradable and non-degradable	2.2	2	6	Lecture with PPT

Disaster management: Introduction to hazards; hazards classification; natural and anthropogenic, disaster management - earthquakes; cyclone; tsunami; floods; landslides; droughts	2.3	2	6	Lecture with PPT
Module 3: Human Rights (13 Hrs)				
Human Rights and duties in India- Preamble to the Indian constitution-Human Rights and Duties in Indian constitution	3.1	3	4	Lecture with PPT
National and International Perspectives: Definitions of Human Right, Relevance of Human Rights in India-Social Aspects-Economic Aspects-Political Aspects	3.2	3	4	Lecture with PPT
Human Rights International Norms- UDHR	3.3	3	2	Lecture with PPT
Redressal Mechanisms against Human Rights Violation: Judiciary -Government systems for Redressal - NHRC and other Statutory Commissions-Media Advocacy-Creation of Human Rights Literacy and Awareness	3.4	3	3	Lecture with PPT

Reference

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14. Stern, Nicholas. The Economics of Climate Change: The Stern Review. Cambridge University Press, Cambridge, UK, 2006.
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SEMESTER VII

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24MB7DSC400	Major/Minor	Advanced Immunology	5	75	4
SBU24MB7DSC401	Major/Minor	Molecular Biology and Genetic engineering	4	60	4
SBU24MB7DSC402	Major/Minor	Microbial Nanotechnology	4	60	4
SBU24MB7DSC403	Major/Minor	Research Methodology and Biostatistics	4	60	4
SBU24MB7DSC404	Major/Minor	IPR and Bioethics	4	60	4
SBU24MB7DSC405	Major/Minor	AMR and One Health Approach	4	60	4

SBU24MB7DSC400: ADVANCED IMMUNOLOGY

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Extend knowledge of humoral immunity, including B cell maturation, activation, and the differentiation processes leading to the generation of effector and memory B cells	U
CO2	Describe the role of cytokines and MHC in immune system.	U
CO3	Extend knowledge of cell-mediated immunity, including T cell maturation, activation, and the differentiation processes leading to the generation of effector and memory T cells.	U
CO4	Discuss about Transplantation immunology, Tumour immunology, Autoimmunity, vaccines and various immunological techniques.	U
CO5	Acquire skills on identification of immune cells and various serological techniques.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	2	1	1	1	-	-	-	1
CO2	-	-	2	1	1	1	-	-	-	1
CO3	-	-	2	1	1	1	-	-	-	1
CO4	-	-	2	2	1	1	1	-	1	1
CO5	-	-	2	2	1	1	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Research paper Review	Review paper Presentation	Seminar	Exam 1	Exam 2	
CO1	x	x	x	x	-	x
CO2	x	x	x	-	x	x
CO3	x	x	x	x	-	x
CO4	x	x	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab involvement	Lab Test	
CO1	-	-	-	-	
CO2	-	-	-	-	
CO3	-	-	-	-	
CO4	-	-	-	-	
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Overview of humoral immune response (15 Hrs)				
B cell maturation in bone marrow, B cell activation- Thymus-dependent activation and Thymus-independent activation	1.1	1	5	Lecture with PPT
B cell differentiation- Formation of plasma cells, memory cells and antibody production. Brief description of antibody diversity	1.2	1	7	Lecture with PPT
Immunological Tolerance-Central and peripheral.	1.3	1	3	Lecture with PPT
Module 2: Role of Cytokines and MHC in immune system (5 Hrs)				
Cytokines- properties, Mode of action-autocrine, paracrine and endocrine action, Functions of cytokines	2.1	2	2	Lecture with PPT
MHC-Class I & Class1I molecules -structure, Antigen processing and presentation, MHC restriction	2.2	2	3	Lecture with PPT
Module 3: Overview of Cell-mediated Immune Response (15Hrs)				
T cell activation-formation of tri-molecular complex, Signal transduction.	3.1	3	5	Lecture with PPT
T cell maturation in the thymus, Thymic selection- Positive and negative selection, Structure of TCR	3.2	3	5	Lecture with PPT
T cell differentiation-Generation of effector and memory cells	3.3	3	5	Lecture with PPT
Module 4: Medical Immunology (10Hrs)				
Tumour immunology-Tumour antigens, TATA, TSTA, Immune response in malignancy, Immunotherapy of cancer	4.1	4	3	Lecture with PPT
Transplantation immunology- Grafts, Types, Allograft and GVH Reaction. Histocompatibility testing, Immunosuppression	4.2	4	3	Lecture with PPT
Autoimmunity and autoimmune disease. Vaccines-types and uses, Immunization schedule, A brief account on new generation vaccines	4.3	4	2	Lecture with PPT
Advanced immunological techniques and applications- ELISA, RIA and Hybridoma Technology- Monoclonal Antibodies.	4.4	4	2	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Abbas, A. K., Lichtman, A. H., and Pillai, S. Cellular and Molecular Immunology. 10th Edition, Elsevier, 2021.
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Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Identification and Enumeration of immune cells (9 Hrs)				
Identification of various immune cells by Leishman staining	1.1	4	3	Hands on training
Differential count and Total Count	1.2	4	3	Hands on training
Hemagglutination	1.3	4	3	Hands on training
Module 7: Serological tests for the diagnosis of microbial infections (21 Hrs)				
Radial Immunodiffusion (RID)	2.1	4	5	Hands on training
Ouchterlony Double Immunodiffusion (ODD)	2.2	4	6	Hands on training
ASO test	2.3	4	2	Hands on training
CRP Test	2.4	4	2	Hands on training
Widal tube test	2.5	4	6	Hands on training

Reference

1. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th ed., New Age International (P) Limited, New Delhi, 2007.

2. Baltz, R. H., Davies, J. E., and Demain, A. L. Manual of Industrial Microbiology and Biotechnology. 3rd ed., American Society of Microbiology, Washington DC, 2012.
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SBU24MB7DSC401: MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Type of Course	Major/Minor		
Course Level	400 -499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the tools and techniques used in genetic engineering	U
CO2	Extend the knowledge of different gene transfer mechanisms in rDNA technology	U
CO3	Discuss on the applications of rDNA technology	U
CO4	Discuss the methods of molecular identification of microorganisms	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	2	-	1	2	1	-	-	1
CO2	1	-	2	-	1	2	1	-	-	1
CO3	1	-	2	-	2	2	1	-	1	1
CO4	1	-	2	-	2	2	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Research paper Review	Review paper Presentation	Seminar	Exam 1	Exam 2	
CO1	x	x	x	x	-	x
CO2	x	x	x	-	x	x
CO3	x	x	x	x	-	x
CO4	x	x	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Tools and techniques for Genetic Engineering (15 Hrs)				
Isolation of genetic material, Creation of rDNA.	1.1	1	4	Lecture with PPT
Enzymes for in vitro modification of nucleic acids– Kinases, Phosphatases, Exonucleases, Restriction Endonucleases, Ligases and Terminal Transferases. Types and properties of restriction enzymes.	1.2	1	4	Lecture with PPT
Modification of Ends - Adapters, Linkers, Homopolymer Tailing.	1.3	1	2	Lecture with PPT
Cloning Vectors- Plasmids and their desirable properties, E coli-based vectors pBR322, pUC19.	1.4	1	3	Lecture with PPT

Bacteriophages λ EMBL. Ti plasmids.				
Brief explanation on Cosmids, Phasmid, Shuttle vectors, YAC, BAC, Artificial chromosome	1.5	1	2	Lecture with PPT
Module 2: Methods of Gene transfer (7 Hrs)				
Artificial transformation and transfection of Bacteria Gene transfer methods – Agrobacterium-mediated, Microinjection, electroporation, biolistic method. Gene transfer by Chemical method - PEG mediated.	2.1	2	4	Lecture with PPT
Selection of recombinants. Blue-white screening, screening for Antibiotic resistance.	2.2	2	3	Lecture with PPT
Module 3: Applications of recombinant DNA technology (9 Hrs)				
Applications in medicines- Production and purification of recombinant proteins - insulin and somatostatin.	3.1	3	2	Lecture with PPT
Applications in Agriculture- 2 GMOs – Golden rice, BT Cotton, Corn Genetically modified bacteria – Superbug	3.2	3	2	Lecture with PPT
Applications in Industry-Bioethanol production.	3.3	3	2	Lecture with PPT
Gene therapy-Gene Silencing through RNA interference and antisense therapy.	3.4	3	3	Lecture with PPT
Module 4- Molecular identification of microorganisms (14 Hrs)				
Introduction to molecular identification- Signature sequences-16SrRNA sequence, fungal ITS sequencing.	4.1	4	2	Lecture with PPT
Molecular typing methods-Pulsed field gel electrophoresis	4.2	4	2	Lecture with PPT
PCR Based microbial typing, genotyping by genetic markers-variable number tandem repeats, multilocus sequence typing.	4.3	4	4	Lecture with PPT
DNA Sequencing-sangers dideoxy sequencing	4.4	4	2	Lecture with PPT
Brief account of unculturable bacteria and metagenomics	4.5	4	4	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

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2. Balasubramanian, D., et al. Concepts in Biotechnology. University Press, India, 2004.
3. Chaudhuri, Kasturi. Microbial Genetics. The Energy and Resources Institute, 2012.
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22. Green, Melvin R., and Sambrook, Joseph. Molecular Cloning: A Laboratory Manual. 4th ed., Cold Spring Harbor Laboratory Press, U.S, 2012.
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SBU24MB7DSC402: MICROBIAL NANOTECHNOLOGY

Type of Course	Major/Minor		
Course Level	400 -499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Extend the knowledge on the historical development, properties and microbial interactions of nanoparticles.	U
CO2	Describe the biological production and characterization techniques of nanoparticles.	U
CO3	Discuss the application of nanoparticles in various fields.	U
CO4	Discuss about Nanotoxicology and Biosafety Aspects.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	-	-	1	1	1	-	-	1
CO2	1	1	-	-	1	1	1	-	-	1
CO3	1	1	-	1	1	1	1	-	-	1
CO4	1	1	-	-	1	1	1	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Research paper Review	Review paper Presentation	Seminar	Exam 1	Exam 2	
CO1	x	x	x	x	-	x
CO2	x	x	x	-	x	x
CO3	x	x	x	x	-	x
CO4	x	x	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Microbial Nanotechnology (15Hrs)				
Definition and scope of nanotechnology, Historical development, Significance in various fields, including microbiology	1.1	1	5	Lecture with PPT
Properties of nanomaterials- Size-dependent, Optical, Mechanical, Electrical and Electronic, Magnetic, Chemical Reactivity, Thermal Properties, Biocompatibility, Self-Assembly	1.2	1	5	Lecture with PPT
Microbial interactions with nanomaterials- Antimicrobial, Biocompatibility, toxicity, Effect on biofilm formation, environmental bioremediation	1.3	1	5	Lecture with PPT

Module 2: Production and Characterization of nanoparticles (15Hrs)				
Nanoparticles Synthesis method- Biological methods; Bottom-Up Synthesis and Top-Down Synthesis with a few examples	2.1	2	5	Lecture with PPT
Biological methods- Concept of Green synthesis, Nanoparticle production using Microbes (Bacteria, Fungi, Yeast), Plants (stem, leaves, latex, seeds).	2.3	2	5	Lecture with PPT
Characterization techniques used in Nanobiotechnology: UV visible spectroscopy, FTIR, Energy Dispersive spectroscopy (EDS), X-ray Diffraction, Microscopy -TEM.	2.4	2	5	Lecture with PPT
Module 3: Applications of Microbial Nanotechnology (20 Hrs)				
Treatment: Effective Drug Delivery, Targeted therapy- Cancer Treatment Biomedical Imaging: Diagnostic Imaging for early detection of diseases -Magnetic Resonance Imaging (MRI) and Computed Tomography (CT)	3.1	3	10	Lecture with PPT
Food: Detection of contaminants and pathogens in food products, Nanocomposites for Food Packaging Crop Improvement: Enhancing nutrient delivery to plants. Environmental Monitoring and Remediation: Nanosensors for detecting pollutants, toxins, and pathogens; Water Purification: Nanomembranes for water purification	3.2	3	10	Lecture with PPT
Module 4: Nanotoxicology and Biosafety (10 Hrs)				
A brief account of biosafety concerns about nanoparticles; attributes contributing to nanomaterial toxicology	4.1	4	2	Lecture with PPT
Epidemiological evidence –entry routes into the human body- Lungs, Intestinal tract, Skin, Eyes, interaction with biological membranes, Neurotoxicity, toxicity of nanoparticles in food, risks of using Nanocomposites for Food Packaging	4.2	4	6	Lecture with PPT
Environmental implications of nanomaterials –Fate and Health threats	4.3	4	2	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Varghese, Thomas, and K.M. Balakrishna. Nanotechnology: An Introduction to Synthesis, Properties and Applications. Atlantis Distributors and Publishers, 2011.
2. Gogotsi, Yury. Nanomaterials – Handbook. CRC Press, Taylor & Francis Group, 2006.
3. Edelstein, Alan S., and Cammarata, Robert C. Nanomaterials: Synthesis, Properties and Applications. Taylor and Francis, 2012.
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SBU24MB7DSC403: RESEARCH METHODOLOGY AND BIOSTATISTICS

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain research fundamentals, types, methods, criteria for good research, problem-solving strategies, and the essentials of research design and literature survey	U
CO2	Describe essential research practices, including understanding and applying sampling techniques, conducting data collection and analysis procedures.	U
CO3	Explain data, as well as measures of central tendencies and measures of dispersion in research contexts.	U
CO4	Explain hypothesis testing, and statistical inference techniques, including the use of software packages such as Excel and SPSS for data analysis in research.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	2	1	1	1	-	-	1
CO2	-	-	-	1	1	1	1	-	-	1
CO3	-	-	-	1	1	1	1	-	1	1
CO4	-	-	-	2	2	1	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Research paper Review	Review paper Presentation	Seminar	Exam 1	Exam 2	
CO1	x	x	x	x	-	x
CO2	x	x	x	-	x	x
CO3	x	x	x	x	-	x
CO4	x	x	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Essentials of Research Methodology (23 Hrs)				
Significance of research, types of research, Research methods and methodology, Research and Scientific Method, Criteria of Good research	1.1	1	5	Lecture with PPT

Identifying research problems- Criteria for selection of problem and evaluating problems, Statement of problem formulation and definition.	1.3	1	5	Lecture with PPT
Research design Research design: need for research design, Features and important concepts relating to research design Features and important concepts relating to research design Different research design, Basic principles of experimental design.	1.2	1	6	Lecture with PPT
Survey of literature: Different methods of literature survey, sources of information, internet, search engines, websites, recording surveying information	1.3	1	4	Lecture with PPT
Hypothesis: Nature and types of hypotheses	1.4	1	3	Lecture with PPT
Module 2: Proficient Research Practices – Sampling to Reporting (12 Hrs)				
Sample and Sampling methods: Sample - meaning, types. Sampling - Unit of sampling, characteristics of good samples, Sampling errors and ways to reduce them.	2.1	2	5	Lecture with PPT
Collection, analysis and interpretation of data-Procedure of data collection-Primary and secondary, analysis and interpretation of data.	2.3	2	4	Lecture with PPT
Research report: Features of the report, format of research report, references pattern.	2.4	2	3	Lecture with PPT
Module 3: Statistics for Data Analysis in Research (10 Hrs)				
Measures of Central Tendencies – Mean, Median and Mode	3.2	3	5	Lecture with PPT
Measures of Dispersion - Range, Mean deviation, Standard Deviation and Co-efficient of Variation.	3.3	3	5	Lecture with PPT
Module 4: Statistical Inference (15 Hrs)				
Testing of Hypothesis: Null and Alternative Hypothesis – Two types of error – Level of significance.	4.1	4	6	Lecture with PPT
Test based on student t-test, Chi–Square, ANOVA.	4.2	4	5	Lecture with PPT
Software packages – EXCEL, SPSS, R software	4.3	4	4	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Gupta, S.P. Statistical Methods. New Delhi: Sultan Chandh.
2. Gurumani, N. Research Methodology for Biological Sciences. Chennai: MJP Publishers.
3. Holmes, Debbie Moody, Peter Dine, and Diana. Research Methods for the Biosciences. Oxford, New York.
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7. Indrayan, A., and Satyanarayana, L. Biostatistics for Medical, Nursing and Pharmacy Students.

SBU24MB7DSC404: IPR AND BIOETHICS

Type of Course	Major/Minor		
Course Level	400 -499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain Intellectual Property Rights with detailed exploration of diverse IPR categories.	U
CO2	Comprehensive understanding of the Patent Acts and amendments and national and international agencies involved in patenting,	U
CO3	Explain intellectual property rights in microbiology, encompassing the protection of microbial strains and products through IPR categories	U
CO4	Discuss bioethics in microbiology, ethical and legal implications in research, ethical challenges and issues.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	1	-	1	1	-	-	-
CO2	-	-	-	1	-	1	1	-	-	-
CO3	1	-	-	1	-	1	1	-	-	-
CO4	-	-	-	1	-	1	1	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Research paper Review	Review paper Presentation	Seminar	Exam 1	Exam 2	
CO1	x	x	x	x	-	x
CO2	x	x	x	-	x	x
CO3	x	x	x	x	-	x
CO4	x	x	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Overview of Intellectual Property Rights (14 Hrs)				
Introduction to Intellectual Property Rights (IPR), Importance of protecting scientific discoveries	1.1	1	2	Lecture with PPT
Types of IPR: Copyright, Trademarks, Patents, Trade Secrets, Industrial Designs, Geographical Indications, Traditional Knowledge, Plant Variety Rights, Database Rights.	1.2	1	4	Lecture with PPT

Qualification for a Patent – Novel, Commercial & Non-obvious	1.3	1	8	Lecture with PPT
Module 2: Patenting (12 Hrs)				
Indian Patent Act 1970; Recent Amendments; Patent application- forms, guidelines, Process of filing of a patent application, Rights of patent holder. Basmati rice patent issue: a case study	2.1	2	6	Lecture with PPT
Agencies involved in patenting: Indian -CGPDTM, IPO, NBA and International- WIPO, EPO, USPTO	2.2	2	6	Lecture with PPT
Module 3: Intellectual Property Rights for Microbiology (14 Hrs)				
Trademarks in microbiology- Protection of microbial strains and products	3.1	3	2	Lecture with PPT
Patenting of microbes- Patent protection to GMO, Access and benefit-sharing in microbial resources, - International agreement- Ex: Nagoya Protocol, International Microorganism Deposit system of WIPO	3.2	3	6	Lecture with PPT
Emerging issues of IPR for Microbiology -Gene editing technologies (CRISPR), Patent infringements and litigations in Microbiology	3.3	3	6	Lecture with PPT
Module 4: Bioethics (20Hrs)				
Introduction to Bioethics- Ethical, legal and social implications (ELSI), Examples for historical cases of ethical issues.	4.1	4	3	Lecture with PPT
Ethics in conduct of Research- Scientific integrity and misconduct, Authorship and publication ethics.	4.2	4	2	Lecture with PPT
Ethical challenges and issues in studying pathogens- Dual-use research of concern (DURC) with examples, Bio-weapons and Bio-terrorism with examples.	4.3	4	4	Lecture with PPT
Vaccines- Vaccine preparation & trials. Antiviral Drug- phases of drug trials, Biosecurity, Animal testing and alternatives Genetically modified Organisms- Biosafety and environmental safety concerns, GMO in India, Labelling of GM foods.	4.4	4	7	Lecture with PPT
Regulatory bodies in India and GEAC, ICMR, DBT, and Institutional Ethics Committees (IECs).	4.5	4	4	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Narayanan, P. Intellectual Property Laws. Eastern Law House, 2001.
2. Goel, Deepa, and Parashar, Shomini. IPR, Biosafety and Bioethics. Pearson Education India, 2013.
3. Intellectual Property Law containing Acts and Rules. Universal Law Publication Company, 2015.
4. Smith, John E. Biotechnology. 3rd ed., Cambridge University Press, 1996.
5. Singh, Prithipal. An Introduction to Biodiversity. Ane Books India, 2007.

6. Paul, Meenu. Intellectual Property Laws. Allahabad Law Agency, 2009.
7. Pradhan, Nirmal Chandra. Basics of Biodiversity. Anmol, 2008.
8. Dwivedi, Padmanabh, Dwivedi, S.K., and Kalita, M.C. Biodiversity and Environmental Biotechnology. Scientific, 2007.
9. Important Links. [List of important links]. Retrieved from:
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11. http://www.wipo.int/portal/index.html.en
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15. http://www.cbd.int/biosafety/background.shtml
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SBU24MB7DSC405: AMR AND ONE HEALTH APPROACH

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss on diverse antimicrobial agents, mode of action, antimicrobial resistance and understanding the concepts like biofilm, and quorum sensing.	U
CO2	Describe on Mechanism of antibiotics and role of microorganisms in antibiotic resistance.	U
CO3	Acquire knowledge on mode of action of antimicrobial resistance	U
CO4	Comprehensive understanding of the One Health approach and acquire knowledge of challenges caused by MDR pathogens and develop strategies to control.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analys1e; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	1	1	2	1	-	-	1
CO2	2	2	1	1	1	2	1	-	-	1
CO3	1	1	1		1	2	1	-	-	1
CO4	1	1	2	1	1	2	1	-	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Research paper Review	Review paper Presentation	Seminar	Exam 1	Exam 2	
CO1	x	x	x	x	-	x
CO2	x	x	x	-	x	x
CO3	x	x	x	x	-	x
CO4	x	x	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to AMR (15 Hrs)				
Antimicrobial agents- definition and types- Antibiotics, Antifungal, Antiviral and Antiprotozoal drugs.	1.1	1	3	Lecture with PPT
Antimicrobial resistance- definition, MDR, XDR, PDR.	1.2	1	3	Lecture with PPT
Effects of AMR. Hospital as a hub of AMR. AMR in the environment and spread of AMR.	1.3	1	3	Lecture with PPT

Reasons for AMR- indiscriminate use, use in poultry and agriculture, self-medication Industrial pollution, untreated disposal of sewage water bodies	1.4	1	3	Lecture with PPT
Brief of antibiotic-resistant genes (ARGs). Brief account on biofilm and AMR, Brief account on Quorum sensing.	1.5	1	3	Lecture with PPT
Module 2: Antibiotics Mechanism of action and AMR Organisms (15 Hrs)				
Antibiotics mechanism of action-cell wall, Folate, Protein inhibition. Toxicity and side effects	2.1	2	3	Lecture with PPT
Methicillin-resistant Staphylococcus aureus (MRSA), Vancomycin-resistant Enterococci (VRE), Multi-drug Resistant Tuberculosis (MDR-TB), ESBL-producing Enterobacteriaceae	2.2	2	12	Lecture with PPT
Module 3: Mechanisms of AMR. (15 Hrs)				
Causes of antimicrobial resistance- natural resistance, Acquired resistance- selective pressure, mutation and gene transfer (brief account).	3.1	3	5	Lecture with PPT
Mechanisms of antimicrobial resistance- Altered target sites- (modified Penicillin-binding proteins), Production of antibiotic inactivating enzymes (beta-lactamases), Altered membrane permeability (disruption of membrane), Efflux pumps. (ABC transporters)	3.2	3	5	Lecture with PPT
Carbapenam resistant Pseudomonas, ESKAPE pathogens. Drug-resistant candida.	3.3	3	5	Lecture with PPT
Module 4: One Health Approach & Prevention of AMR (15 Hrs)				
Introduction to one health approach. Global health Vs. One health.	4.1	4	2	Lecture with PPT
Applications of One Health approach- prevention of AMR, A brief account of National One Health Mission.	4.2	4	5	Lecture with PPT
Antibiotic policy, surveillance in health care centers. Alternate treatment options- phage therapy.	4.3	4	4	Lecture with PPT
Brief of Global Action Plan, National action plan, state action plan to combat Antimicrobial Resistance (GAP). Kerala Antibiotic Resistance Strategic Action Plan (KARSAP)	4.4	4	4	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Kon, K., & Rai, M. Antibiotic Resistance: Mechanisms and New Antimicrobial Approaches. Elsevier Science, 2016.
2. Antibiotic Resistance: Mechanisms and Antimicrobial Approaches. States Academic Press, 2022.
3. Prescott, L.M., Harley, J.P., & Klein, D.A. Microbiology. 6th ed., McGraw-Hill, 2005.
4. One Health: People, Animals, and the Environment. Wiley, 2014.
5. WHO Guidelines on Use of Medically Important Antimicrobials in Food-producing Animals. World Health Organization, 2017.
6. Black, J.G., & Black, L.J. Microbiology: Principles and Explorations. Wiley, 2018.

7. Tortora, G.J., Funke, B.R., & Case, C.L. Microbiology. Pearson Benjamin Cummings, 2010

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SEMESTER VIII

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24MB8DSC400	Major	Clinical Microbiology	5	75	4
SBU24MB8DSC401	Major	Pharmaceutical Microbiology	5	75	4
SBU24MB8DSC402	Major	Forensic Biology	5	75	4
SBU24MB8PRJ400	Major	Project			12

SBU24MB8DSC400: CLINICAL MICROBIOLOGY

Type of Course	Major		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Extend the knowledge on microbiology laboratory safety methods	U
CO2	Express the knowledge on specimen management	U
CO3	Summarize the knowledge on etiology, pathogenesis and laboratory diagnosis of various infections.	U
CO4	Discuss on nosocomial infections and clinical laboratory management	U
CO5	Apply the knowledge on isolation and identification of various clinical specimens	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	1	1	1	1	-	-	-	1
CO2	1	-	1	1	1	1	-	-	-	1
CO3	1	-	2	1	1	1	1	-	-	1
CO4		-	2	2	1	1	1	-	-	1
CO5	1	-	1	1	2	-	-	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Research paper Review	Review paper Presentation	Seminar	Exam 1	Exam 2	
CO1	x	x	x	x	-	x
CO2	x	x	x	-	x	x
CO3	x	x	x	x	-	x
CO4	x	x	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab involvement	Lab Test	
CO1	-	-	-	-	
CO2	-	-	-	-	
CO3	-	-	-	-	
CO4	-	-	-	-	
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Microbiology laboratory safety (7 Hrs)				
Chemical Safety, Fire Safety, Electrical Safety, Biosafety	1.1	1	3	Lecture with PPT
Biological safety cabinets, Biosafety levels, Bioterrorism	1.2	1	2	Lecture with PPT
Mailing of bio hazardous materials	1.3	1	2	Lecture with PPT
Module 2: Specimen Management (9 Hrs)				
Collection, handling and transport of clinical specimens	2.1	2	3	Lecture with PPT
Specimen preservation	2.2	2	3	Lecture with PPT
Specimen workup	2.3	2	3	Lecture with PPT
Module 3: Diagnosis of infections associated with specific organ system (22 Hrs)				
Upper and lower respiratory tract infections- Etiology, pathogenesis and laboratory diagnosis	3.1	3	8	Lecture with PPT
Urinary tract infections, Genital tract infections and sexually transmitted diseases	3.2	3	7	Lecture with PPT
Gastro intestinal tract, Central nervous, blood -circulatory system	3.3	3	7	Lecture with PPT
Module 4: Clinical Laboratory Management(7Hrs)				
Nosocomial infections	4.1	4	2	Lecture with PPT
Infection control	4.2	4	2	Lecture with PPT
Accreditation of laboratories-NABL	4.3	4	1	Lecture with PPT
Good Laboratory practices	4.4	4	2	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Black, Jacquelyn G. Microbiology: Principles and Explorations. 9th ed., Wiley, 2014.
2. Sood, Ramnik. Medical Laboratory Technology: Methods and Interpretation. Jaypee Brothers Medical Publisher, 2003.
3. Kindt, Thomas J., et al. Kuby Immunology. 6th ed., W. H. Freeman & Company, 2006.
4. Forbes, Betty A., et al. Bailey & Scott's Diagnostic Microbiology. 12th ed., Mosby-Year Book, London, 2007.
5. Mukherjee, Kanai Lal, and Ghosh S. Medical Laboratory Technology. 2nd ed., Tata McGraw-Hill Education, 2010.
6. Sonnenwirth, Allen C., and Jarett, L. Gradwohl's Clinical Laboratory Methods and Diagnosis. 8th ed., Mosby-Year Book, London, 1980.
7. Cheesbrough, Monica. District Laboratory Practice in Tropical Countries. Vol. 2. 2nd ed., Cambridge University Press, 2006.
8. Mackie, T. J., McCartney, J. E., and Collee, J. G. Mackie & McCartney Practical Medical Microbiology. 13th ed., Churchill Livingstone, 1989.
9. Topley, W. W. C., et al. Topley and Wilson's Principles of Bacteriology, Virology and Immunology. Hodder Arnold, 1990.
10. Blair, J. E., Lennette, E. H., and Truant, J. P. Manual of Clinical Microbiology. American Society for Microbiology, 1970.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Isolation and identification of bacteria from clinical samples(18Hrs)				
Study of normal microbial flora of human body	1	CO5	6	Hands on training
Isolation and identification of bacteria from clinical samples- Blood, urine, pus, sputum	1.2	CO5	8	Hands on training
Disc diffusion assay	1.3	CO5	4	Hands on training
Module 7: Isolation and identification of fungi (12 Hrs)				
Culture methods for isolation and identification of fungi- KOH mount preparation, Slideculture technique	2.1	CO5	6	Hands on training
Gram staining and Germ tube test of *Candida albicans*	2.2	CO5	6	Hands on training

Reference

1. Aneja, K.R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th ed., New Age International (P) Limited, New Delhi, 2007.
2. Baltz, R.H., Davies, J.E., and Demain, A.L. Manual of Industrial Microbiology and Biotechnology. 3rd ed., American Society of Microbiology, 2012.
3. Dubey, R.C., and Maheswari, D.K. Practical Microbiology. 2nd ed., S. Chand & Co., New Delhi, 2002.
4. Goldman, E., and Green, L.H. Practical Handbook of Microbiology. 2nd ed., CRP Press, 2008.
5. Gunasekaran, P. Laboratory Manual in Microbiology. 2nd ed., New Age International (P) Limited, New Delhi, 2002.
6. Kalaichelvan, P.T. Microbiology and Biotechnology Laboratory Manual. MJP Publishers, Chennai, 2005.
7. Kannan, N. Laboratory Manual in General Microbiology. 2nd ed., Panima Publishing Co., New Delhi, 2002.
8. McNeil, B., and Harvey, L.M. Practical Fermentation Technology. John Wiley & Sons, Ltd, Chichester, 2008.
9. Murugalatha, N., et al. Microbiological Techniques. MJP Publishers, Chennai, 2012.
10. Cappuccino, J.G., and Sherman, N. Microbiology: A Laboratory Manual. 10th ed., Pearson Education India, 2014.
11. Morello, J.A., Granato, P.A., and Morton, V. Lab Manual and Workbook in Microbiology: Applications to Patient Care. 12th ed., McGraw Hill, 2018.
12. Brown, Alfred E., and Smith, Heather R. Benson's Microbiological Applications, Laboratory Manual in General Microbiology. 14th ed., McGraw-Hill College, 2016.

SBU24MB8DSC401: PHARMACEUTICAL MICROBIOLOGY

Type of Course	Major		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Demonstrate the principles of chemotherapy and antimicrobial agents.	U
CO2	Explain the spoilage, sterilization of pharmaceutical products, sterility testing and preservation of pharmaceutical products	U
CO3	Demonstrate the role of microbial metabolites in the pharmaceutical field.	U
CO4	Determine the concepts of drug designing and quality management in pharmaceuticals	U
CO5	Determine the microbiological techniques including crowded plate technique, antibiotic assays and enabling them to interpret experiments in pharmaceutical science in adherence to safety considerations	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	1	-	2	-	-	-	1
CO2	1	2	-	1	-	2		-	-	1
CO3	1	1	-	1	1	2	-	-	-	1
CO4	1	2	-	1	2	2	-	-	-	1
CO5	1	1	1	1	1	2	-	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Research paper Review	Review paper Presentation	Seminar	Exam 1	Exam 2	
CO1	x	x	x	x	-	x
CO2	x	x	x	-	x	x
CO3	x	x	x	x	-	x
CO4	x	x	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab involvement	Lab Test	
CO1	-	-	-	-	
CO2	-	-	-	-	
CO3	-	-	-	-	
CO4	-	-	-	-	
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Pharmaceutical Microbiology (13 Hrs)				
History of Chemotherapy- Contributions of Paul Ehrlich, Joseph Lister, Alexander Fleming, Florey and chain contributions.	1.1	1	5	Lecture with PPT
Brief account on Antibiotics and synthetic antimicrobial agents - Antibacterial agents, Antifungal agents, Antiviral agents, and Anti-protozoan agents.	1.2	1	8	Lecture with PPT
Module 2: Sterilization and Sterility Testing of Pharmaceutical Products (10 Hrs)				
Sterilization methods for pharmaceutical products – Thermal methods- Steam sterilization, dry heat radiations – gamma radiations Filtration Chemical sterilization – gaseous method- ethylene oxide	2.1	2	5	Lecture with PPT
Microbial Sterility testing of different pharmaceutical preparations (solids, liquids, ophthalmic and other sterile products) according to IP, BP and USP.	2.2	2	5	Lecture with PPT
Module 3: Microbial Products in Pharmaceuticals (10 Hrs)				
Pharmaceuticals produced by microbial fermentations Antibiotics – Penicillin, Streptomycin Vitamins – Cyanocobalamine.	3.2	3	5	Lecture with PPT
Brief account on new generation vaccines - DNA vaccines, synthetic peptide vaccines, live carrier vaccine and multivalent subunit vaccines. Vaccine clinical trials.	3.3	3	5	Lecture with PPT
Module 4: Drug Design (12 Hrs)				
Rational drug design- Basic concept and steps of drug design. Briefly explain Lead drug and Pro-drug with examples	4.1	4	6	Lecture with PPT
Quality assurance and quality management in pharmaceuticals- ISO, WHO and USFDA.	4.3	4	6	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Hugo, W.B., and Russell, A.D. Pharmaceutical Microbiology. 6th ed., Blackwell Scientific Publications.
2. Hanlon, Geoff, and Hodges, Norman A. Essential Microbiology for Pharmacy and Pharmaceutical Science. Wiley-Blackwell, 2013.
3. Kar, Ashutosh. Pharmaceutical Microbiology. 1st ed., New Age International (P) Ltd Publishers, 2019.
4. Chakraborty, C., and Bhattacharya, A. Pharmacogenomics: An Approach to New Drug Development. Biotech Books, New Delhi, 2004.

5. Dutton, C.J., et al. Peptide Antibiotics. Marcel Dekker Inc., NY, USA, 2002.
6. Krogsgaard-Larsen, P., Lilijefors, T., and Madsen, U. Textbook of Drug Design and Discovery. 3rd ed., Taylor and Francis, London, 2004.
7. Vyas, S.P., and Dixit, V.K. Pharmaceutical Biotechnology. CBS Publishers & Distributors, New Delhi.
8. Cooper, Murray S. Quality Control in the Pharmaceutical Industry. Vol. 2, Academic Press, New York.
9. Saghee, Madhu Raju, et al. Microbiology and Sterility Assurance in Pharmaceuticals and Medical Devices. Business Horizons, 2011.
10. Seth, S.D. Textbook of Pharmacology. 2nd ed., Elsevier, New Delhi, 2004.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Microbiological Assay of Antibiotics and Analysis of Pharmaceutical Products (30 Hrs)				
Isolation of antibiotic-producing organisms by Crowded Plate technique	1.1	5	5	Hands on training
Microbiological assay of antibiotics by cup plate method.	1.2	5	5	Hands on training
Determination of MIC of Beta-lactam/aminoglycoside/ tetracycline	1.3	5	5	Hands on training
Analysis of pharmaceutical products for microbial contamination and load (syrups, suspensions, creams and ointments, ophthalmic preparations).	1.4	5	5	Hands on training
Determination of antimicrobial activity of a disinfectant	1.5	5	5	Hands on training
Antibiotic sensitivity test- Disc Diffusion	1.6	5	5	Hands on training

Reference

1. Aneja, K. R. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th ed., New Age International (P) Limited, New Delhi, 2007.
2. Baltz, R. H., Davies, J. E., and Demain, A. L. Manual of Industrial Microbiology and Biotechnology. 3rd ed., American Society of Microbiology, 2012.
3. Dubey, R. C., and Maheswari, D. K. Practical Microbiology. 2nd ed., S. Chand & Co., New Delhi, 2002.
4. Goldman, E., and Green, L. H. Practical Handbook of Microbiology. 2nd ed., CRP Press, 2008.
5. Gunasekaran, P. Laboratory Manual in Microbiology. 2nd ed., New Age International (P) Limited, New Delhi, 2002.
6. Kalaichelvan, P. T. Microbiology and Biotechnology Laboratory Manual. MJP Publishers, Chennai, 2005.
7. Kannan, N. Laboratory Manual in General Microbiology. 2nd ed., Panima Publishing Co., New Delhi, 2002.
8. McNeil, B., and Harvey, L. M. Practical Fermentation Technology. John Wiley & Sons, Ltd, Chichester, 2008.
9. Murugalatha, N., et al. Microbiological Techniques. MJP Publishers, Chennai, 2012.
10. Cappuccino, J. G., and Sherman, N. Microbiology: A Laboratory Manual. 10th ed., Pearson Education India, 2014.

11. Morello, J. A., Granato, P. A., and Morton, V. Lab Manual and Workbook in Microbiology: Applications to Patient Care. 12th ed., McGraw Hill, 2018.
12. Brown, A. E., and Smith, H. R. Benson's Microbiological Applications, Laboratory Manual in General Microbiology. 14th ed., McGraw-Hill College, 2016.
13. Gunasekaran, P. Laboratory Manual in Microbiology. 2nd ed., New Age International (P) Limited, New Delhi, 2002.
14. Janarthanan, S., and Vincent, S. Practical Biotechnology: Methods and Protocols. Orient BlackSwan/Universities Press, 2007.
15. Jane, M., et al. Practical Handbook in Microbial Biotechnology. LAP Lambert Academic Publishing, 2012.
16. Kalaichelvan, P. T. Microbiology and Biotechnology Laboratory Manual. MJP Publishers, Chennai, 2005.
17. Kannan, N. Laboratory Manual in General Microbiology. 2nd ed., Panima Publishing Co., New Delhi, 2002.
18. Murugalatha, N., et al. Microbiological Techniques. MJP Publishers, Chennai, 2012.
19. Prince, C. P. Practical Manual of Medical Microbiology. Jaypee Brothers Medical Publishers (p) Ltd., New Delhi, 2009.
20. Cappuccino, J. G., and Sherman, N. Microbiology: A Laboratory Manual. 10th ed., Pearson Education India, 2014.
21. Morello, J. A., Granato, P. A., and Morton, V. Lab Manual and Workbook in Microbiology: Applications to Patient Care. 12th ed., McGraw Hill, 2018.
22. Brown, A. E., and Smith, H. R. Benson's Microbiological Applications, Laboratory Manual in General Microbiology. 14th ed., McGraw-Hill College, 2016.

SBU24MB8DSC402: FORENSIC BIOLOGY

Type of Course	Major		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the basic concepts of forensic biology and significance of biological evidence.	U
CO2	Understand the importance of seminal and other body fluids in forensic biology	U
CO3	Explain the importance of blood in crime investigations.	U
CO4	Understand the importance of hair and fiber in crime investigations and analysis of diatoms in drowning cases	U
CO5	Acquire skills in Forensic DNA Analysis	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	1	1	-	1	1	-	1	-
CO2	-	-	1	1	-	1	1	-	1	1
CO3	-	-	1	1	-	1	1	-	1	1
CO4	-	-	1	1	-	1	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Research paper Review	Review paper Presentation	Seminar	Exam 1	Exam 2	
CO1	x	x	x	x	-	x
CO2	x	x	x	-	x	x
CO3	x	x	x	x	-	x
CO4	x	x	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment	ESE
	Record	Viva	Lab involvement	Lab Test	
CO1	-	-	-	-	
CO2	-	-	-	-	
CO3	-	-	-	-	
CO4	-	-	-	-	
CO5	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Forensic Biology (6 Hrs)				
Forensic biology: History and scope, divisions- Nature and importance of biological evidences.	1.1	1	6	Lecture with PPT
Module 2: Forensic serology (20 Hrs)				
Collection, preservation and packaging of biological evidences. Seminal Stains and other body fluids.	2.1	2	6	Lecture with PPT
Composition, functions and morphology of spermatozoa. Identification of seminal stains- Presumptive Tests-Acid Phosphatase Test, Barberios Test and Florence Crystal Test. Confirmatory Test -Sperm Detection.	2.2	2	6	Lecture with PPT
Body fluids: Forensic significance of other body fluids as Saliva, Sweat and faecal matters, their collection	2.3	2	8	Lecture with PPT
Module 3: Blood Stains (15 Hrs)				
Components of Blood. Identification of blood stains: Presumptive tests- Benzidine test, Phenolphthalein test, Leucomalachite test, TetraMethylbenzidine test and O-Toludine, Luminol test. Confirmatory tests- Haemochromogen test, Haematin test and Haemin test	3.1	3	8	Lecture with PPT
Bloodstain Pattern Analysis (BPA): Biological and physical properties of human blood, Droplet Directionality from bloodstain patterns, Determination of Point of Convergence and Point of Origin, Impact spatter and mechanisms, Importance and Legal aspects of BPA	3.2	3	7	Lecture with PPT
Module 4: Hair, Fibres and Diatoms (19 Hrs)				
Structure of human hair: Inner and Outer morphology, biochemistry of hair and growth stages- Comparison of human and animal hair: medulla, Medullary index calculation, Cuticle examination- Fibre – Classification	4.1	4	7	Lecture with PPT
Natural, semi-synthetic and synthetic fibres and their properties- Structure analysis for different types of fibres and their Forensic significance	4.2	4	6	Lecture with PPT
Classification, Location, Structure, types, detection and identification of diatoms and Forensic Significance. In drowning cases.	4.3	4	6	Lecture with PPT
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Brown, T. Gene Cloning and DNA Analysis: An Introduction. 5th ed., Blackwell Publishing, London, 2006.
2. Butler, J. Advanced Topics in Forensic DNA Typing: Methodology. 1st ed., Academic Press, London, 2009.

3. Easteal, S., McLeod, N., & Reed, K. DNA Profiling: Principles, Pitfalls and Potential. Harwood Academic Publishers, New Jersey, 1991.
4. Primorac, D., & Schanfield, M. Forensic DNA Applications: An Interdisciplinary Perspective. CRC Press, New York, 2014.
5. Rudin, N., & Inman, K. An Introduction to Forensic DNA Analysis. 2nd ed., CRC Press, New York, 2001.
6. Spencer, C. Genetic Testimony: A Guide to Forensic DNA Profiling. Pearson.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Forensic Techniques (30 Hrs)				
DNA typing from fresh blood	1.1	5	8	Hands on training
DNA typing from dried blood	1.2	5	8	Hands on training
Analysis of DNA by Gel Electrophoresis	1.3	5	7	Hands on training
Report writing for DNA protein profiling for a particular disease	1.4	5	7	Hands on training

Reference

1. Brown, T. Gene Cloning and DNA Analysis: An Introduction. 5th ed., Blackwell Publishing, London, 2006.
2. Butler, J. Advanced Topics in Forensic DNA Typing: Methodology. 1st ed., Academic Press, London, 2009.
3. Easteal, S., McLeod, N., & Reed, K. DNA Profiling: Principles, Pitfalls and Potential. Harwood Academic Publishers, New Jersey, 1991.
4. Primorac, D., & Schanfield, M. Forensic DNA Applications: An Interdisciplinary Perspective. CRC Press, New York, 2014.
5. Rudin, N., & Inman, K. An Introduction to Forensic DNA Analysis. 2nd ed., CRC Press, New York, 2001.
6. Spencer, C. Genetic Testimony: A Guide to Forensic DNA Profiling. Pearson.

SBU24MB8PRJ400: PROJECT

Type of Course	Major		
Course Level	400-499		
Credit	12		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Developing skills to conduct advanced research in their chosen field of study, employing methodologies and critical analysis.	A
CO2	Acquire skills to showcase their capacity for independent inquiry and scholarly writing.	A
CO3	Acquire interdisciplinary knowledge and contribute innovative insights to the respective field of study.	A
CO4	Enhance critical thinking abilities and refine communication skills through presenting their findings.	A
CO5	Develop advanced skills in project management, problem-solving, preparing themselves for professional pursuits in their discipline.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	-	2	2	2	-	-	1	2
CO2	2	-	-	2	2	2	-	-	1	2
CO3	2	-	-	2	2	2	-	-	1	2
CO4	2	-	-	2	2	2	-	-	1	2
CO5	2	-	-	2	2	2	-	-	1	2

Rubrics for Assessment Tools

Each course contains specific assessment tools. However, the faculty teaching the course has the freedom to alter these tools according to the course requirements, with prior permission from the respective Board of Studies.

Rubrics for Assignment

Criteria	Level 1	Level 2	Level 3	Level 4	Score
Descriptives used	Script presented is disorganized and provides an unsupported beginning, middle and end.	Script is organized simplistically and methodically and provides a simplistic beginning, middle and end	Script is organized systematically and logically and provides a logical beginning, middle and end	Script is organized skillfully and purposefully and provides an insightful beginning, middle and end.	1
Quality of reporting	Description is poor	The quality of the description is fair but lack stability	The quality & style of reporting is good but unsuccessful in connecting the findings	The quality & style of reporting is very good & findings are well connected with theory	1
References	No references	Some references but irrelevant	Relevant references, but not in the proper format	Relevant references & in the proper format	1

Rubrics for Seminar

Criteria	Level 1	Level 2	Level 3	Level 4	Score
Communication (Oral)	The student is either distracting, overly quiet or only makes remarks that do not advance the discussion.	Student participate but only sometimes offers ideas that move the discussion in new direction. Some distracting speech	Student participate regularly offering ideas, push the discussion in new direction	Student offering information being communicated with high degree of effectiveness, pushing the discussion in new direction	1
Preparation	Frequently arrives unprepared	Sometimes arrives unprepared or with only superficial preparation	Arrives fully prepared with seminar notes with limited book reference.	Arrives fully prepared with seminar material and in depth preparation.	1
Content	Thesis not clear and information presented not related to the seminar topic	Great deal of information not clearly connected to seminar topic	Many good points related to the seminar topic	Material related to seminar topic,all points clearly made	1

Penalty for late submission:

If submitted within 1 week after the stipulated time 75% of the marks calculated as per the above rubrics will be awarded to the students.
If submission is after 1 week of deadline but within the extended time fixed by the course in charge, only 50% of the marks determined as per rubrics will be awarded.

Rubrics for Research Paper Review

Criteria	Level 1	Level 2	Level 3	Level 4	Score
Content	Central purpose or argument is not clearly identified. Analysis is vague or not evident. Reader is confused or may be misinformed	Information supports a central purpose or argument at times. Analysis is basic or general. Reader gains few insights	Information provides reasonable support for a central purpose or argument and displays evidence of a basic analysis of a significant topic. Reader gains some insights	Balanced presentation of relevant and legitimate information that clearly supports a central purpose or argument and shows a thoughtful, in-depth analysis of a significant topic. Reader gains important insights	1
Organization	The writing is not logically organized. Frequently, ideas fail to make sense together. The reader cannot identify a line of reasoning and loses interest.	In general, the writing is arranged logically, although occasionally ideas fail to make sense together. The reader is fairly clear about what writer intends.	The ideas are arranged logically to support the central purpose or argument. They are usually clearly linked to each other. For the most part, the reader can follow the line of reasoning	The ideas are arranged logically to support the purpose or argument. They flow smoothly from one to another and are clearly linked to each other. The reader can follow the line of reasoning.	1
Sentence Structure	Errors in sentence structure are frequent enough to be a major distraction to the reader	Some sentences are awkwardly constructed so that the reader is occasionally distracted.	Sentences are well-phrased and there is some variety in length and structure. The flow from sentence to sentence is generally smooth	Sentences are well-phrased and varied in length and structure. They flow smoothly from one to another.	1

Rubrics for Research paper presentation

Criteria	Level 1	Level 2	Level 3	Level 4	Score
Content and Knowledge	Information not presented clearly, concisely, nor logically. Ideas unsupported. Inappropriate.	Information not always clear, and line of reasoning not always easy to follow. Information and ideas mostly appropriate.	Presents all the pertinent information, clearly, concisely, and logically. Focuses on the most appropriate information.	Presents all the pertinent information clearly, concisely, and logically. Focuses on the most appropriate information. Includes well-articulated, innovative, and creative ideas.	1
Organization and Structure	Presentation jumps among disconnected topics; main points unclear Does not contain the information required. Missing introduction and conclusion. Very significantly over or under time.	Main points clearly stated, Introduction and conclusion unclear. Unbalanced in terms of time management – too much time on one topic, too little on another. Significantly over or under time (± 1 minute)	Main points must be inferred by audience; audience can follow presentation, but holes are evident. Timing well organized. Slightly over or under time (± 30 seconds)	Main points clearly stated and explained; logical, smooth organization. Timing well organized. Innovative and effective. On time (5 min)	1
Quality of Visual and Oral Communication	Speaking unclearly or without confidence. Awkward pauses. Text and figures unreadable.	Reading from the slides. Suitable speaking volume, but poor choice of wording(e.g. non-technical or vague). Text and figures are mostly readable but not all are effective.	Audible, understandable, confident and appropriate technical language. Text and figures readable and effective.	Audible, understandable, confident and appropriate technical language. Compelling and convincing. Text and figures readable and effective.	1

Rubrics for Work book

Criteria	Level 1	Level 2	Level 3	Level 4	Score
Clarity	Script is confusing and hard to follow	Script is appropriate and hard to follow	Script is relevant and easy to follow	Script is purposeful and easy to follow	1
Quality of content	Content is undeveloped and does little to sustain the attention of the reader	Provides suitable content that interests the reader	Provides relevant content that engages the reader	Provides pertinent content that captivates the reader	1
Preparation	Student is not adequately prepared; Does not appear to have read the material.	Student has read the material but not closely or has read only come of the assigned material.	Student has read and thought about the material.	Student is consistently well prepared.	1

Rubrics for Viva

Criteria	Level 1	Level 2	Level 3	Level 4	Score
Content Knowledge	Limited understanding of subject matter. Difficulty responding to questions	Basic understanding of subject matter. Adequate response to questions but may lack depth	Solid understanding of subject matter. Responds effectively to questions with adequate depth and clarity	Exceptional understanding of subject matter. Responds proficiently to questions, demonstrating depth of knowledge and critical thinking	1
Critical thinking	Limited ability to analyze or evaluate information. Struggles to make connection between concepts.	Some ability to analyze and evaluate information. Make connections between concepts with some support	Strong analytical and evaluative skills. Makes insightful connections between different concepts or theories	Exhibits exceptional critical thinking skills. Makes sophisticated connections and synthesizes complex ideas effectively.	1
Communication skills	Speaks unclearly or incoherently. Minimal participation	Speaks with some clarity but may lack coherence at times. Adequate participation	Speaks clearly and articulately actively engages in the discussion with appropriate body language	Speaks eloquently and persuasively. Engages deeply in the discussion showing enthusiasm and confidence	1

Rubrics for Lab involvement

Criteria	Level 1	Level 2	Level 3
General Lab Practice	Unaware of general lab practices	Some laxity in good lab practices	Aware of good lab practice
Use of microscope	Errors in both light setting and microscope handling	Errors in light setting or microscope handling	Light setting and focusing are correct
Specimen Preparation	Error in preparation and mounting	Error in preparation or mounting	Good preparation and proper mounting

Rubrics for Record

Criteria	Level 1	Level 2	Level 3
Diagram	Incomplete records	Complete records but with errors in labelling and captions	Complete record with proper labelling and captions /Legends
Punctuality	Delay in timely submission of record sheets	Submission of records on the ensuing day of lab work	Submission on the day of lab work

Appendix

SHORT TERM COURSES

The main objective of the short term courses offered by the college is to supplement the students with various skills and technical know-how outside the structured academic curriculum, to produce quality citizens who are academically proficient, self-reliant and socially committed. The courses have compulsory components and optional components that equip the students to attain various programme objectives envisaged by the Vision and Mission statements of the college.

All Short-Term Courses (STCs) are coordinated by the Department of Short Term Courses, headed by a Director and is supervised by a Vice Principal nominated by the Principal. Each component of the STC is coordinated and managed by a Faculty Convener. The Advisory Board of the Department consists of the Vice-Principals, Director of the Short Term Courses and the various Conveners.

In case of any grievances, students can approach the Grievance Redressal Cell of the STC which consists of the Vice-Principal in Charge, Director and the concerned Convener. If the student feels that the issue was not adequately addressed, he/she can approach the Grievance Redressal Cell of the college. The grading pattern for all courses will be the same as in the UG regulations 2024. The courses offered by the department are given in the following table.

	Name	Semesters	Type	Credit
1	Value Education	I to VI	Compulsory	3
2	Basic Life Support System and Disaster Management (BLS & DM)	I	Compulsory	1
3	Social Awareness Course (SAC)	I and II	Compulsory	2
4	Skill Development Courses (SDC)	II and III	Optional	2
5	Finishing School	III and IV	Compulsory	1
6	Virtual Lab Experiments	V	Optional	1

REGULATIONS FOR SHORT TERM COURSES

VALUE EDUCATION

Value Education is a compulsory extra credit course with three (3) credits for all the students admitted to the undergraduate programmes.

Duration

The duration of the course shall be three academic years (six semesters). There shall be minimum 60 hours spread over three years with 20 hours every academic year.

Evaluation

The evaluation of each course shall contain two parts.

i. Continuous evaluation (every year)
ii. Final evaluation (every year)

There shall be a maximum of 50 marks comprising of forty (40) marks for final evaluation and ten (10) marks for continuous evaluation.

Continuous Evaluation

Component	Marks
Assignment	5
Attendance	5
Total	10

1. **Assignment**

   The students shall submit at least one assignment in every year. The marks for assignment is five (5).

2. **Attendance**

   The minimum requirement of aggregate attendance during a year for appearing the final examination shall be 75%.

Marks for attendance

Maximum of five (5) marks will be given for attendance as follows.

% of Attendance	Marks
90 and above	5
85-89	4
80-84	3
76-79	2
75	1

(Decimals shall be rounded off to the next higher whole number)

Final evaluation

Final evaluation shall be conducted by the course coordinator at the end of every year.

There shall be an annual written examination of one and a half hours (1½) duration with a maximum forty marks (40), every year.

The question paper shall be strictly on the basis of model question paper set by the Expert Committee.

A question paper consists of short answer type, short essay type and long essay type questions.

The total marks of the course (three years combined) shall be one hundred and fifty (150).

Award of certificate

A separate minimum 30% marks each for continuous evaluation and final evaluation and an aggregate minimum of 35% are required for a pass in the course.

If a student does not acquire minimum marks in first and second years, he/she can continue the course.

The student shall be eligible to get certificate only after completing the course with D Grade. On successful completion of the course, the grade awarded will be indicated in the Mark cum Grade Card.

The grading pattern will be the same as in UG Regulations 2024.

The course shall be completed during the tenure of the programme.

BASIC LIFE SUPPORT SYSTEM AND DISASTER MANAGEMENT (BLS & DM)

- The main objective of this course is to provide intensive training on Basic Life Support System and Disaster Management with the help of professional trainers and adequate numbers of mannequins and kits for imparting the training to students.
- This course is compulsory for all the undergraduate students of this college and has one (1) credit.
- The course on BLS & DM shall be conducted by a nodal centre created in the College.
- Each student shall undergo five (5) hours of hands-on training in BLS & DM organised by the Centre for BLS & DM.
- After the completion of the training, the skills acquired shall be evaluated using an offline/online test and grades shall be awarded.
- Nodal Centre for BLS & DM shall conduct an online test and publish the results.

- Students who could not complete the requirements of the BLS & DM training shall appear for the same along with the next batch.
- The grading of the course is as per the grading pattern in UG Regulations 2024.

SOCIAL AWARENESS COURSE (SAC)

- The aim of SAC is to make students aware of the problems that different societies and communities face on a day-to-day basis and to be conscious of the difficulties and hardships of society.
- This is a compulsory course with two (2) credits.
- Social Awareness Course shall be conducted by a nodal centre consisting of the convenor, other faculty members nominated by the Principal.
- The centre shall identify the areas where the students can serve the society through the course.
- During the first semester itself, the centre shall organise activities to sensitize the students about the significance and relevance of Social Awareness and publish a list of different areas where they can work as volunteers.
- The centre shall allot students to various areas based on their preference.
- Students shall carry out the voluntary work allotted to them after the regular class hours/weekends/holidays falling in the first and second semesters and the summer vacation following the second semester.
- Evaluation of the SAC activity shall be based on the hours of work put in by a student. A minimum of 50 hours of social work (corresponding to 50 marks) is required for the successful completion of the course. Every additional work beyond the minimum 50 hours shall fetch five (5) marks per hour. Maximum marks shall be 100.
- Students who donate blood during the first year shall be given 10 marks on production of the certificate from the medical officer. However, marks earned through blood donation shall not be counted for a pass in the course. Mark for blood donation shall be awarded only once during the SAC.
- Two credits shall be awarded to students who complete the requirements of SAC.
- The grading will be as per the grading pattern in the UG Regulations 2024.
- Students who could not complete the requirements of the SAC shall appear for the same with the next batch.
- The Director of Short-Term Courses and Convenor of SAC has the right to exclude students who are physically challenged from SAC, if requested.

SKILL DEVELOPMENT COURSES (SDC)

- This is a compulsory component of STC with two (2) credits.
- SDC's shall be completed within the first four semesters of the programme.
- Depending on the nature of the course, there will be a theory component and a skill development component.
- The credit will be awarded only if the student gets a D grade (35% marks) and above.
- A student can do a maximum of three skill Development Courses according to his/her choice, but pass in at least one course is compulsory.
- The Convenor of SDC will coordinate the course.
- The Head of the Department concerned in consultation with the faculty members may prepare a syllabus for the SDC, which will be approved by the Board of Studies concerned.

Evaluation of SDC

The evaluation the course shall be done internally and contain two parts.

i. Continuous evaluation
ii. Final evaluation

Both continuous evaluation and final evaluation shall be carried out using indirect grading. The marks for continuous evaluation is twenty (20) and that of the final evaluation is eighty (80).

Continuous evaluation

The components of the continuous evaluation and their marks are as below.

For all courses, without practical

There are two components for continuous evaluation, which include attendance and assignment. All the components of the continuous evaluation are mandatory.

Component	Marks
Attendance	5
Assignments	15
Total	**20**

Marks for attendance

Minimum 75% attendance is compulsory for attending the final examination.

% of Attendance	Marks
90 and above	5
85 - 89	4
80 – 84	3
76 – 79	2
75	1

(Decimals shall be rounded mathematically to the nearest whole number)

For all courses with practical

The components for continuous evaluation of courses with practical are given below.

Component	Marks
Attendance	5
Lab/skill work involvement	15
Total	**20**

Assignments

At least one assignment shall be submitted for the course.

Final evaluation

The final evaluation of theory and practical courses shall be conducted by the office of the Controller of Examinations. It can be in the form of 80 marks written examination or 80 marks project/practical examination or 80 marks written and project/practical examination combined, as decided by the Board of Studies concerned.

FINISHING SCHOOL

- It is a compulsory course with one (1) credit.
- The course provides compulsory training for all under graduate students of this college.
- The training is to help students develop their soft skills and interview skills.
- The training shall impart soft skills comprising of language skills, personal presentation and grooming, table manners, resume preparation, group discussion techniques, and interview skills among the undergraduate students.
- This course shall be conducted during the third and fourth semesters for all the undergraduate students.

- There will be a total of 20 contact hours which shall be handled by a team of professional members/faculty. In addition, a one-day outbound training session by a team of professional trainers that touches on the aspects of creativity, problem solving and team building shall also be organized.
- The students shall be assessed on the basis of the components given below.

Component	Marks
Attendance	5
Aptitude Test	10
Assignments	10
Group discussion	10
Interview	15
Total	**50**

Marks for attendance

Maximum of five (5) marks will be given for attendance as follows.

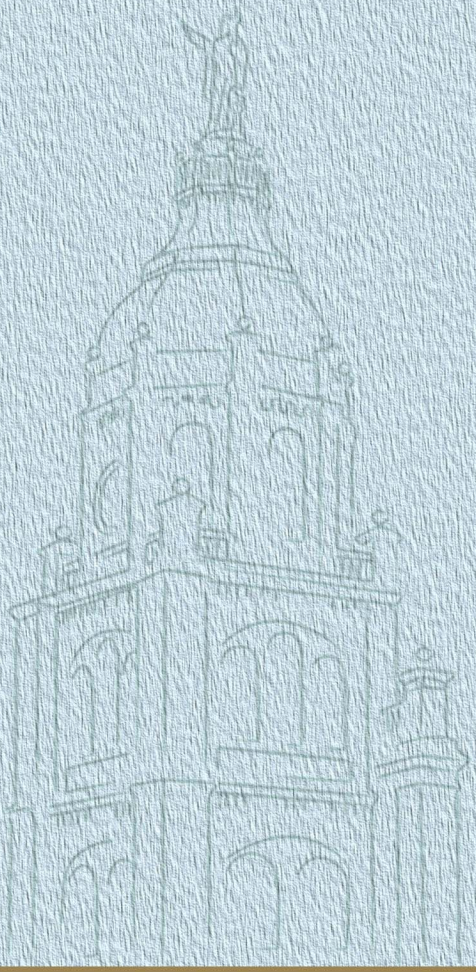
% of Attendance	Marks
90 and above	5
85-89	4
80-84	3
76-79	2
75	1

(Decimals shall be rounded off to the next higher whole number)

Grades will be awarded as per grading pattern in UG Regulations 2024.

VIRTUAL LAB EXPERIMENTS

- This is an optional course with one (1) credit.
- The main aim of the Virtual Lab Experiments is to provide remote-access to simulation-based Labs in various disciplines of Sciences which enthuse students to conduct experiments by arousing their curiosity.
- The Convenor will coordinate the Virtual Lab component and he may use the services available in different virtual lab platforms after the approval of the advisory body.
- Students have to do at least 36 hours of experiments and they get a maximum of one credit for this.
- Convenor and the mentor of the student shall oversee the progress and assign grades as per the grading pattern in UG Regulations 2024 after the completion of the programme.



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